Lincoln University

Te Whare Wānaka o Aoraki

AOTEAROA • NEW ZEALAND

Climate change - Pastoral Responses

27 June 2019

U3A - Dunedin

(Session A)

Professor Derrick Moot

Introduction

- Climate change
- Dairy industry response
- Dryland farming response
- Port Hills fire – recovery and response
- Forestry –saviour of sinner?

Photo: S Larsen
Lincoln University

85 post grads + 40 visiting interns/scholars

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.

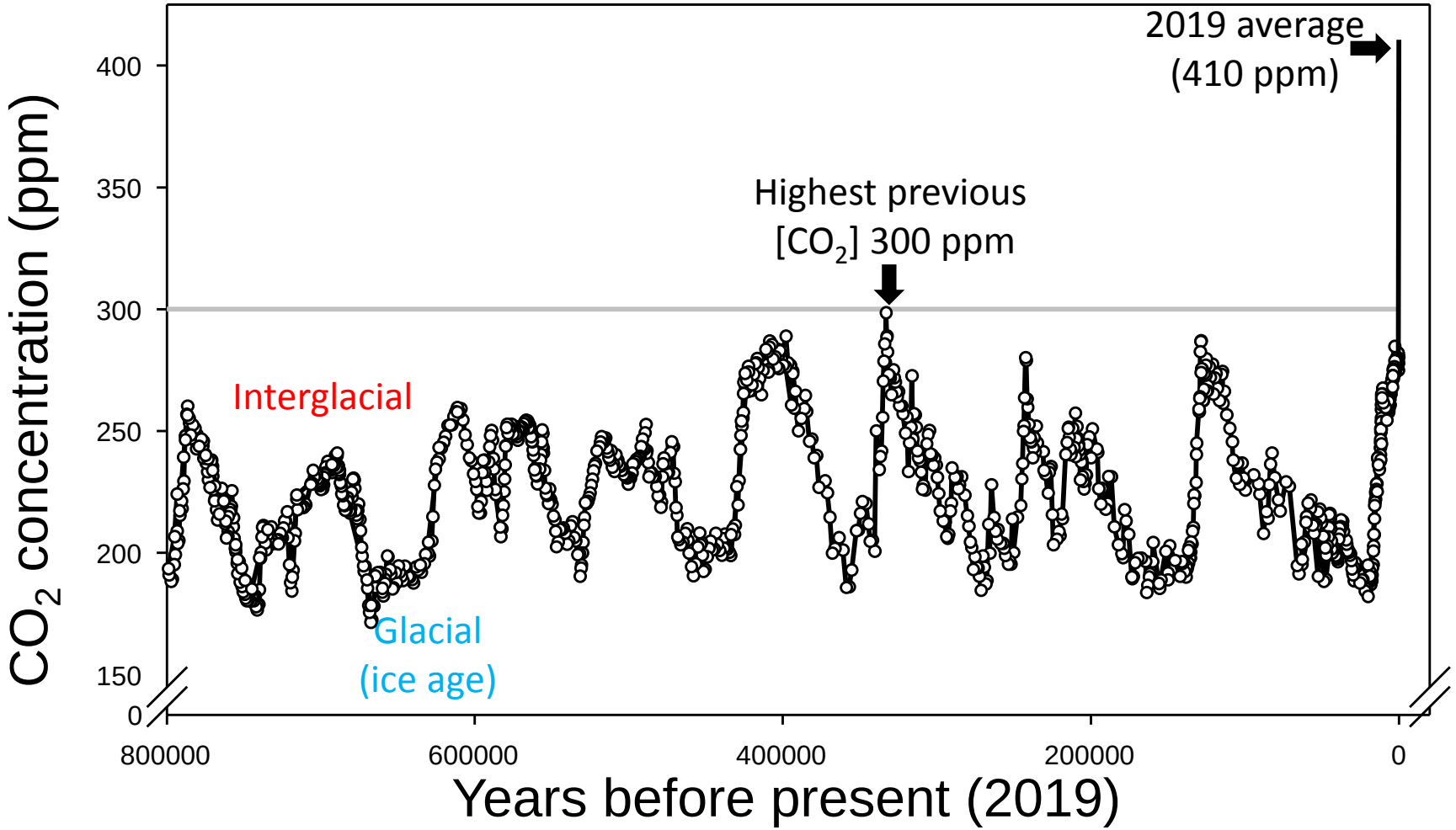
Value of support

Value of good data

The Village Pub

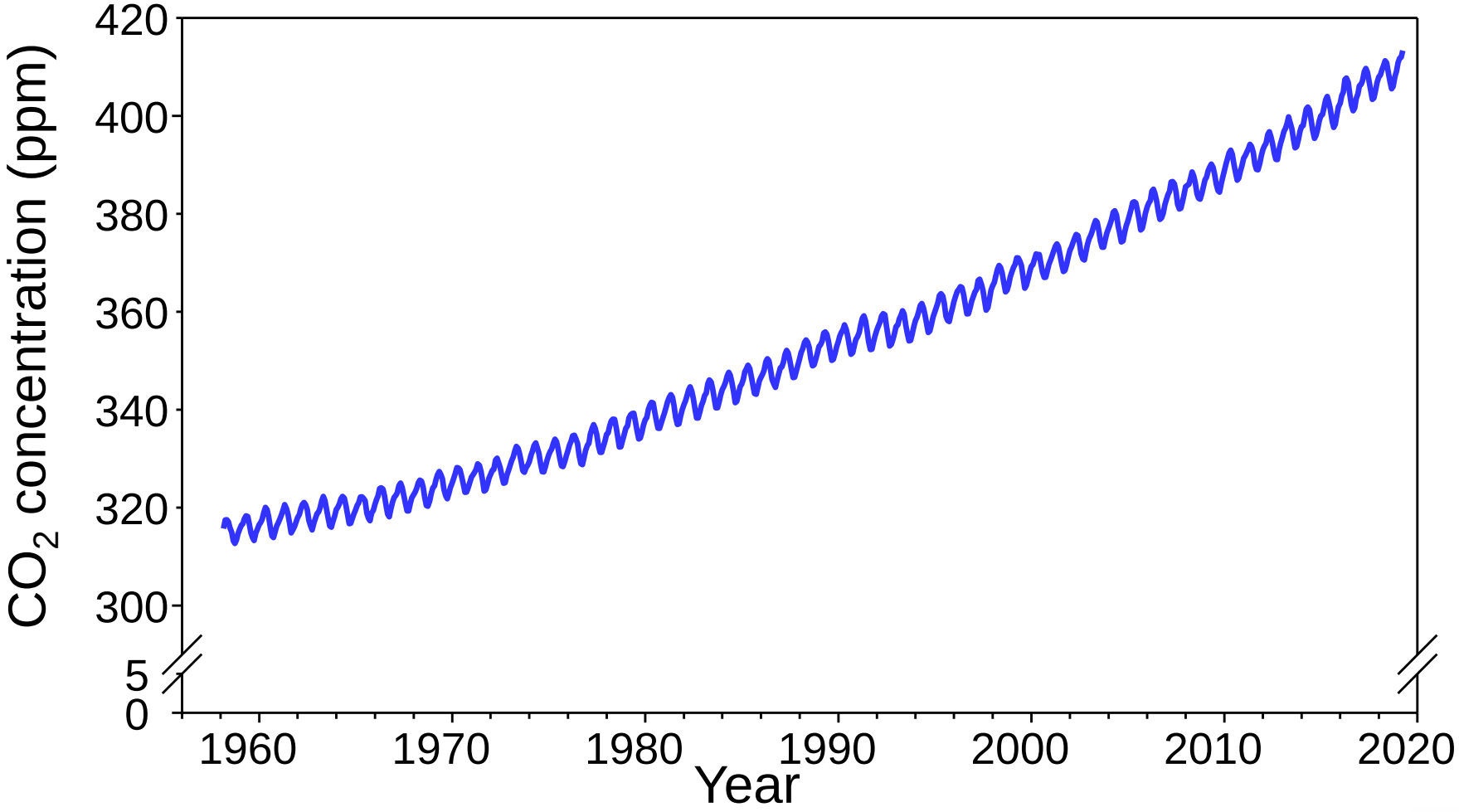
Roger Protz *and* Homer Sykes

CO_2 concentrations over the last 800 000 years



Updated from Lindsey, R. 2018. https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide with data sourced from NOAA Climate.gov, based on EPICA Dome C data (Lüthi *et al*., 2008) provided by NOAA NCEI Paleoclimatology Program and https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/state-of-the-climate/.

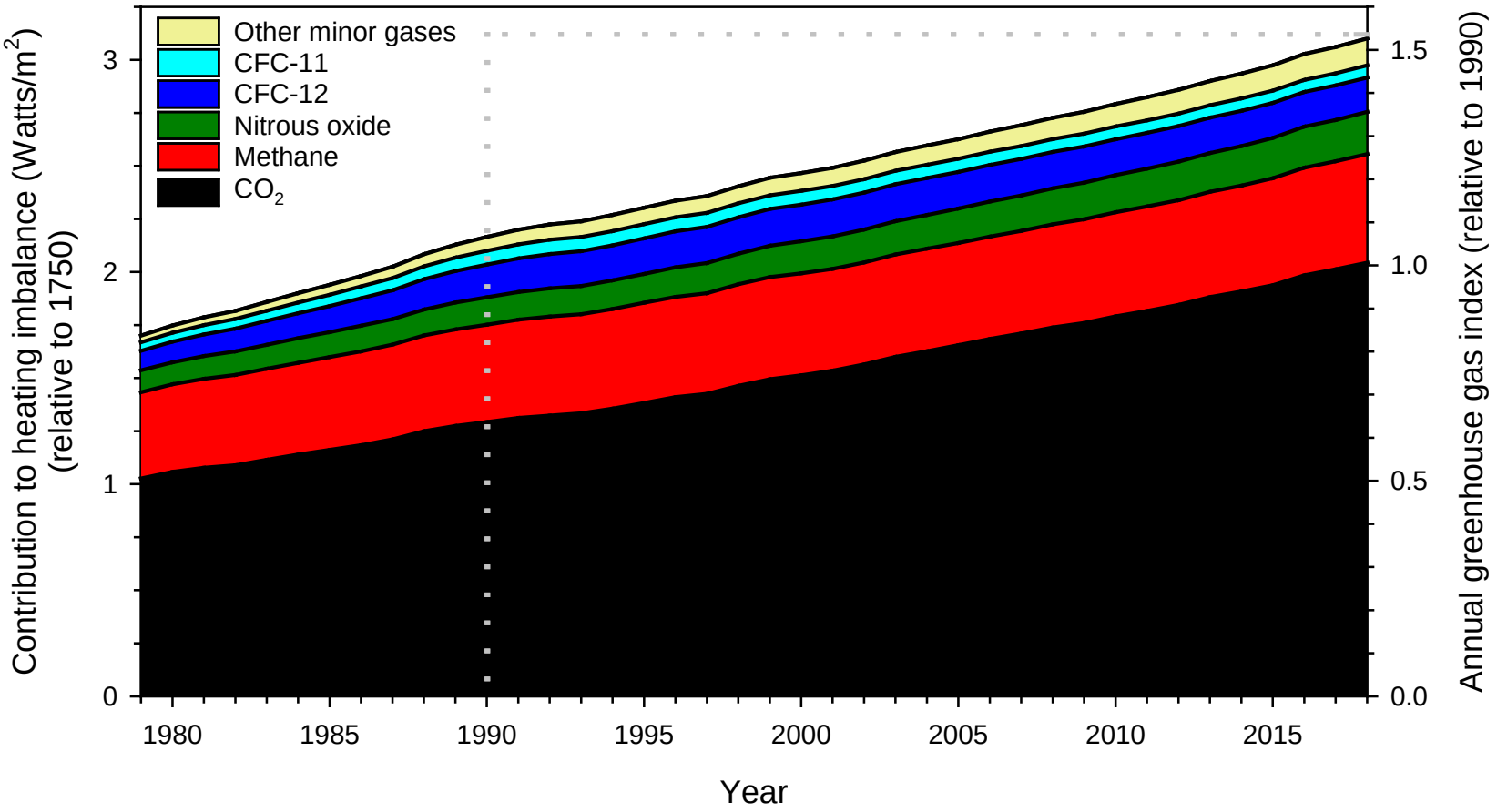
CO_2 concentration at Mauna Loa, Hawaii



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)

Influence of all major human-produced greenhouse gases (1979-2018)



Heating imbalance (Watts/m^2) relative to the year 1750 caused by all major human-produced greenhouse gases: carbon dioxide, methane, nitrous oxide, chlorofluorocarbons 11 and 12, and a group of 15 other minor contributors. Today's atmosphere absorbs about 3 extra watts of incoming solar energy over each square meter of Earth's surface. According to NOAA's Annual Greenhouse Gas Index (right axis) the combined heating influence of all major greenhouse gases has increased by 43% relative to 1990. NOAA Climate.gov graph, based on data from NOAA ESRL (graph re-created and updated from R. Lindsey 2018 https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide (accessed 28/5/2019).

Main recommendations

To meet WHO air quality standards by 2005

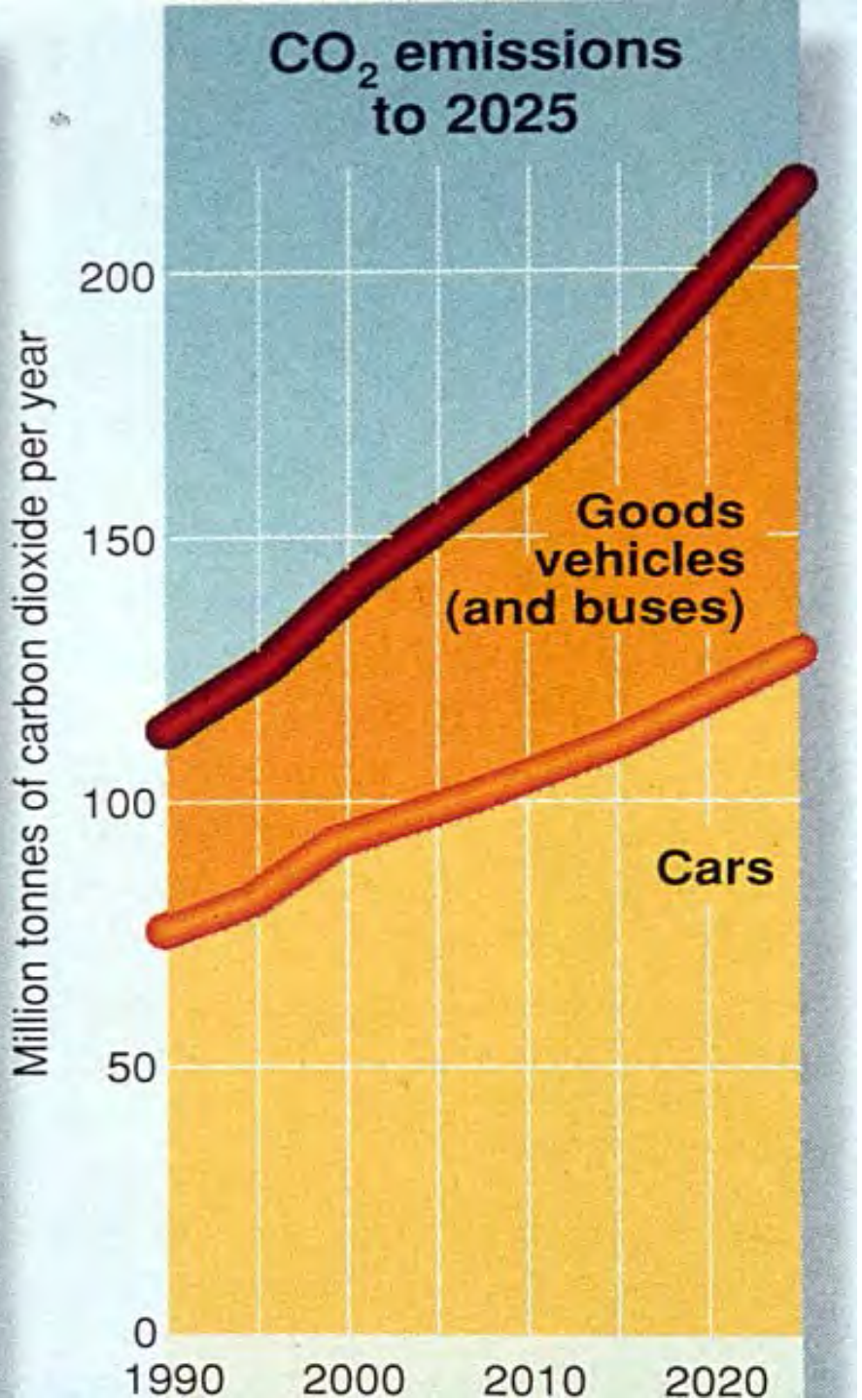
To improve the fuel efficiency of new cars by 40 per cent by 2005

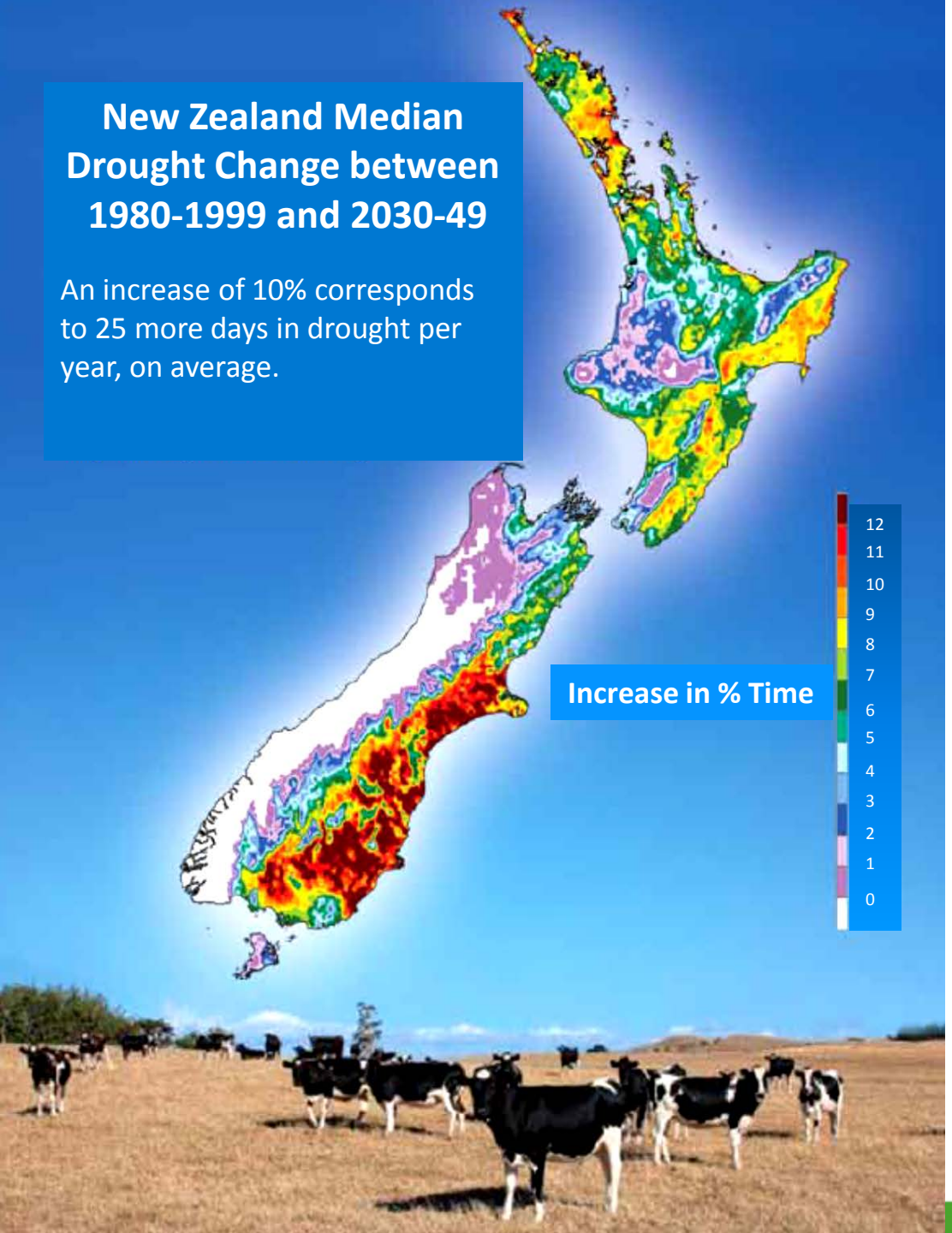
A doubling of the price of petrol by 2005

To cut emissions of carbon dioxide to 80 per cent of the 1990 levels by 2020

To increase the proportion of rail freight from 6·5 per cent to 10 per cent by the end of the century and to 20 per cent by 2010

To tax aircraft fuel





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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

“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

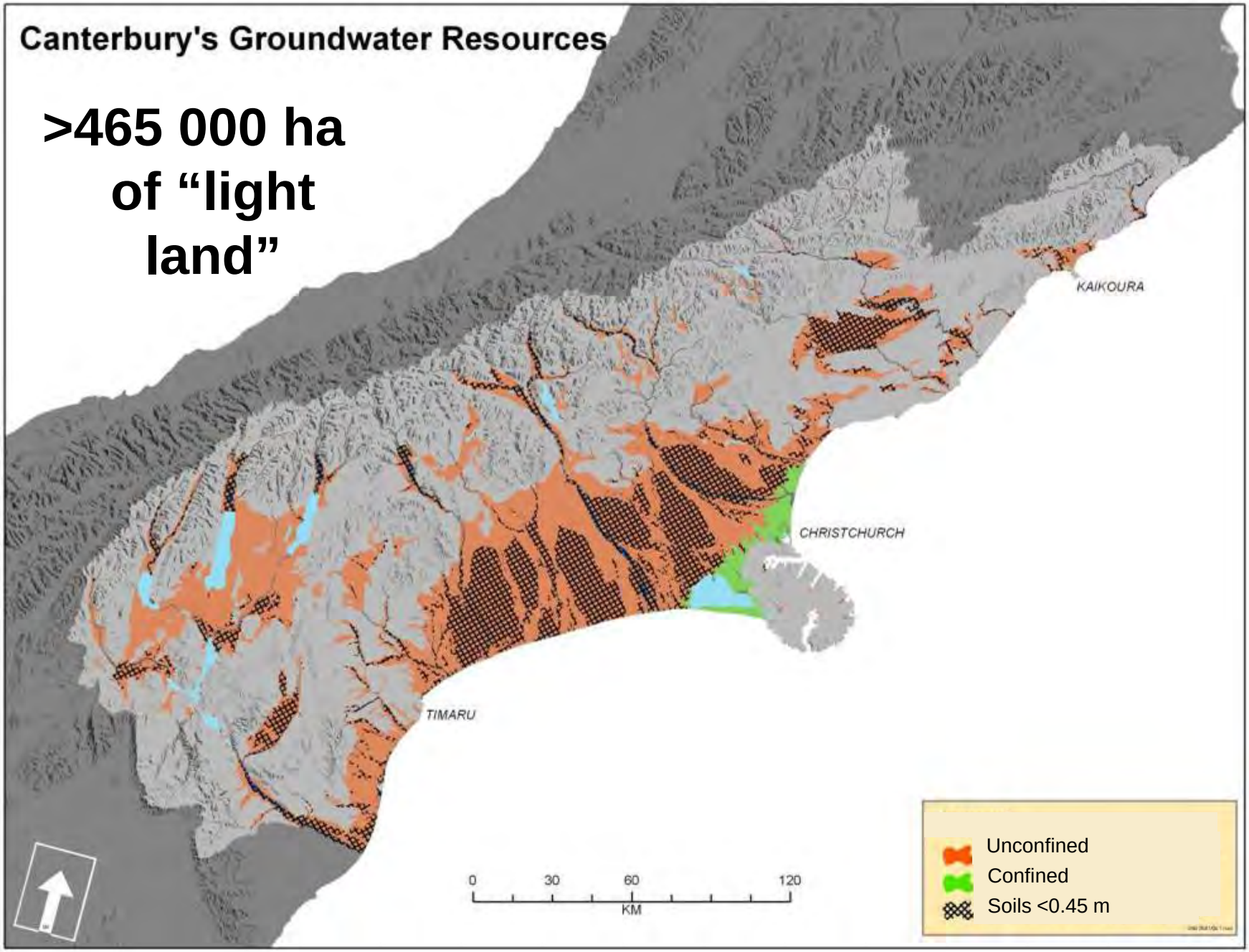
By 2030 - Drier:

Drought – increased duration and frequency

Photo: DJ Moot
Lincoln University

Photo: DJ Moot
Lincoln University

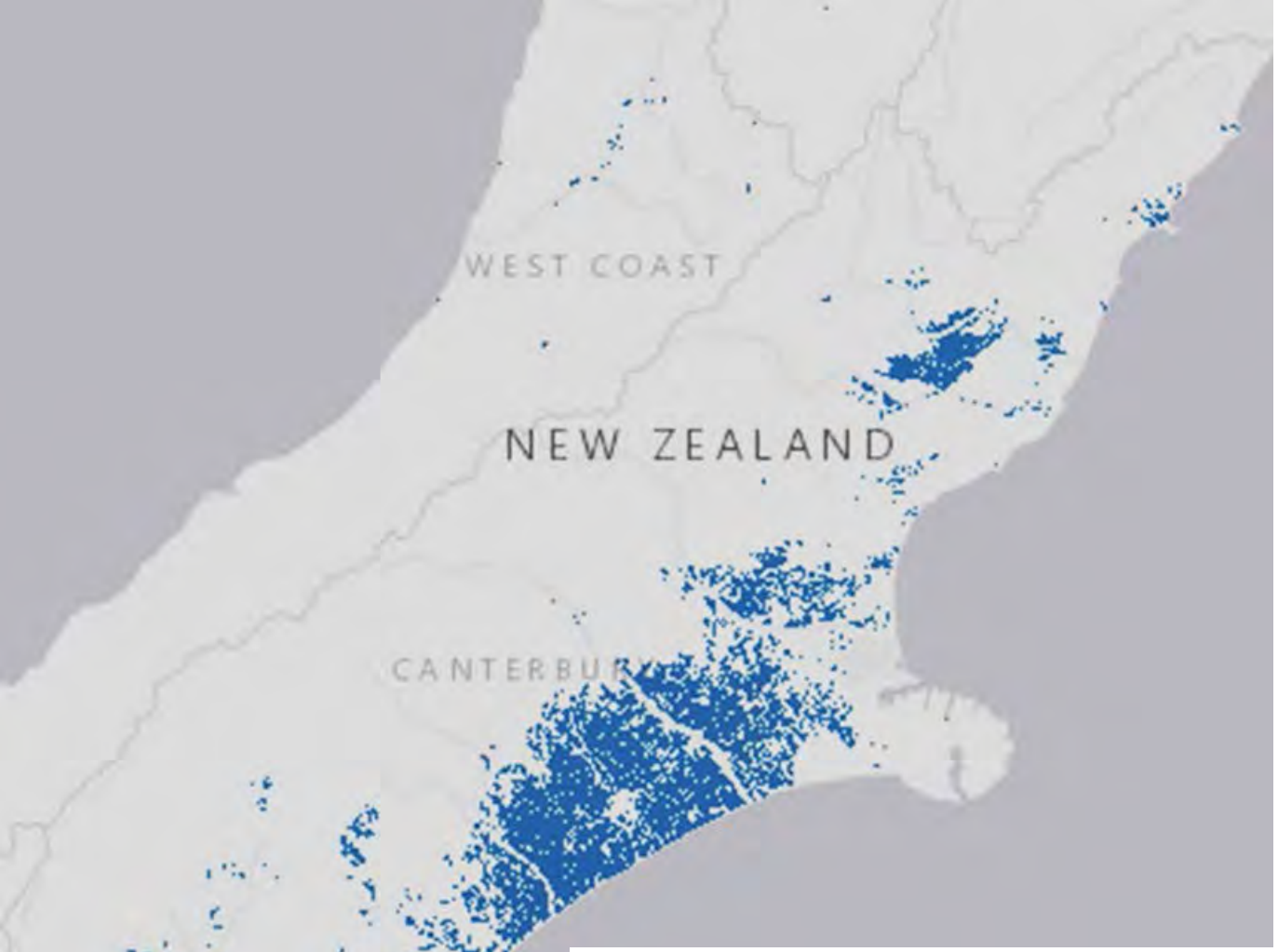
New Zealand's specialist land-based university



Source: Ken Taylor ECan

Abundant aquifer water = 500,000 ha irrigated dairy

Photo: Dr WR Scott
Lincoln University



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Irrigated land 2015-2017

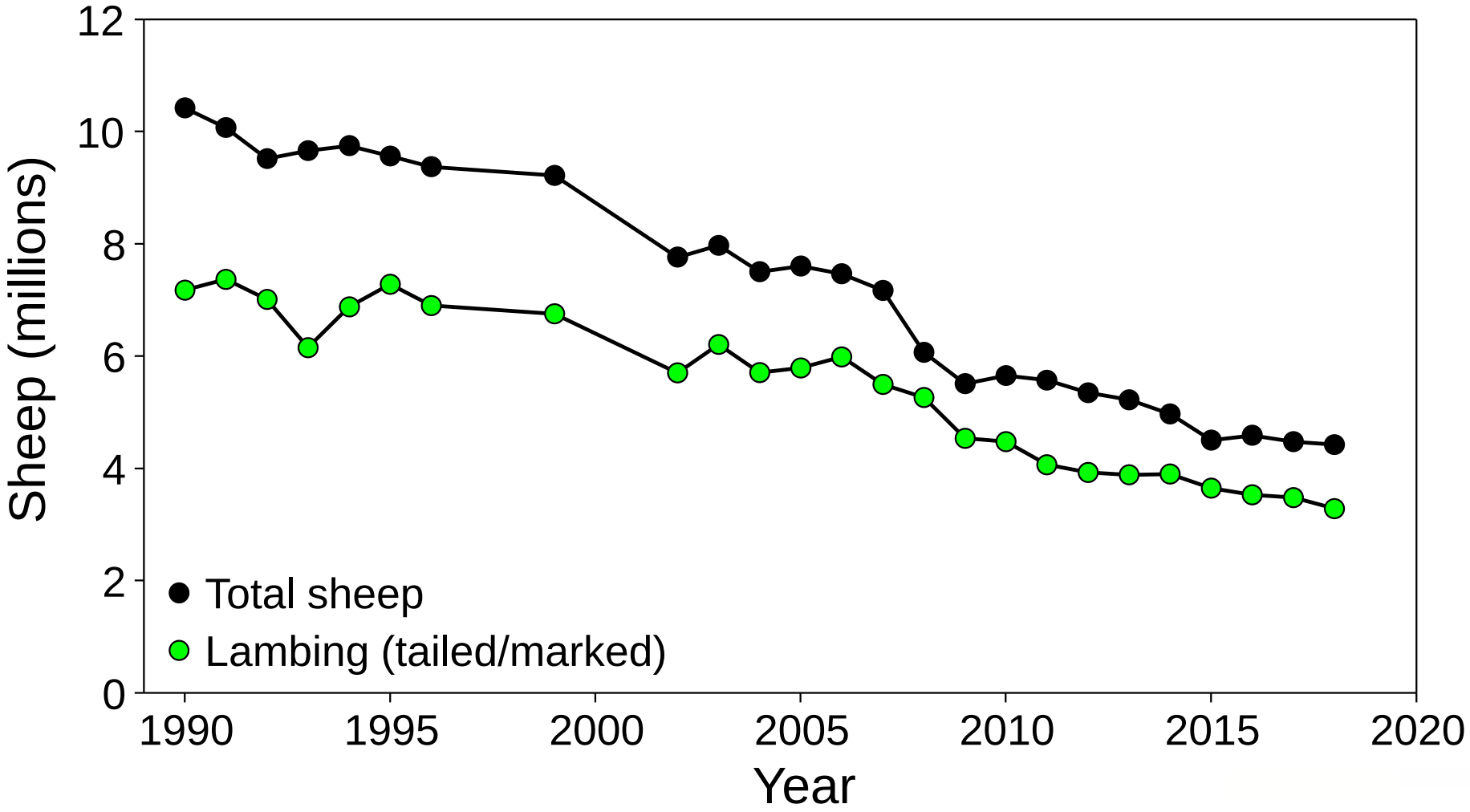
Source: https://statisticsnz.shinyapps.io/irrigated_land/
Accessed: 18/9/2018

In 2017

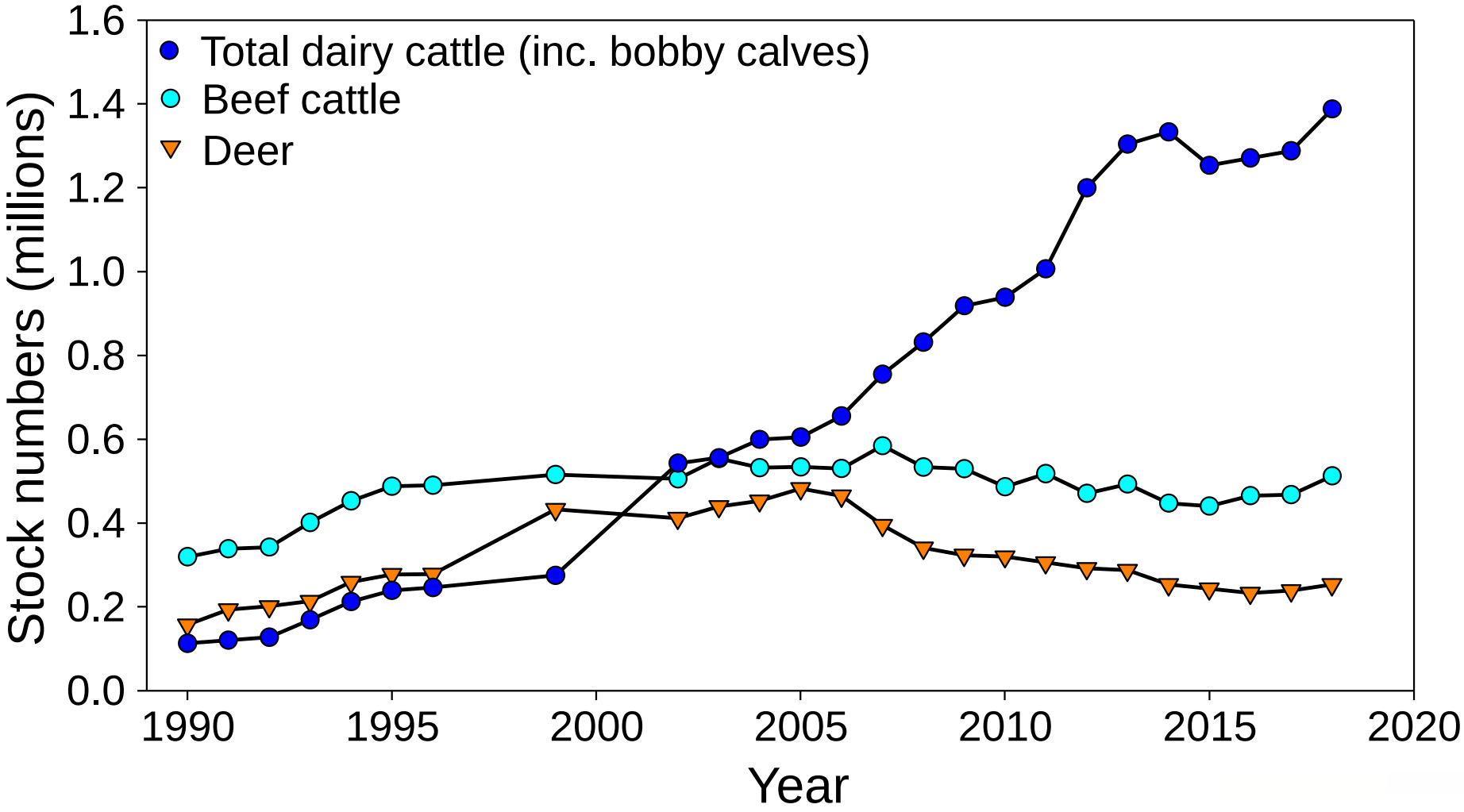
Irrigated land covered 3% (˜795 000 ha) of NZ's land area.

Most was in Canterbury (63.8% or 507,420 ha).

Sheep numbers in Canterbury



Cattle & Deer numbers in Canterbury



Dairying in Canterbury

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

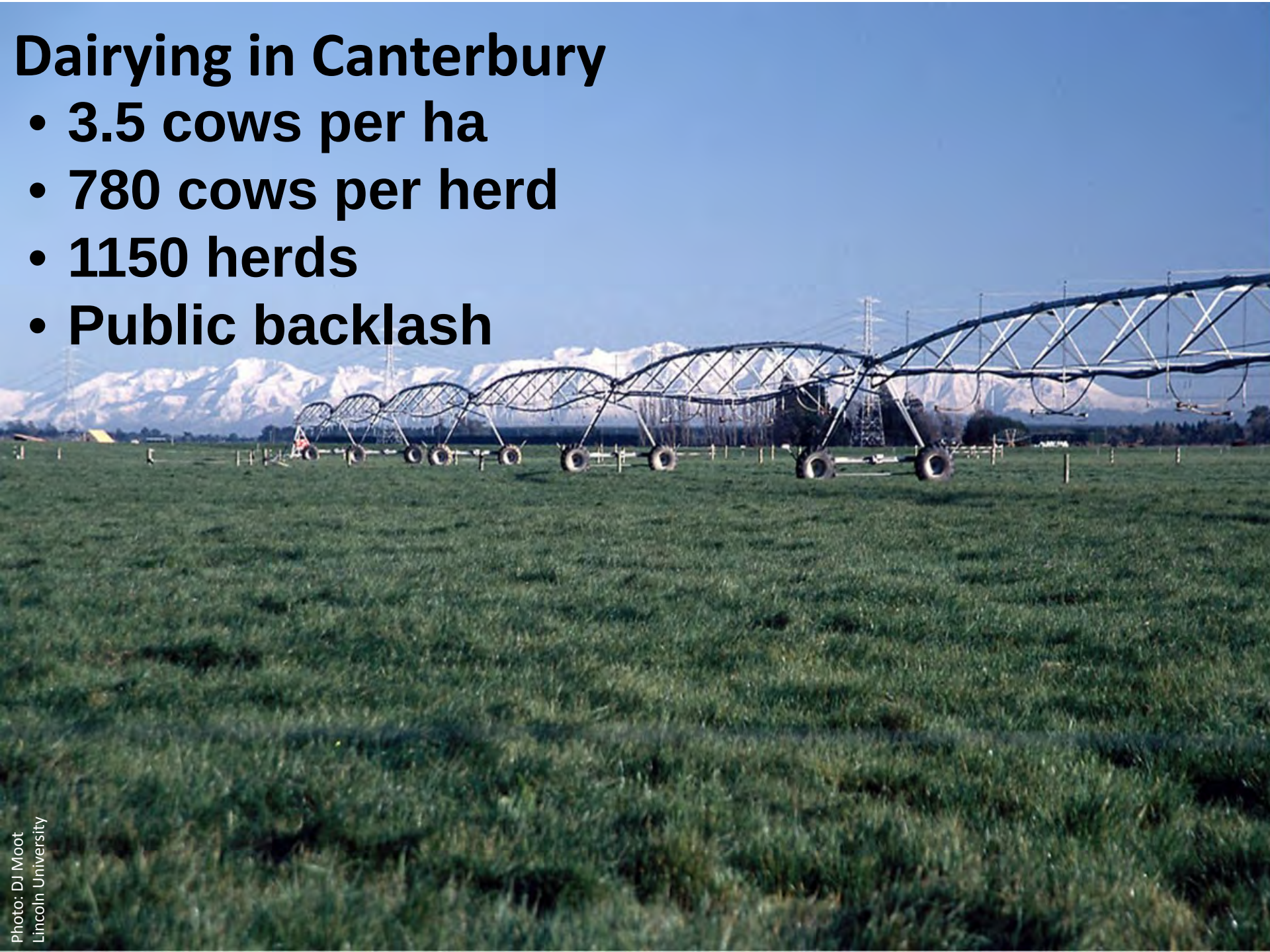


Photo: DJ Moot
Lincoln University

THE PRESS, Christchurch

The shame of our dying lowland waterways

The Timaru Herald

Warning on dairying dangers

Dairying killing fish, say anglers

'Clean and green image at risk'

by Seth Robson

Canterbury's reputation as a fishing paradise is under threat from farm pollution killing fish in rivers, fishermen say.

Canterbury rivers in crisis, say anglers

by Seth Robson

Problems in the Avon and Heathcote rivers are symptomatic of a crisis in Canterbury's lowland waterways caused by modern farming methods, say anglers.

MAF rejects anglers' dairy claim

by Lois Watson

The Ministry of Agriculture and Forestry (MAF) disputes claims that the growth of dairying in Canterbury is contributing to the decline in the quality of the region's waterways.

Pollution predictions disputed

By Lindsay Mutch
Staff Reporter

Claims salmon and dairy farming will become major pollution problems for South Canterbury were yesterday decried by Agriculture Minister Jim Sutton and a local man who farms both fish and cows.

Pollution claim 'unfair' to farmers

by Lois Watson

Dairy farmers deny that effluent from their farms is to blame for the poor state of South Island fishing rivers.

Public concern about agriculture's effect on water…

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Experiment site

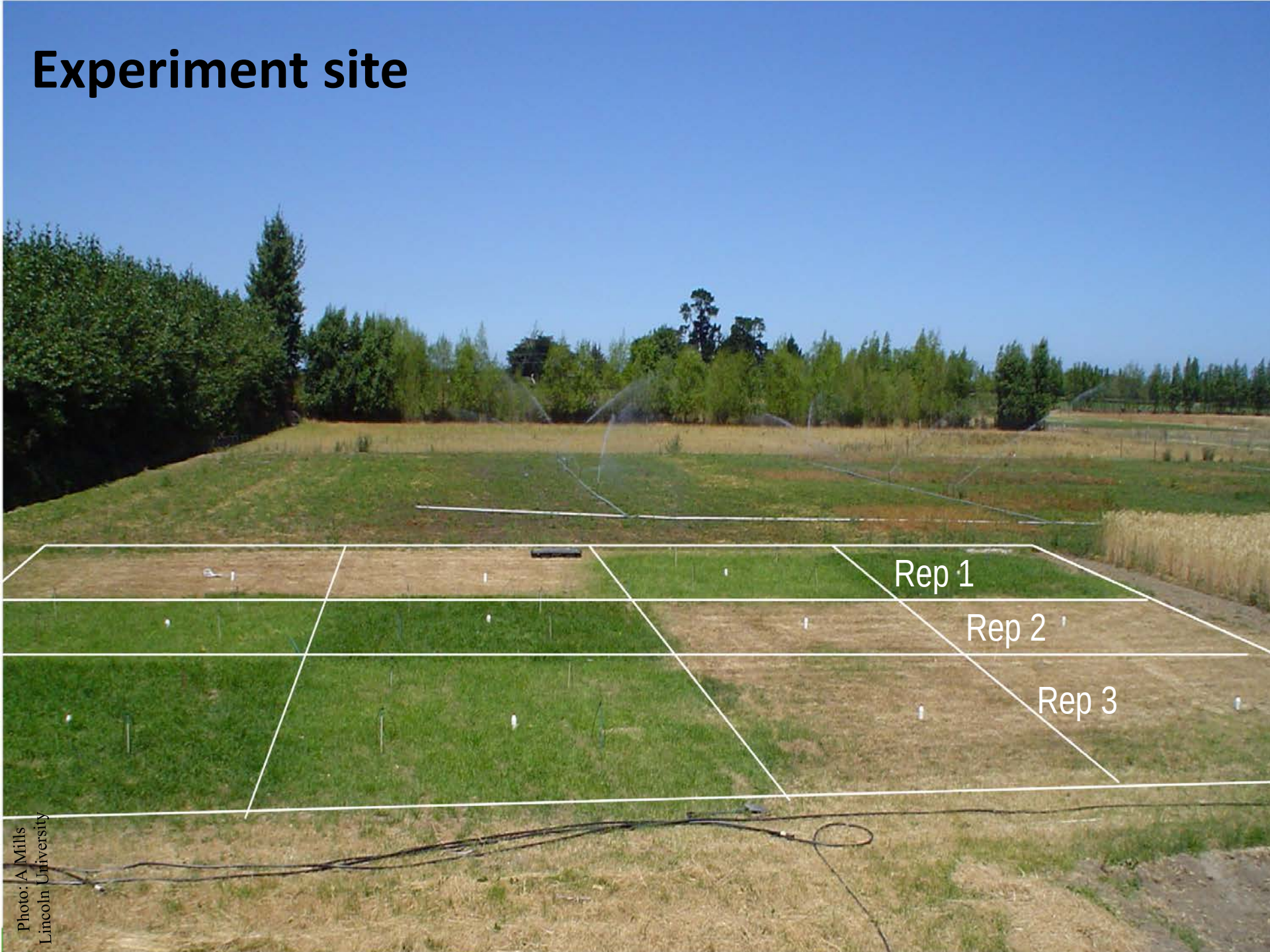
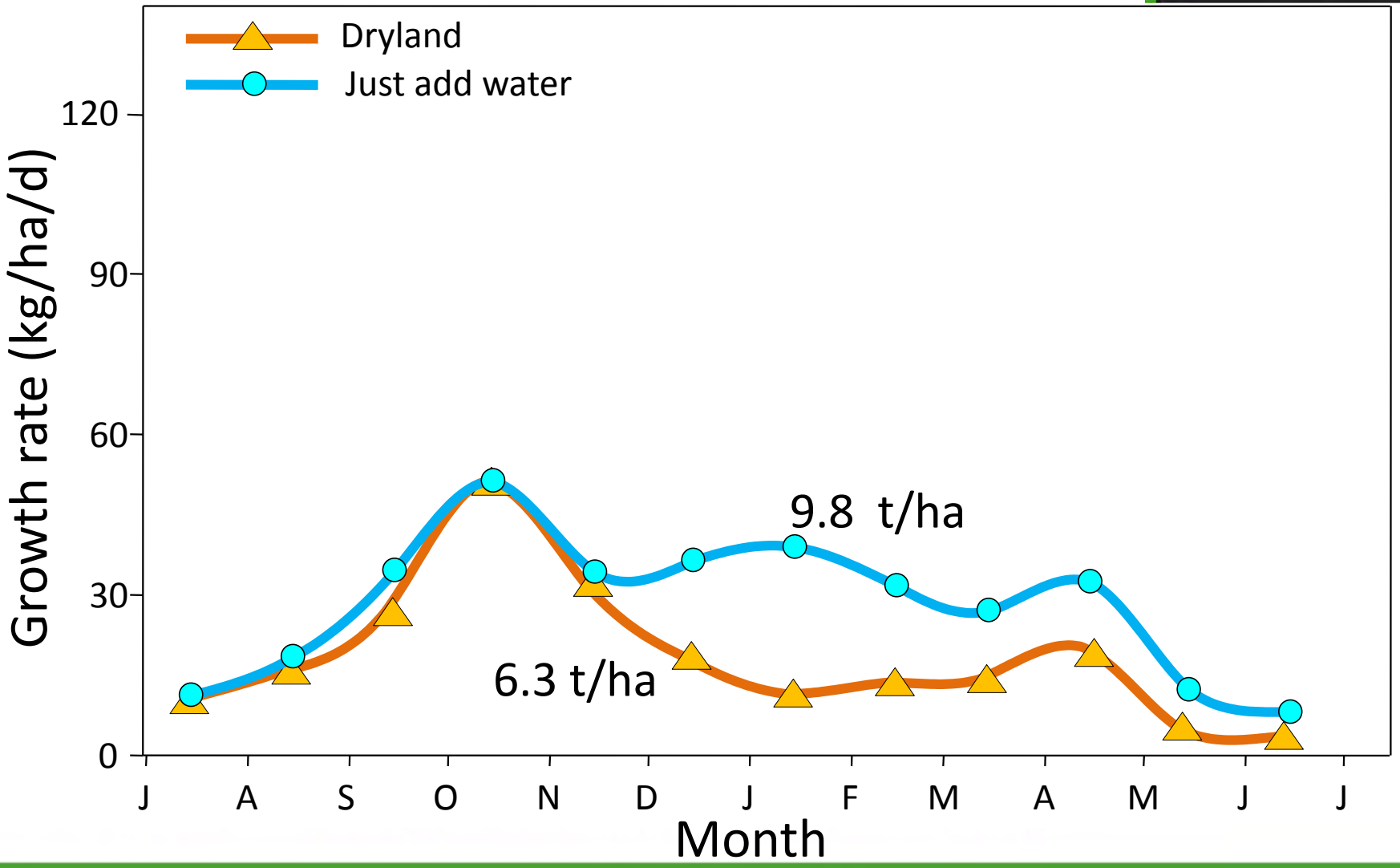


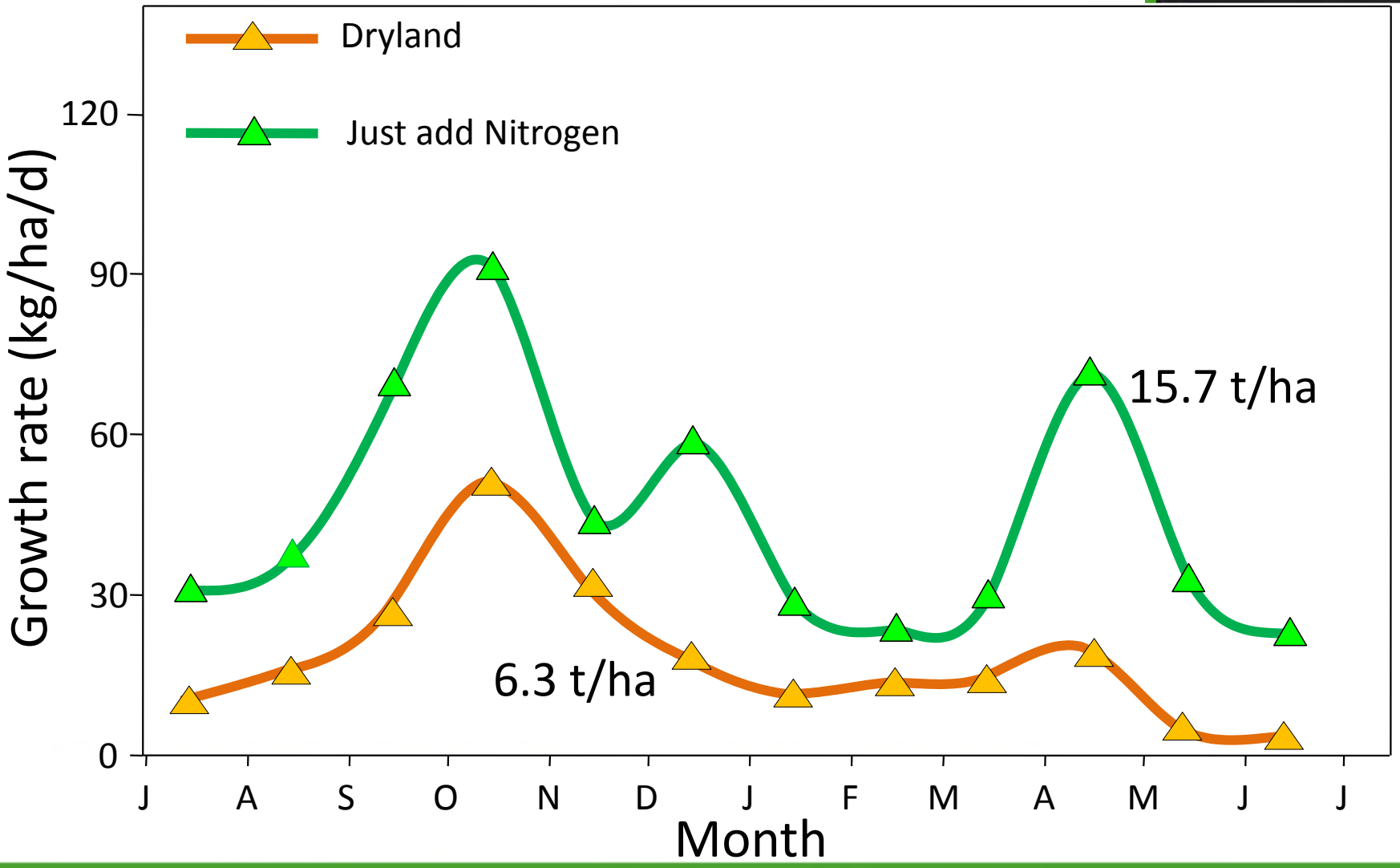
Photo: A Mills
Lincoln University

Growth rates (2 year means)



Mills *et al*. 2006, 2009

Growth rates (2 year means)



Mills *et al*. 2006, 2009

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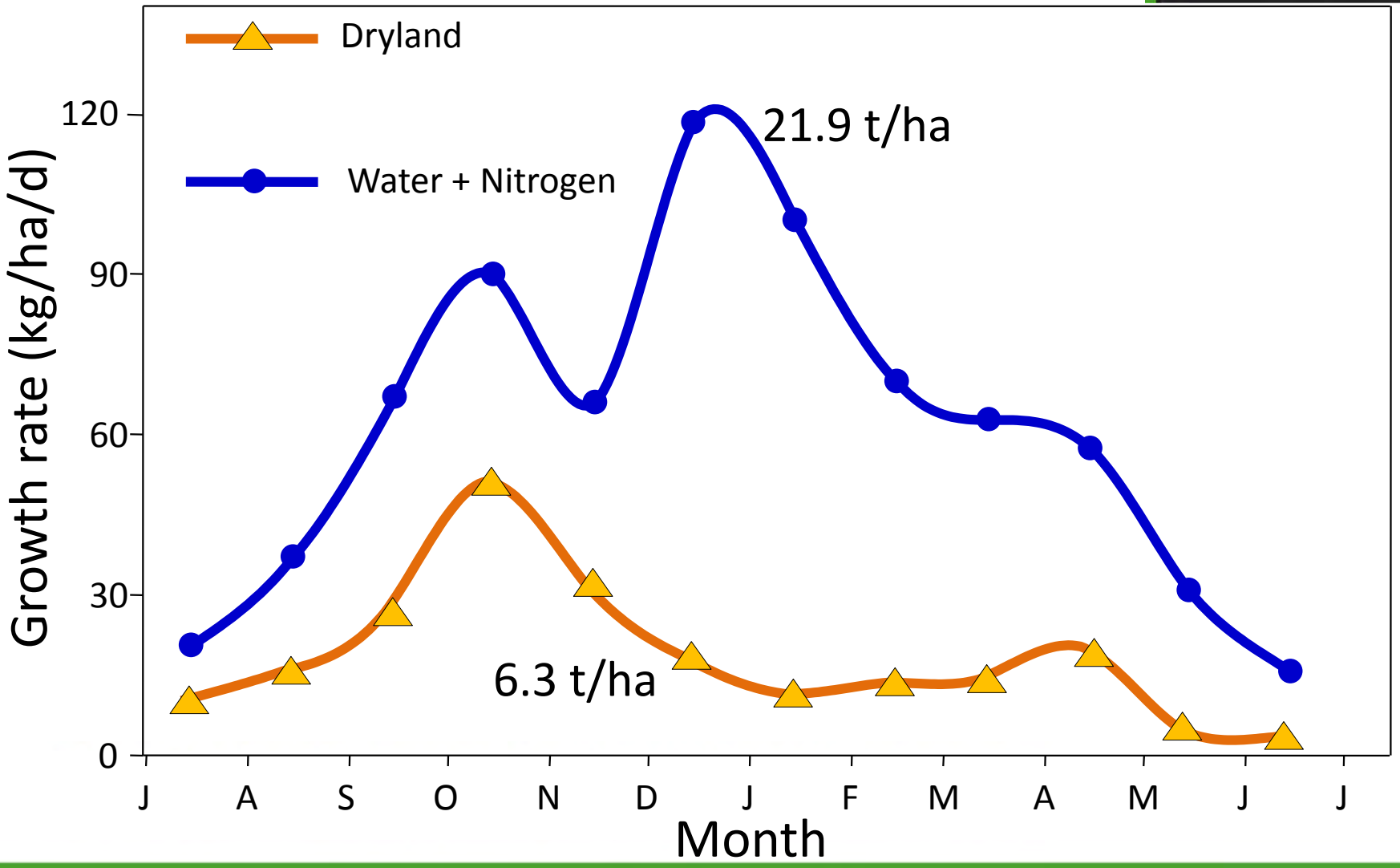

Mills *et al*. 2006, 2009

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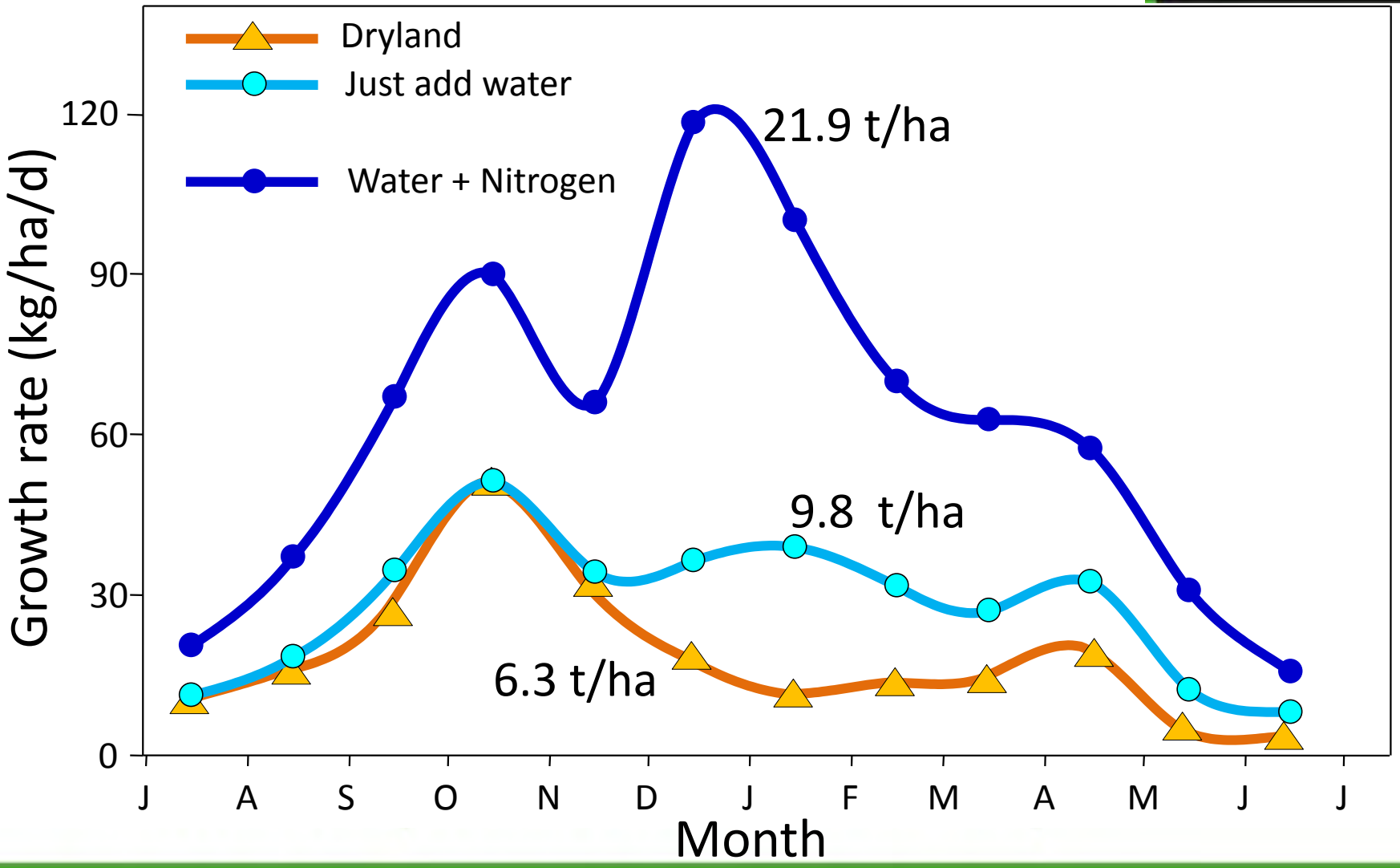
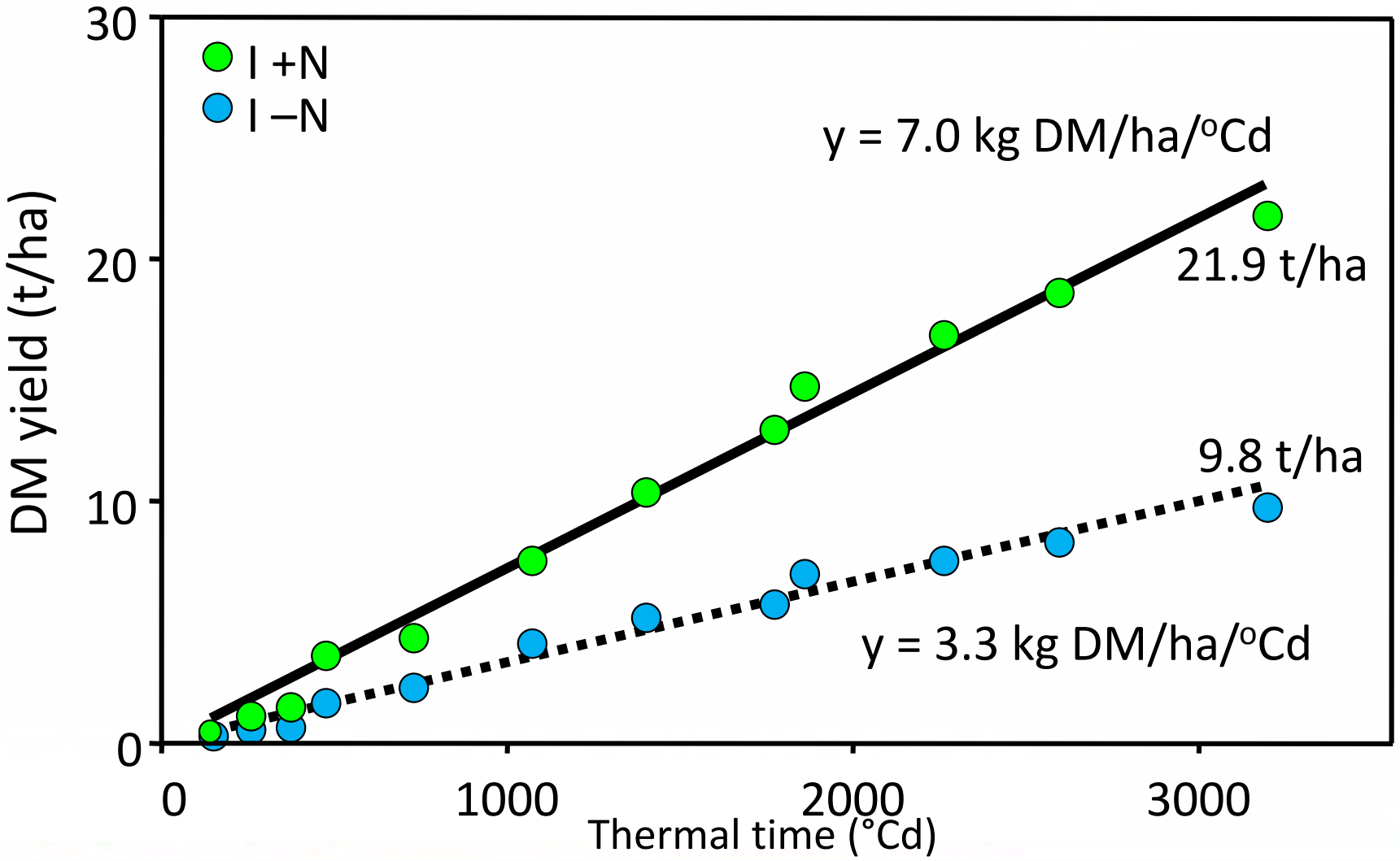
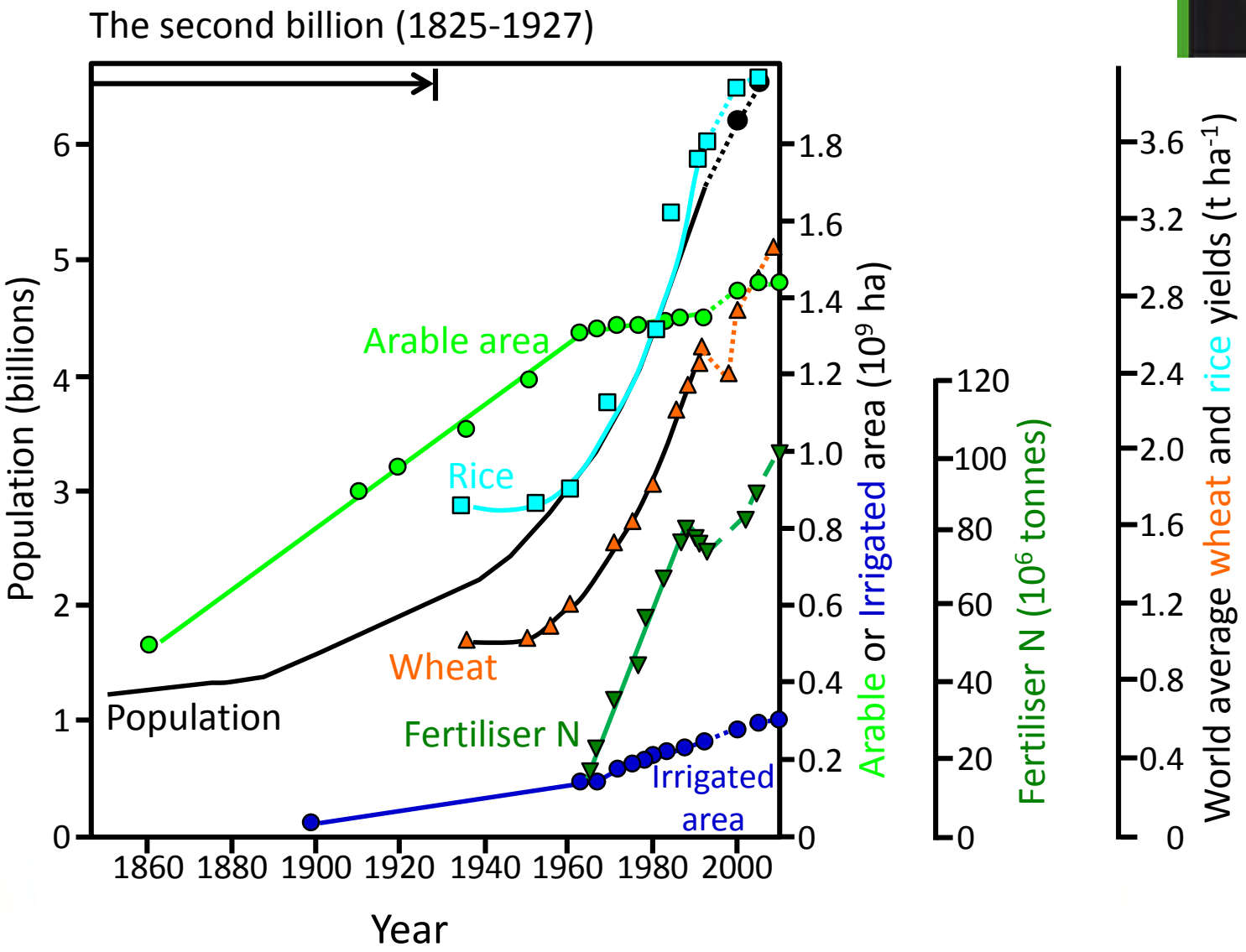


Mills *et al*. 2006, 2009

The Nitrogen gap



Mills *et al*. 2006; 2009



Redrawn from Evans 1998 (solid), modified & updated by M.K. van Ittersum (2011; dotted) & FAOSTAT (N use; dashed; 2019)

Nitrogen dilution curve

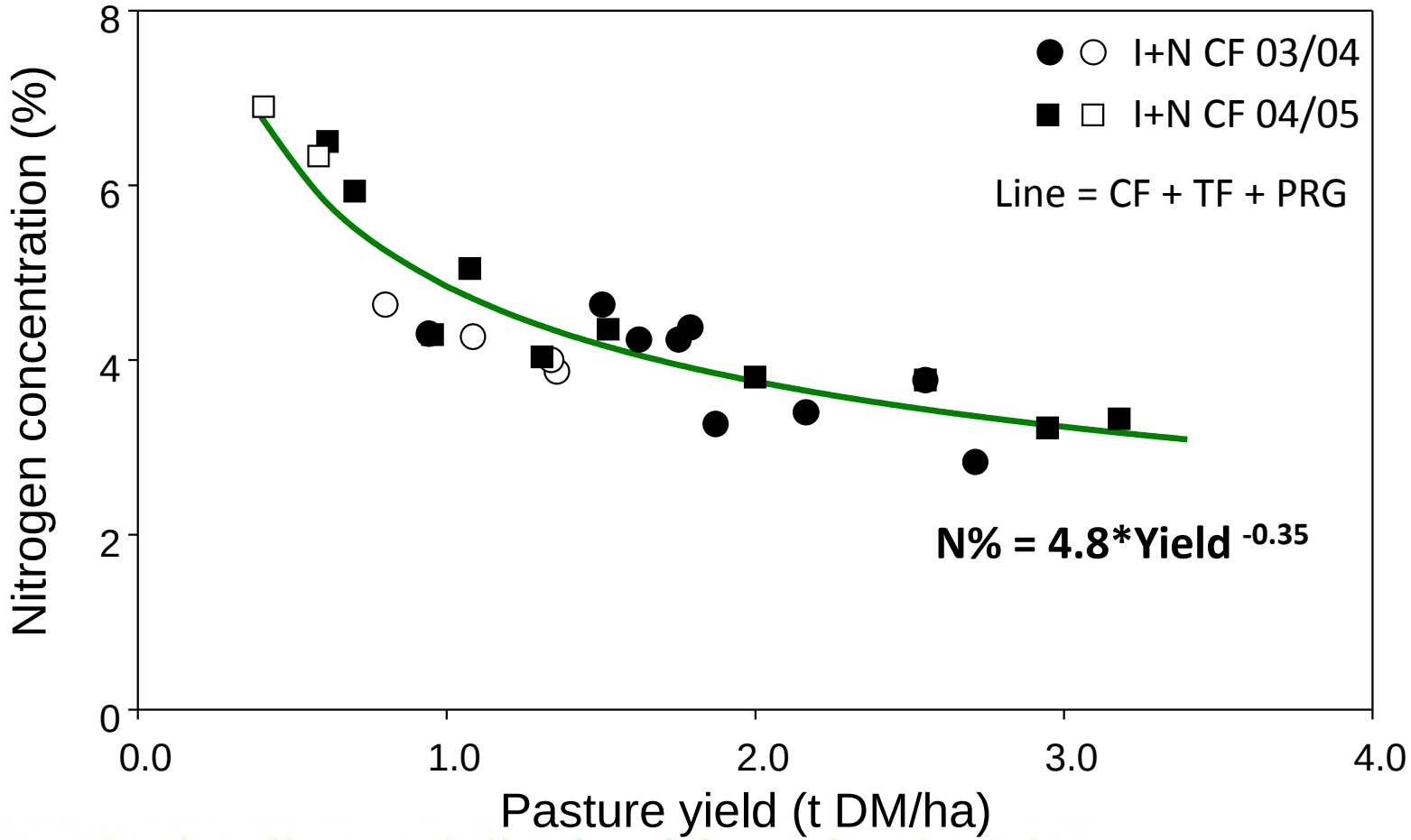
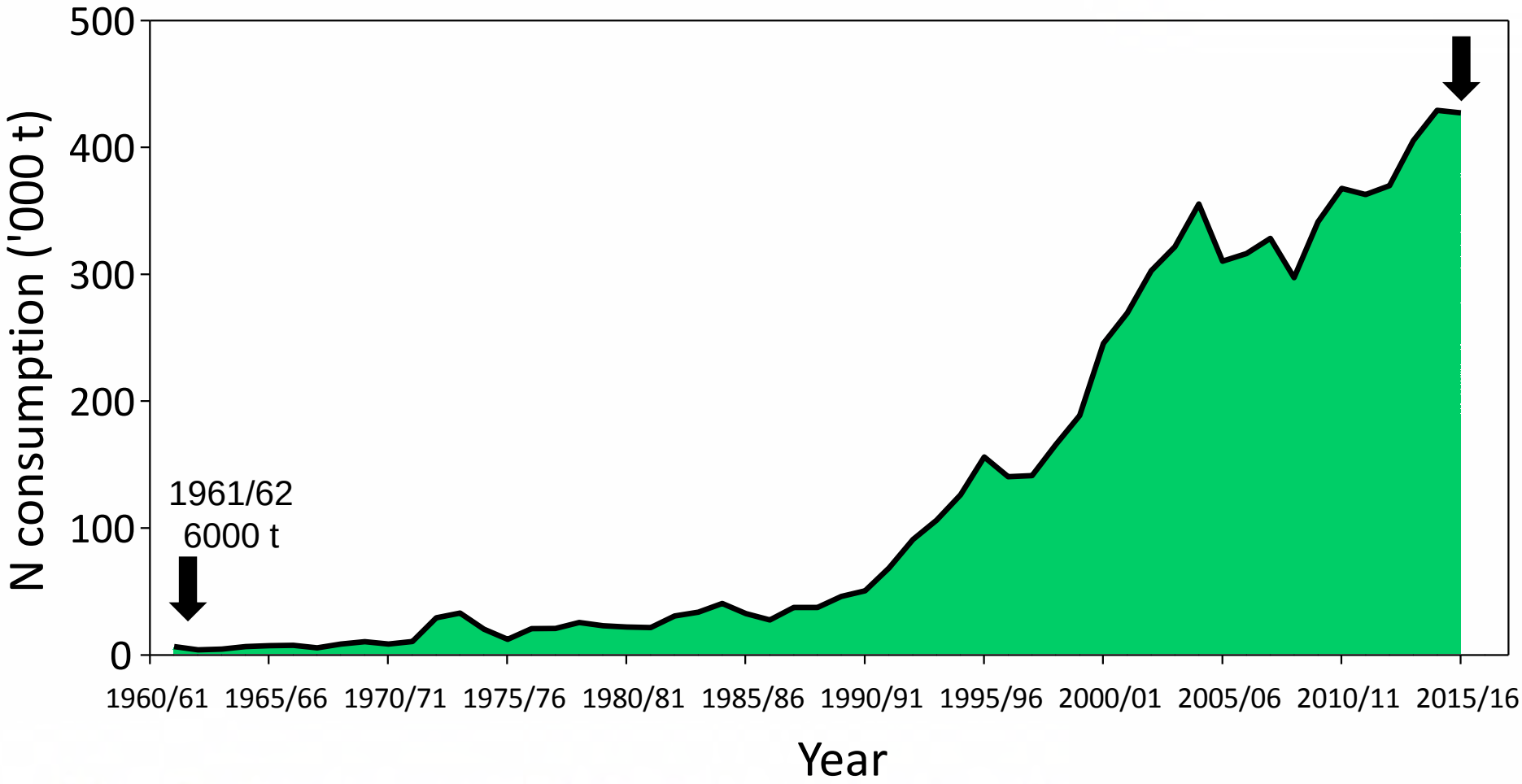
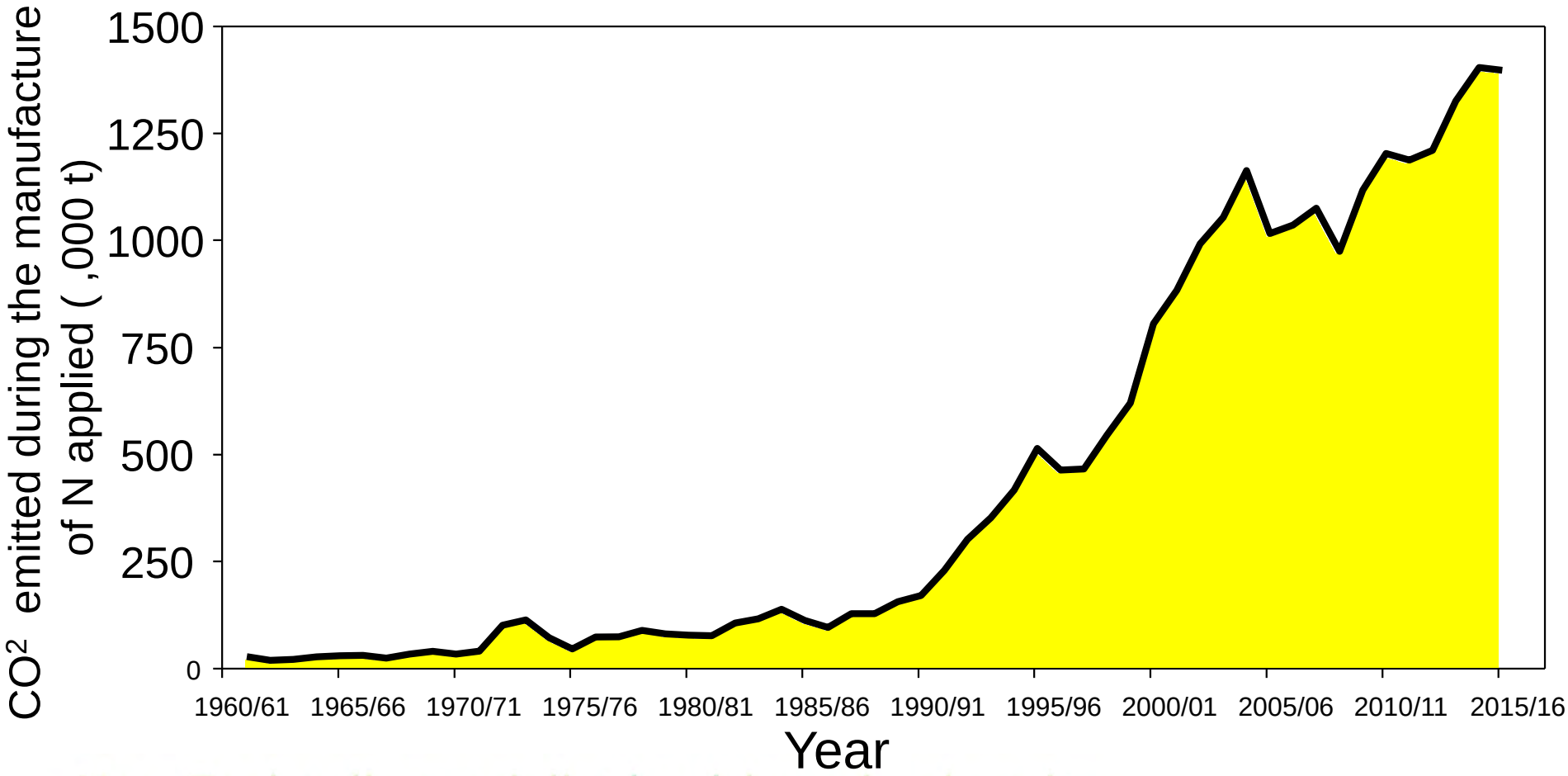


Figure incorporates data from Mills 2007, Lemaire & Salette 1982, Soussana *et al*. 1996

Nitrogen applied in NZ

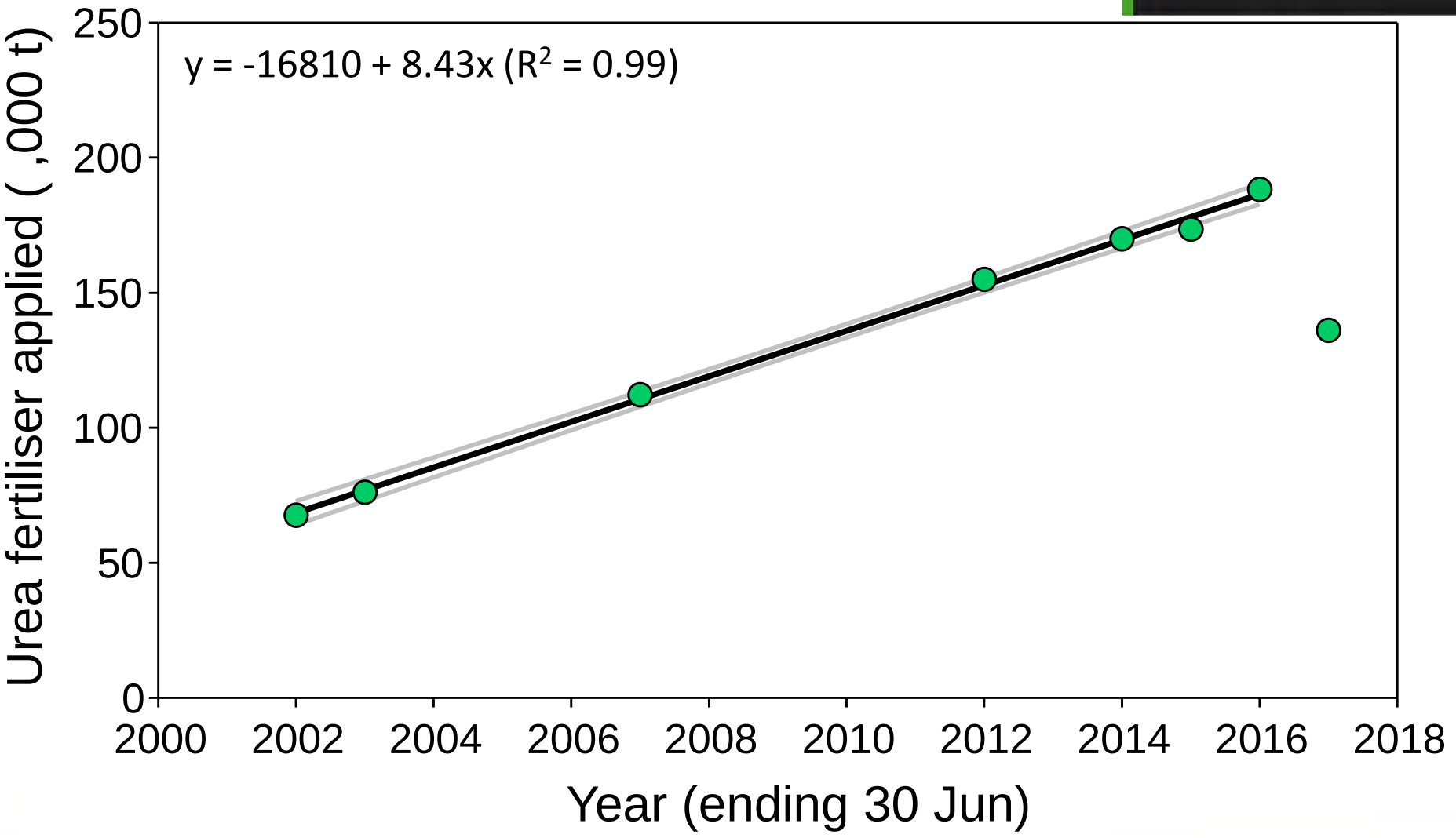


CO_2 emissions generated in the production of N fertiliser

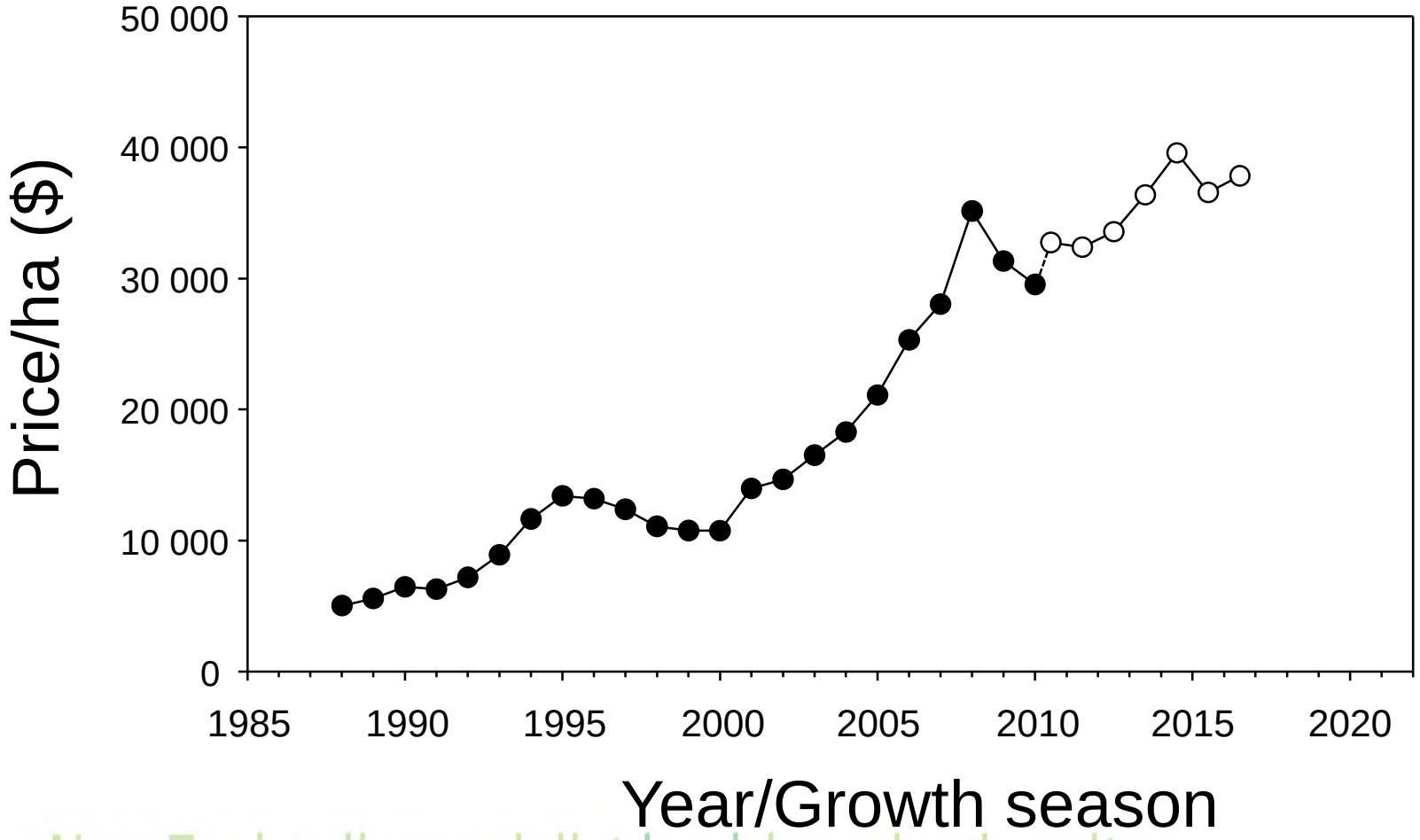


Based on Saunders *et al*., 2006 & Wells 2001 assuming all N consumed in NZ was manufactured using natural gas (including imported N fert)

Urea use in Canterbury

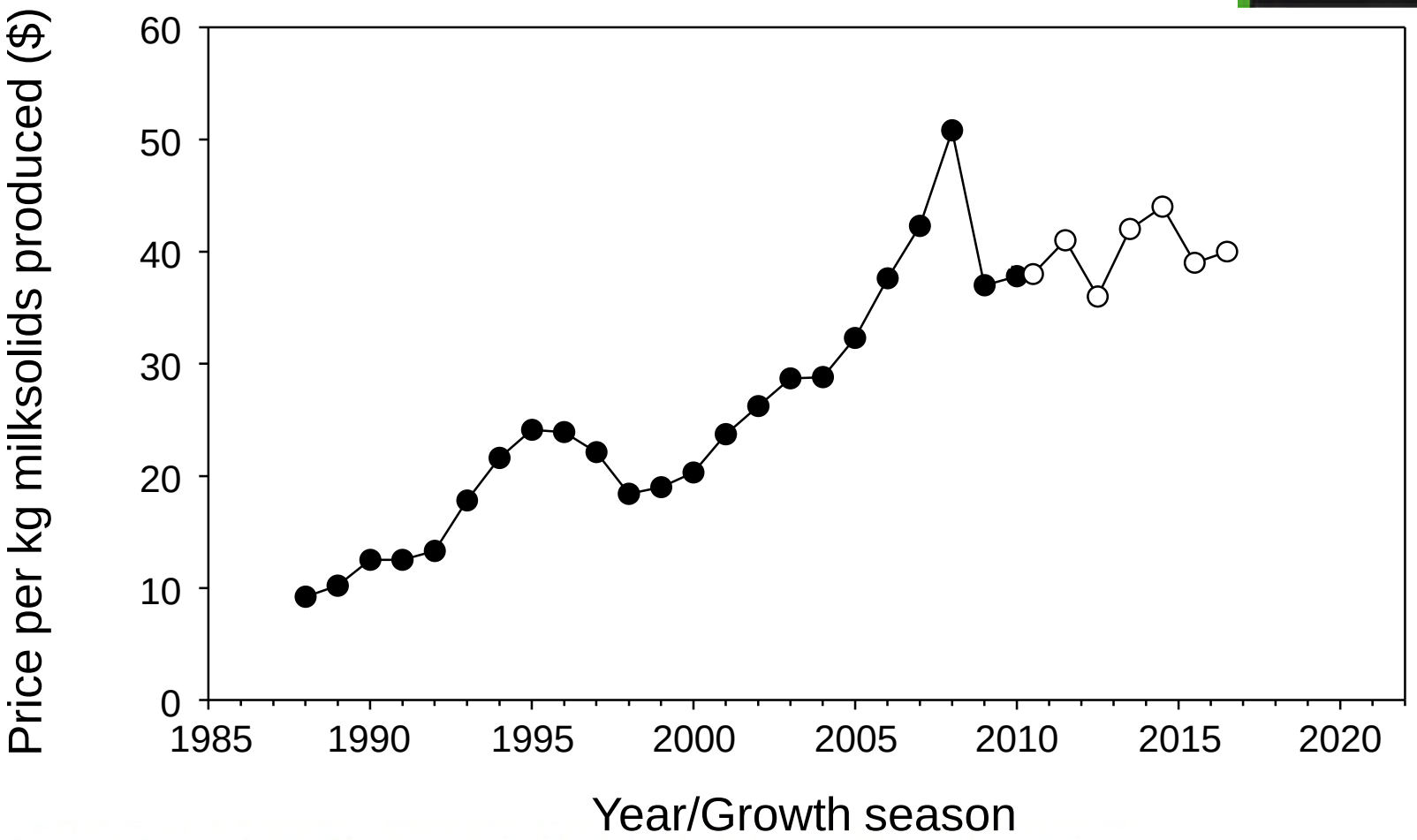


Change in the price of dairy land



Data sourced from DairyNZ New Zealand Dairy Statistics
https://www.dairynz.co.nz/publications/dairy-industry/ Accessed: 17/9/2018. (QV.co.nz 1988-2010, REINZ 2009/10-2016/17)

Land price per kg milksolids produced



Data sourced from DairyNZ New Zealand Dairy Statistics
https://www.dairynz.co.nz/publications/dairy-industry/ Accessed: 17/9/2018. (QV.co.nz 1988-2010, REINZ 2009/10-2016/17)

Intensification Loop

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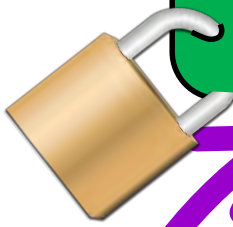
Water + Nitrogen



Increased pasture production

Increased outputs

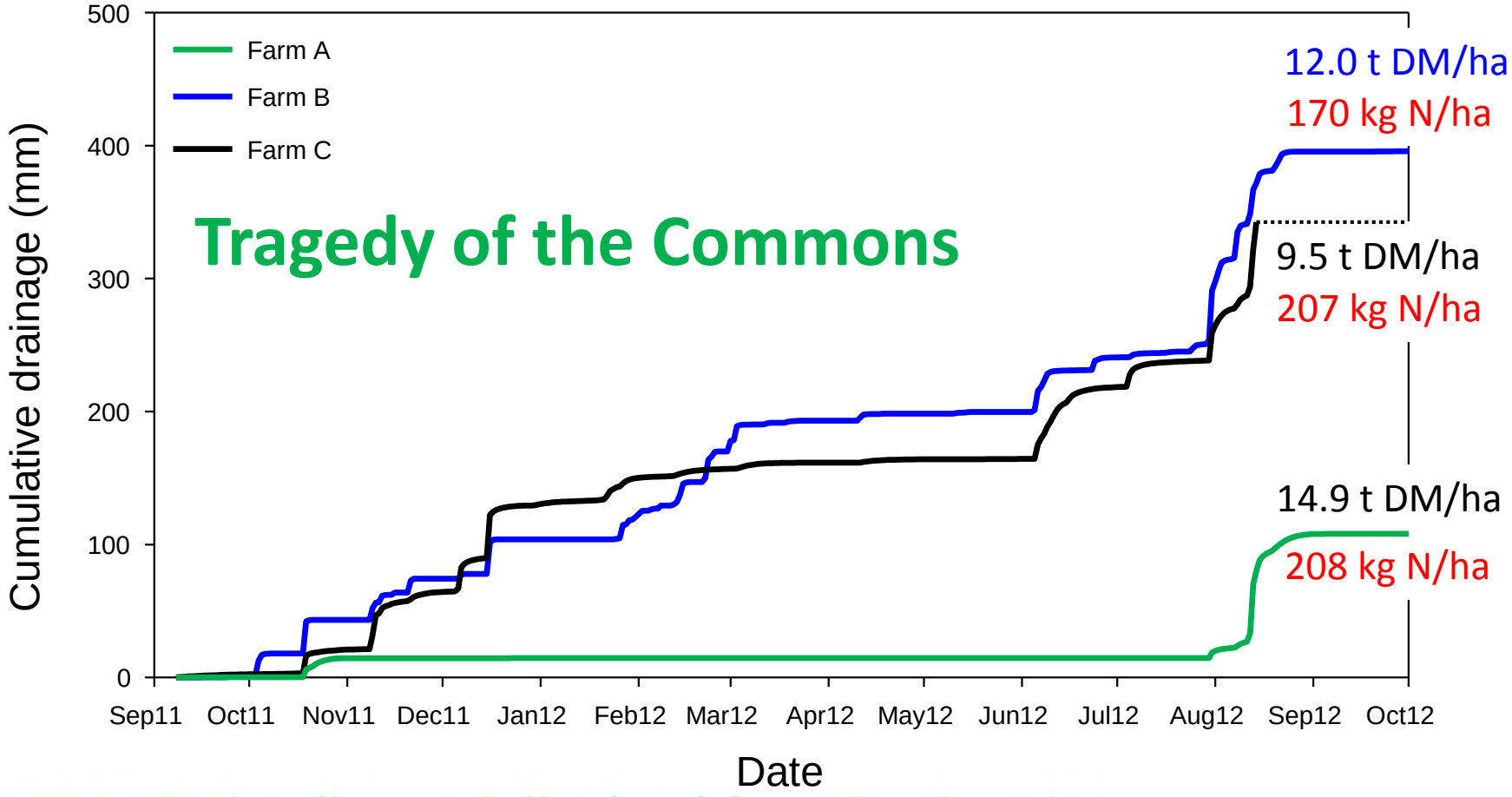
(more milk = increased income)

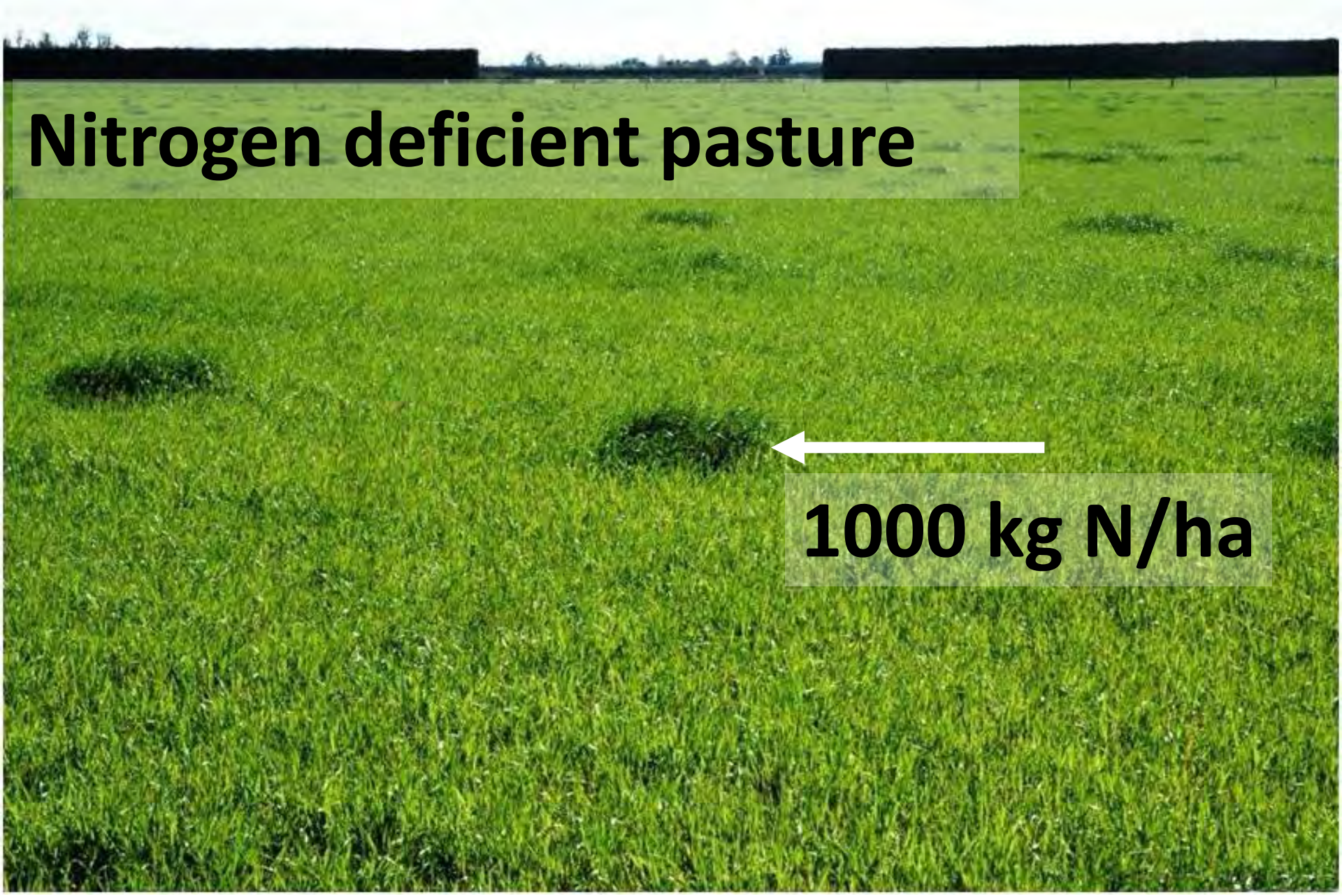
Increased land value

Fenced water ways, large herds – N deficient pastures

Photo: DJ Moot
Lincoln University

Cumulative drainage (mm)

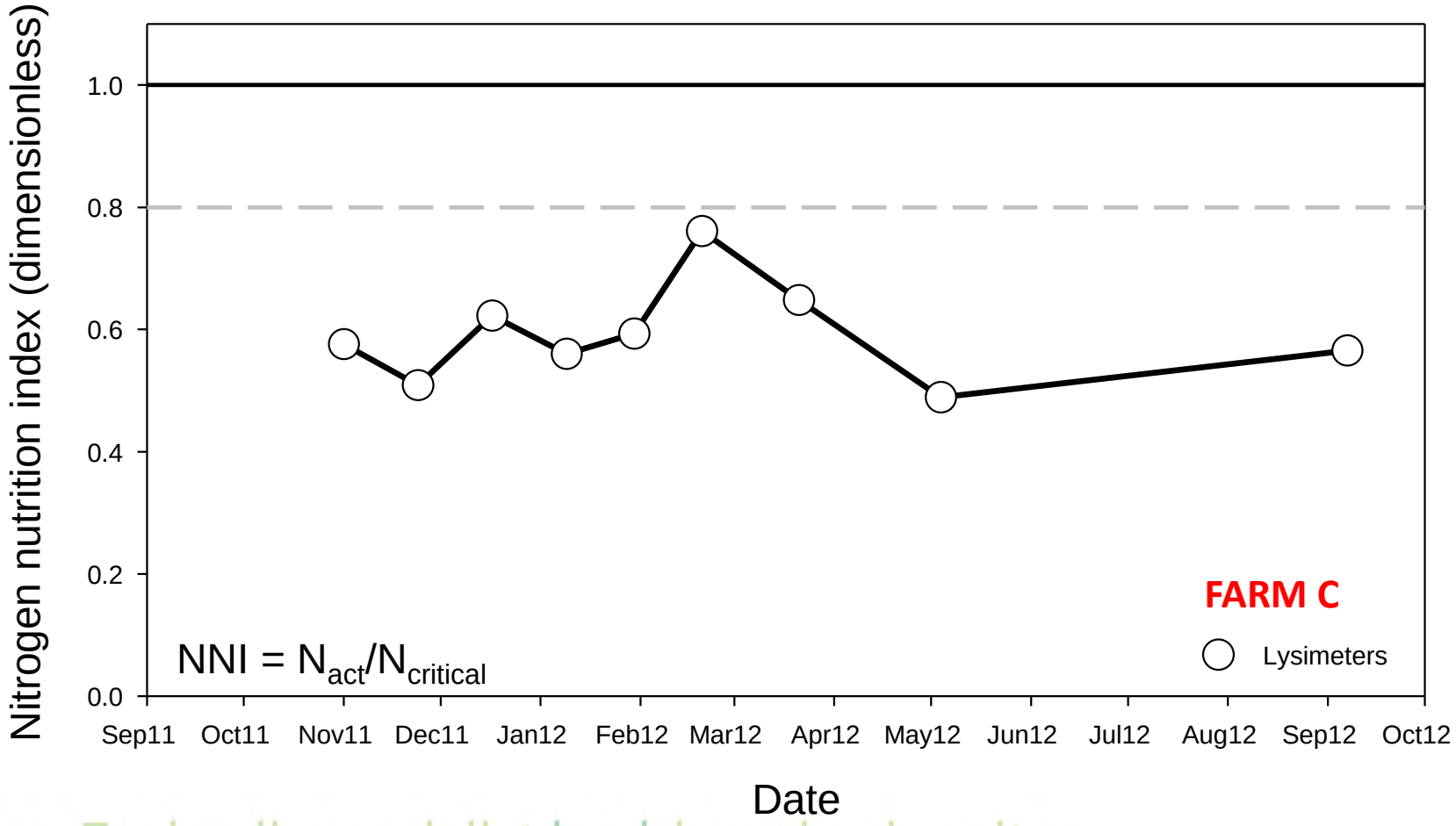




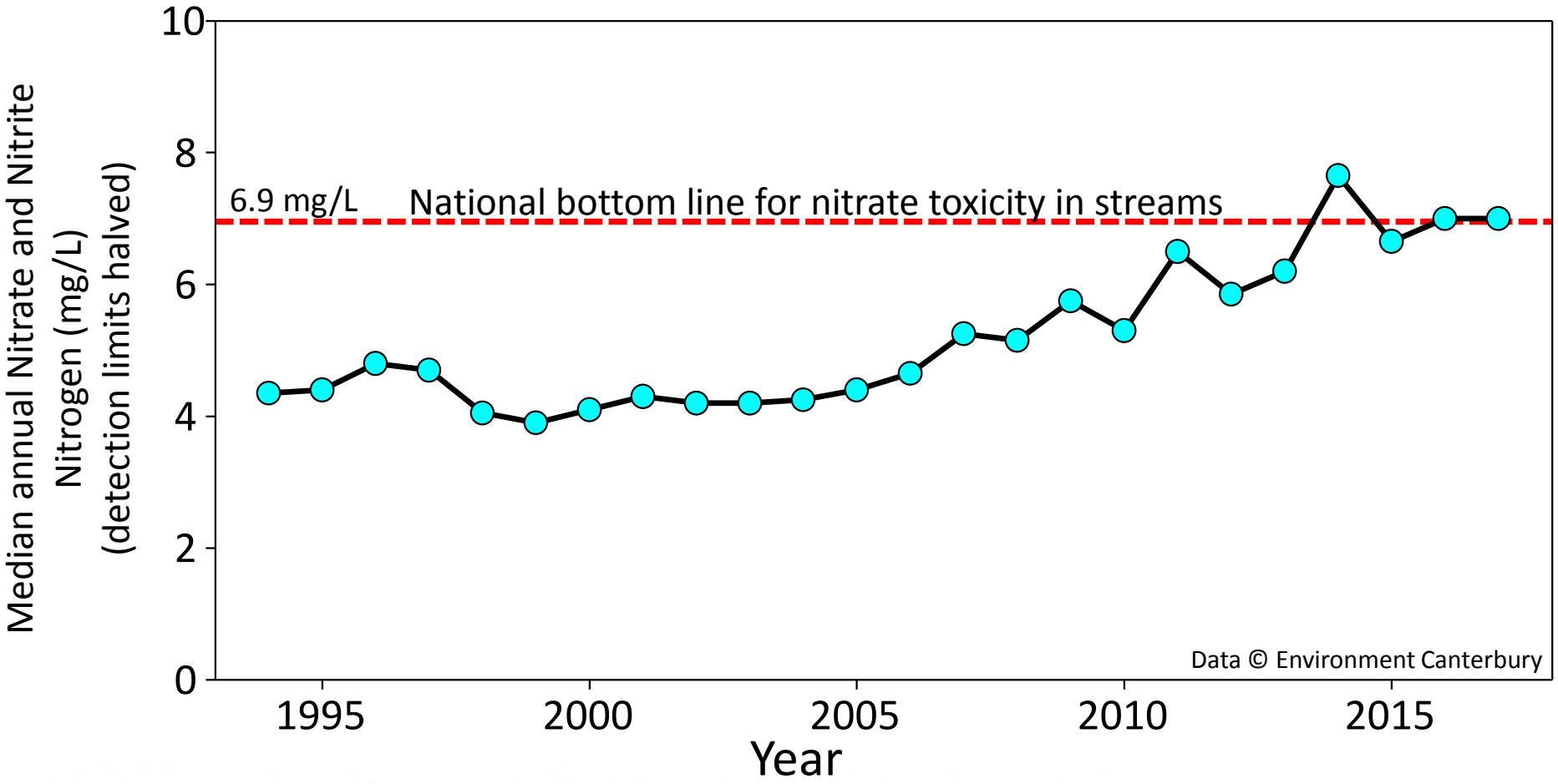
Nitrate = effluent of affluence

Nitrogen nutrition index

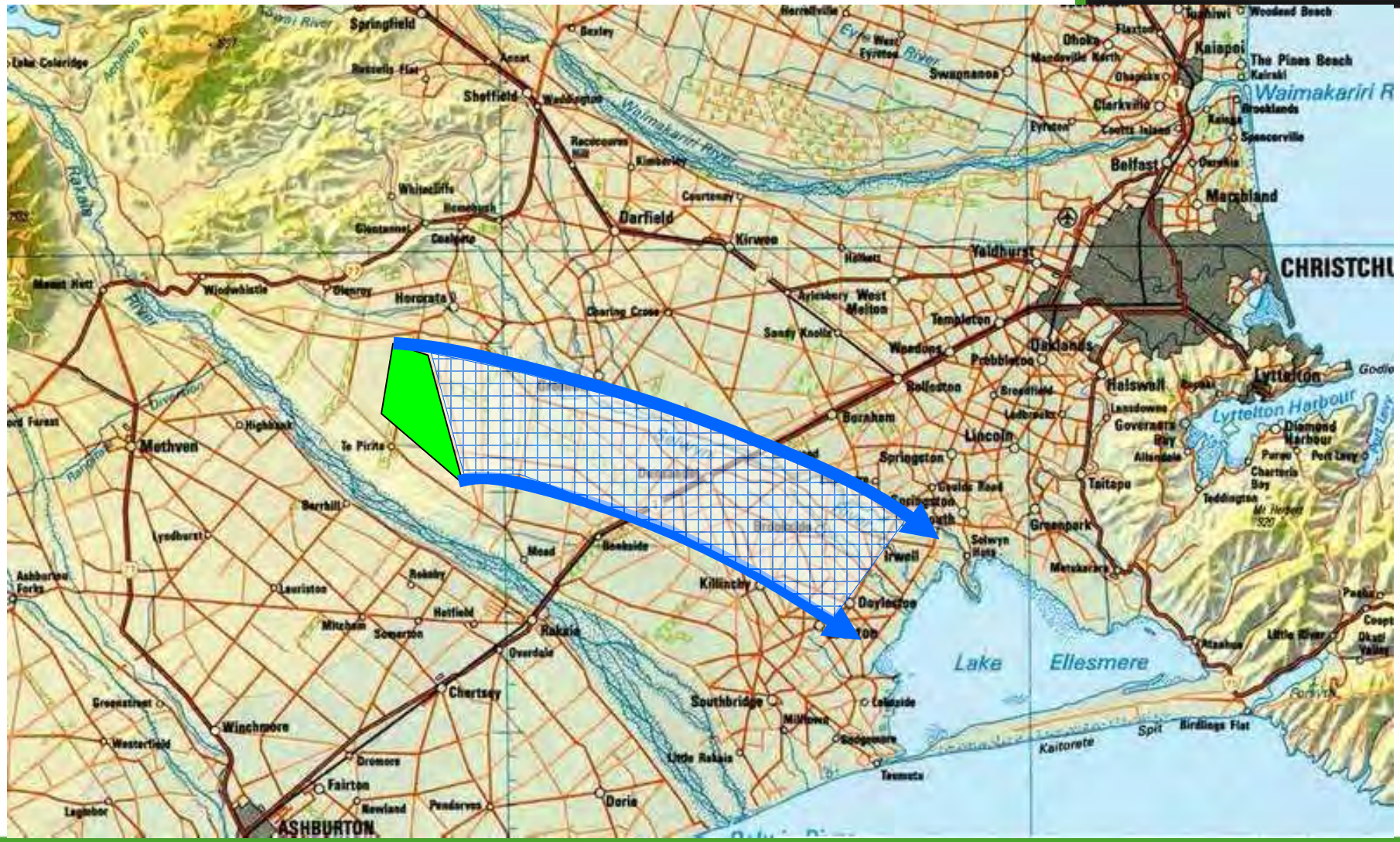
Over irrigated under fertilized



Nitrate + Nitrite measured at Harts Creek, Canterbury



Intensive dairy development



Need to reduce agriculture's impact on water quality

Nitrate (NO_3^-) leaching and water contamination:

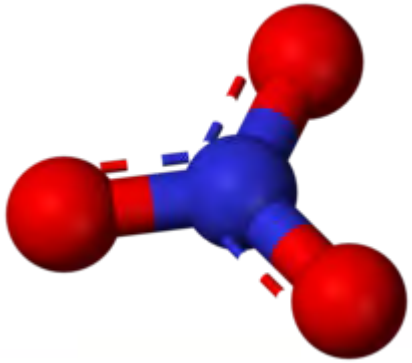
- Risk to drinking water (?)
- Surface water eutrophication

Weed and Algal blooms in rivers & lakes

Photos supplied by Prof. K.C. Cameron, Lincoln University

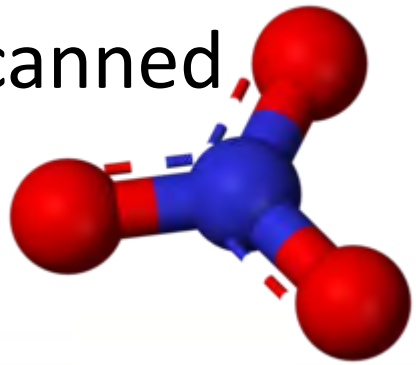
Nitrate – NO_3^- friend or foe?

- Dissolved in and moves in water
- Rapidly absorbed by our bodies
- Concentrated on our tongue
- Converted to nitrite which kills bacteria
- Dogs versus rats



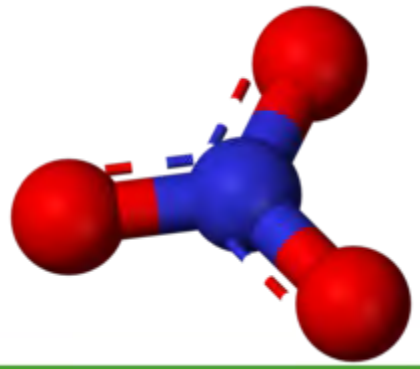
Nitrate – NO_3^- friend or foe?

- Reduces skin infections – nitrate from sweat
- HP athletes e.g. lettuce (60 mg/serving), beetroot
- Heart attack victims
- Accepts electrons to form nitrite which kills bacteria
- Preservative to kill botulism spores in canned food



Nitrate levels – where from?

- 30 mg/L - median annual value – NZ freshwater
- ≤50 mg/L – satisfactory = NZ legislation
- 50-100 mg/L – acceptable WHO
- >100 mg/L – not recommended WHO
- 175-700mg/L – dosed to babies (1948)



…nitrate leaches vertically through free-draining soil

OVERSEER assumes everything below 60 cm is leached

Most leaching occurs in winter & early spring

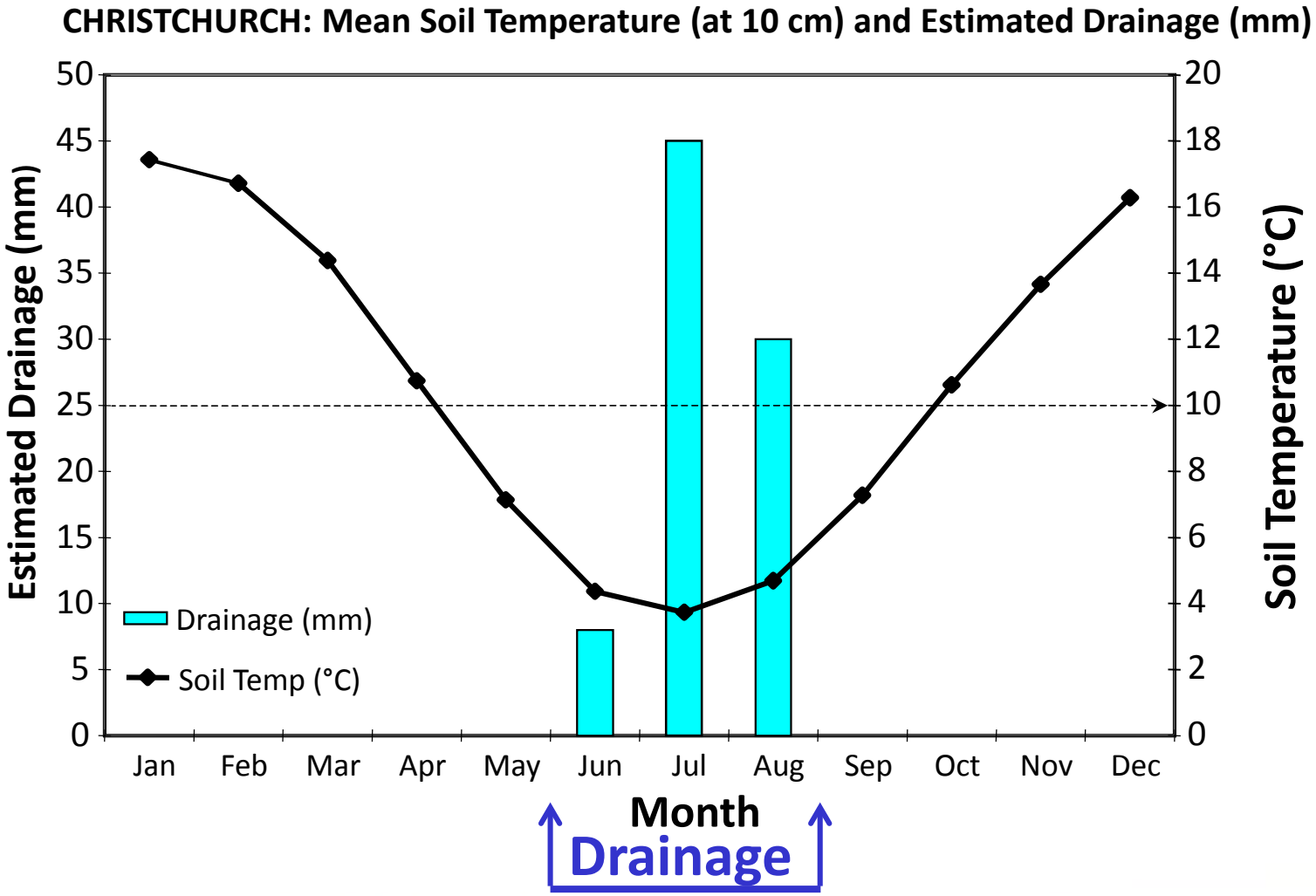
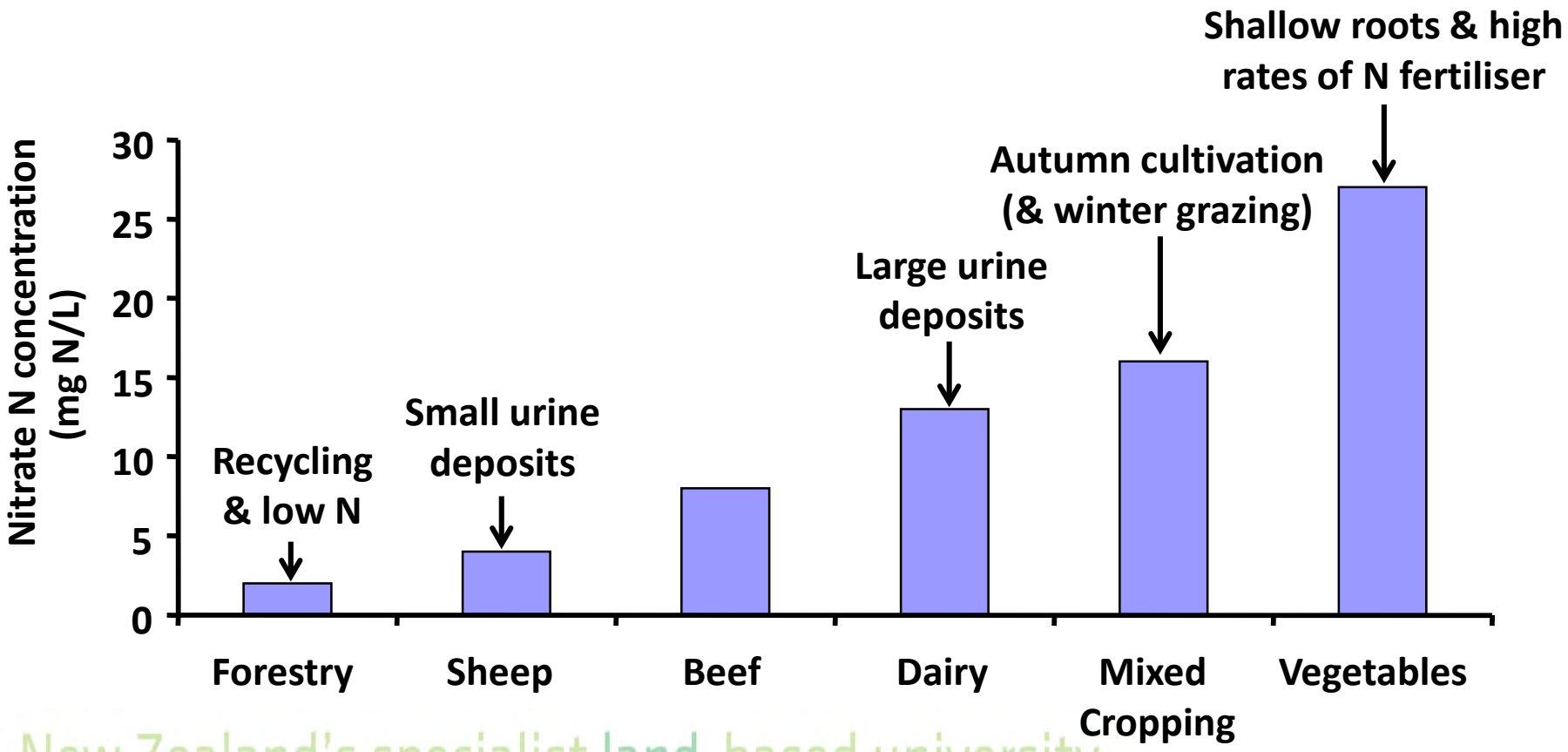


Image supplied by Prof. K.C. Cameron, Lincoln University

Approximate concentrations of nitrate-N in drainage water from different land use systems.



Di *et al*. 2005

Autumn cultivation of pasture soil releases nitrogen that can be leached over winter

Photo supplied by Prof. K.C. Cameron, Lincoln University

What are the N leaching losses from Winter Grazing Blocks?

Best Management Practices to Reduce Nitrogen Leaching Losses

- **Fertiliser and Effluent**
  – applied at rates and times to meet plant demand and avoid losses
- **Wintering**
  – sow a 'catch crop' of oats asap after grazing; or use a stand off pad?
- **Alternative pasture species**
  - some species increase plant N uptake in winter (Italian ryegrass)
- **Lower input/more efficient farm systems**

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