21 August 2017

Lincoln University
Te Whare Wānaka o Aoraki
AOTEAROA • NEW ZEALAND

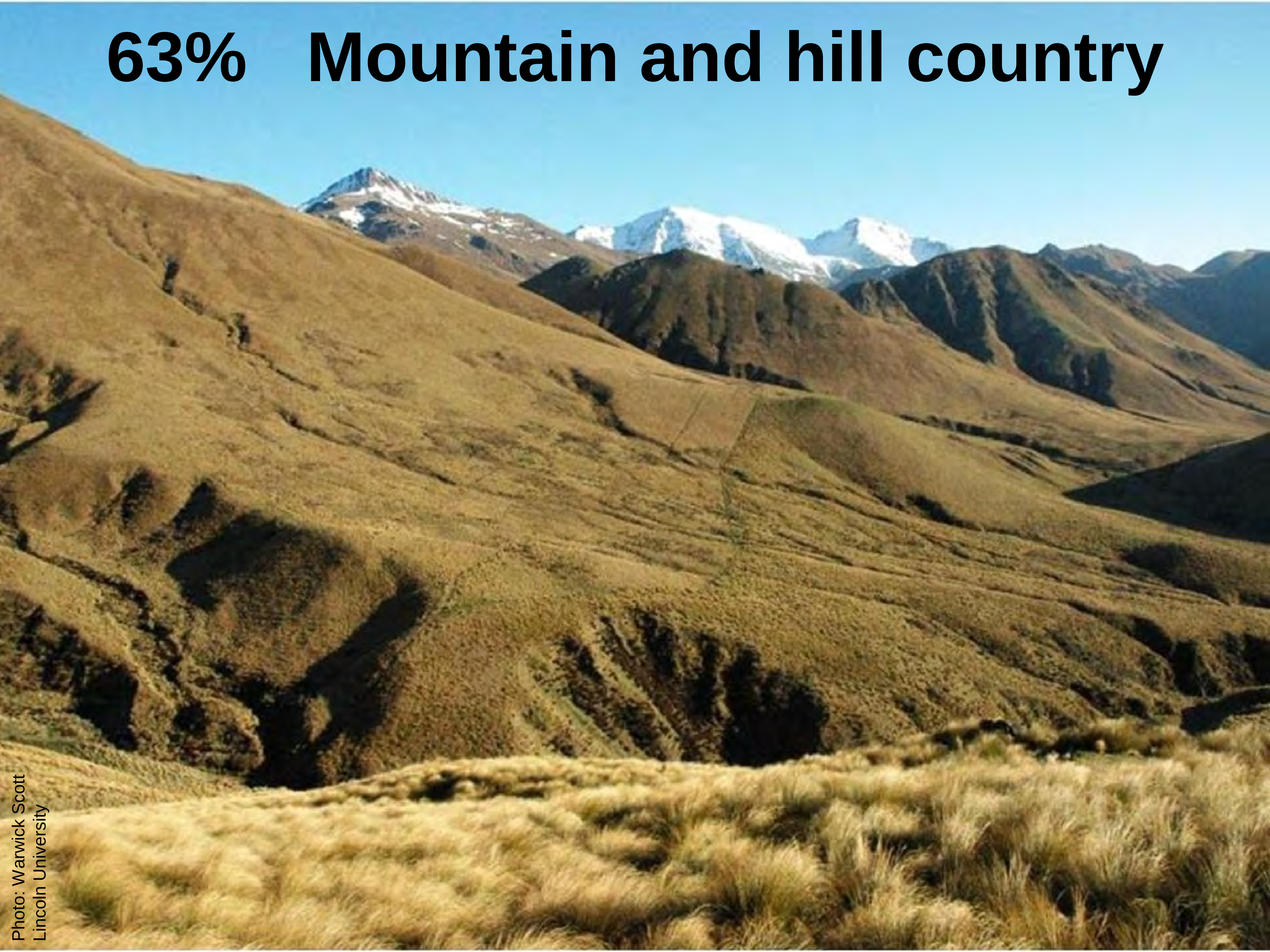
Agronomy of crops and pastures

Incitec Pivot at Lincoln University

Derrick Moot

Photo: Warwick Scott
Lincoln University

63%   Mountain and hill country



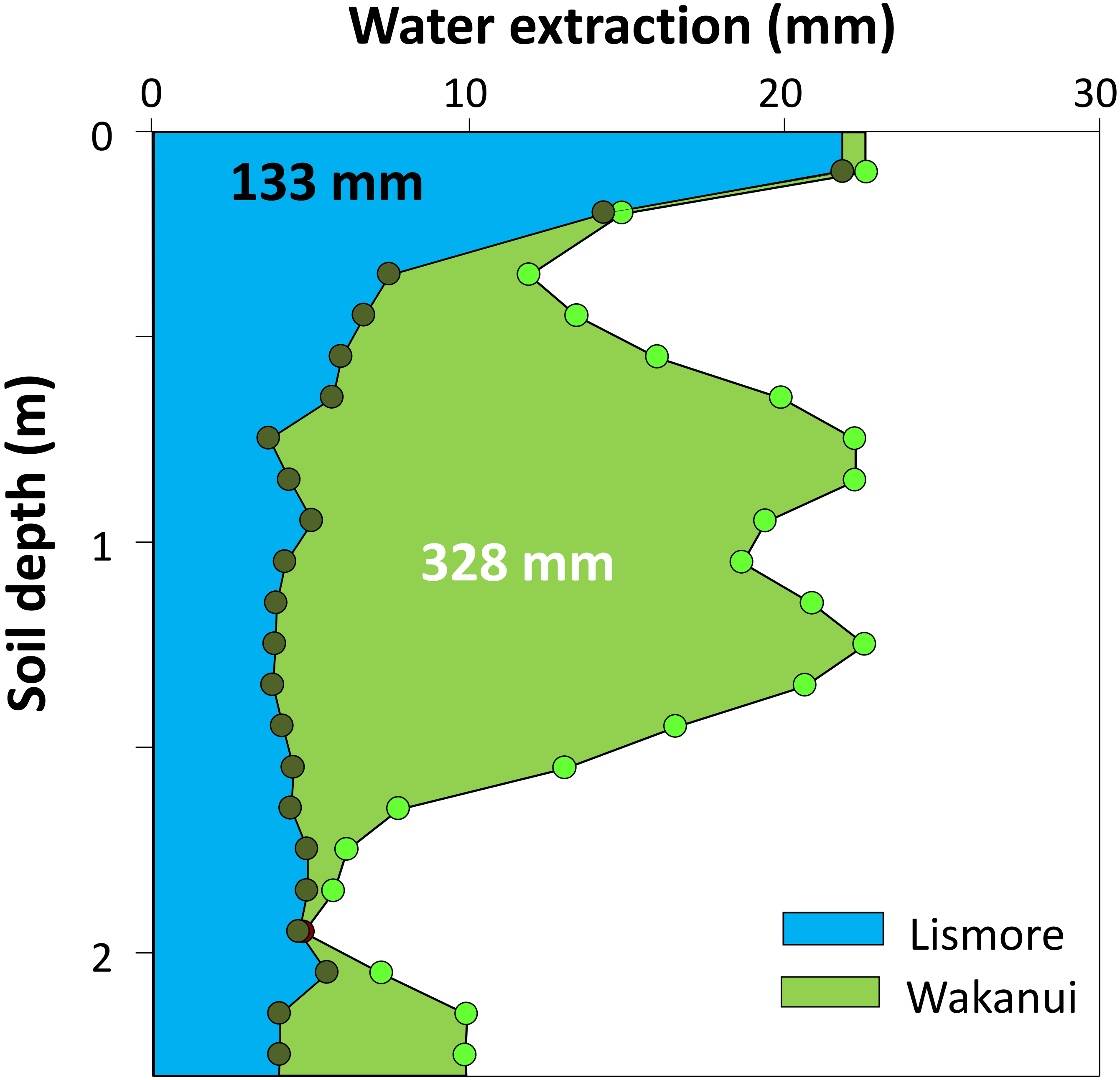
13% Inland basins

Brown & Naish, GNS pers. Comm.


High variability over short spaces

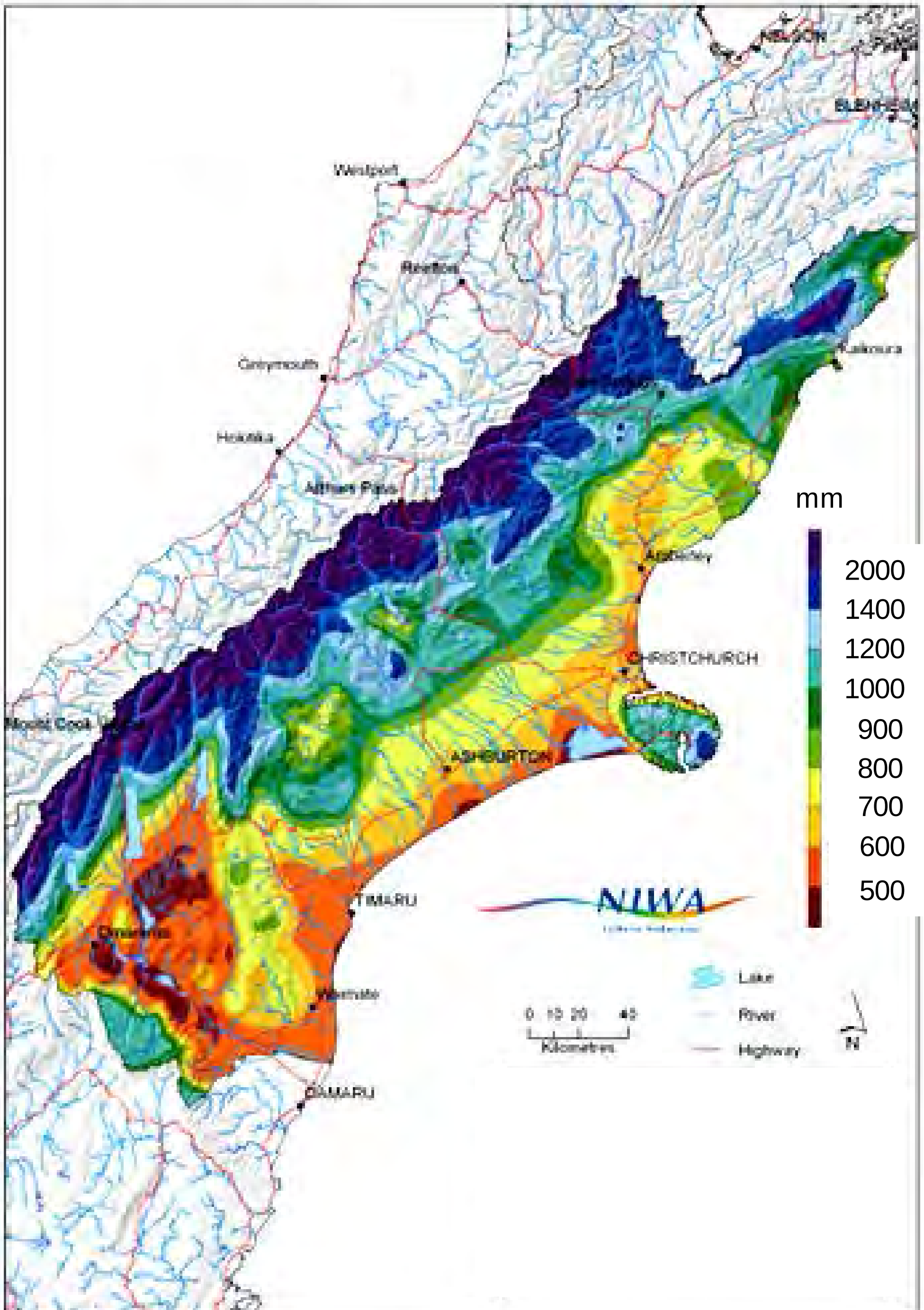
The sediment load of Canterbury rivers is 10x the global average


Soil water extraction - Wakanui
Photo DJ Moot
Lincoln University



Soil water extraction

Deep Wakanui soil has 200 mm more available water

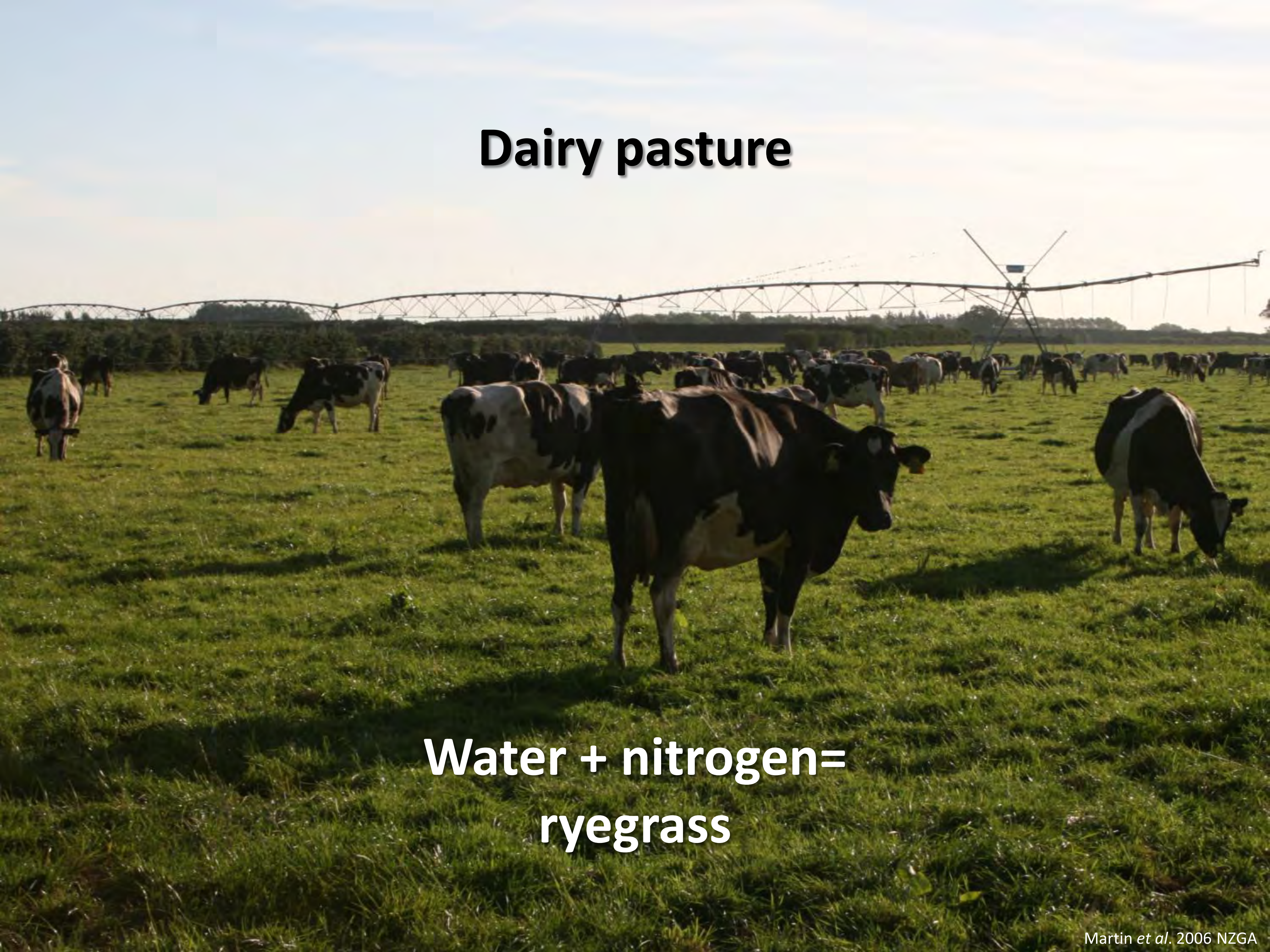


Climate

Median rainfall (mm)
(1971-2000)

Unimproved scrub land on light soils

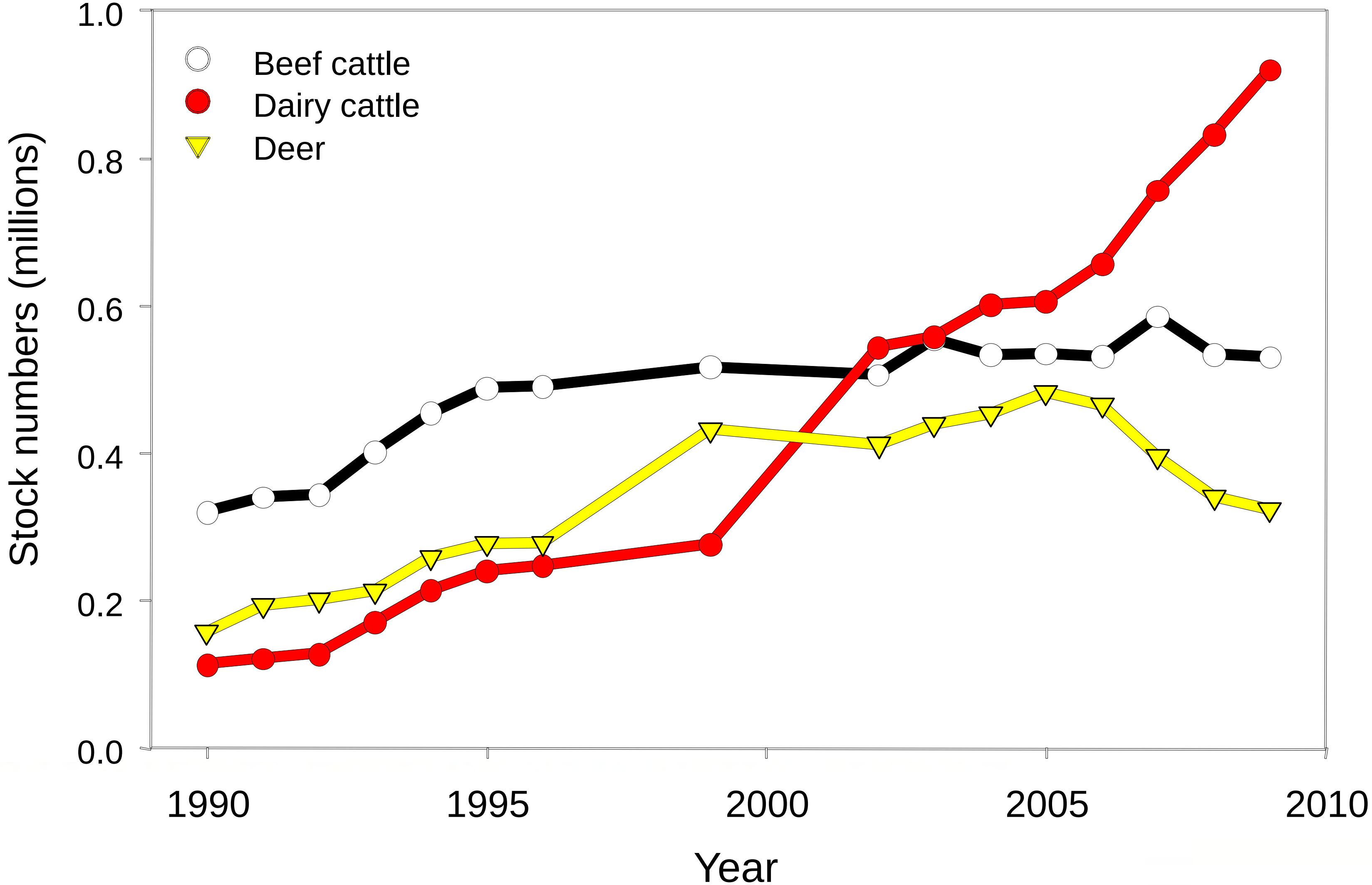
Dairy pasture



Water + nitrogen= ryegrass

Martin *et al*. 2006 NZGA

The population...deer & cattle



Moot et al 2010; Department of Statistics

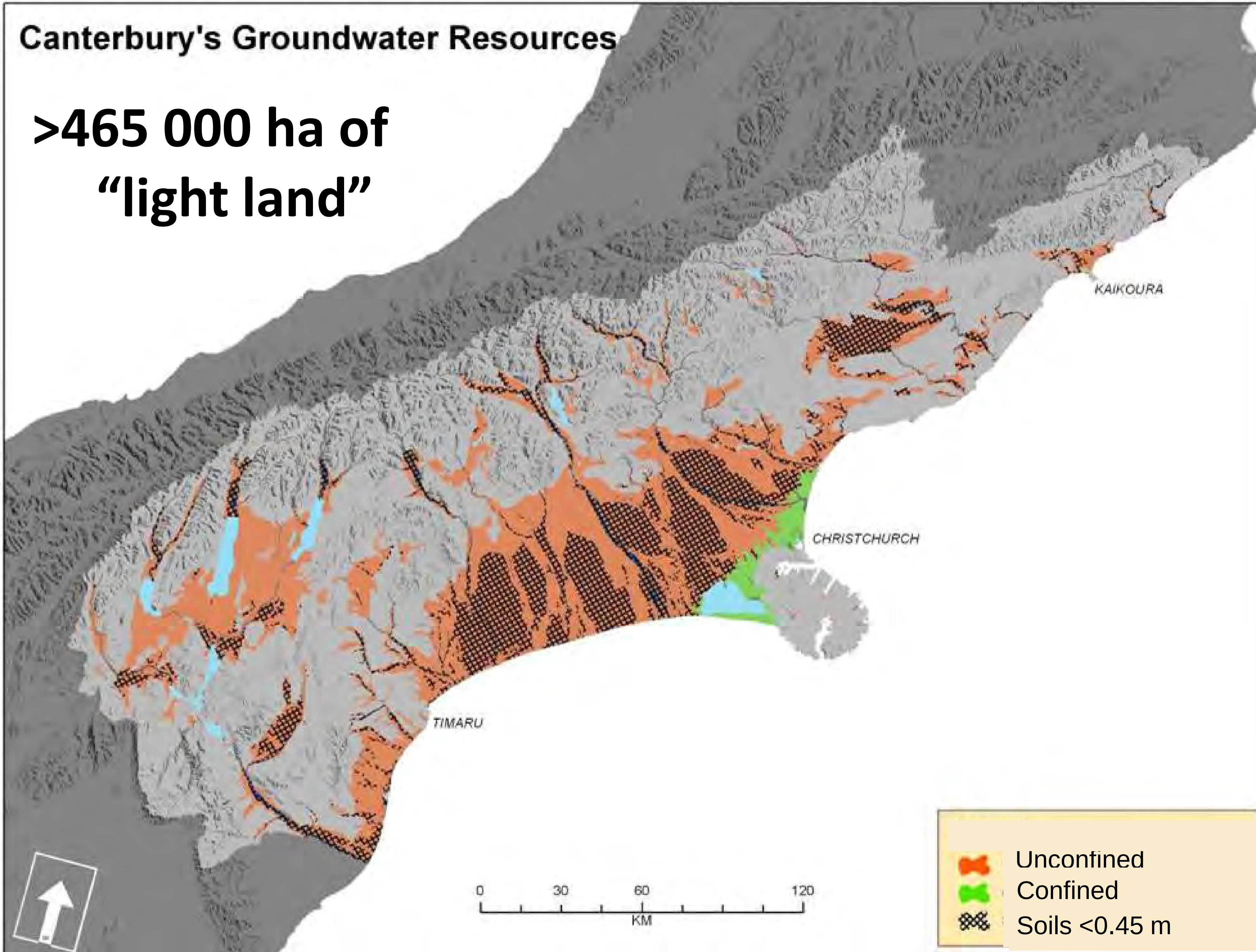
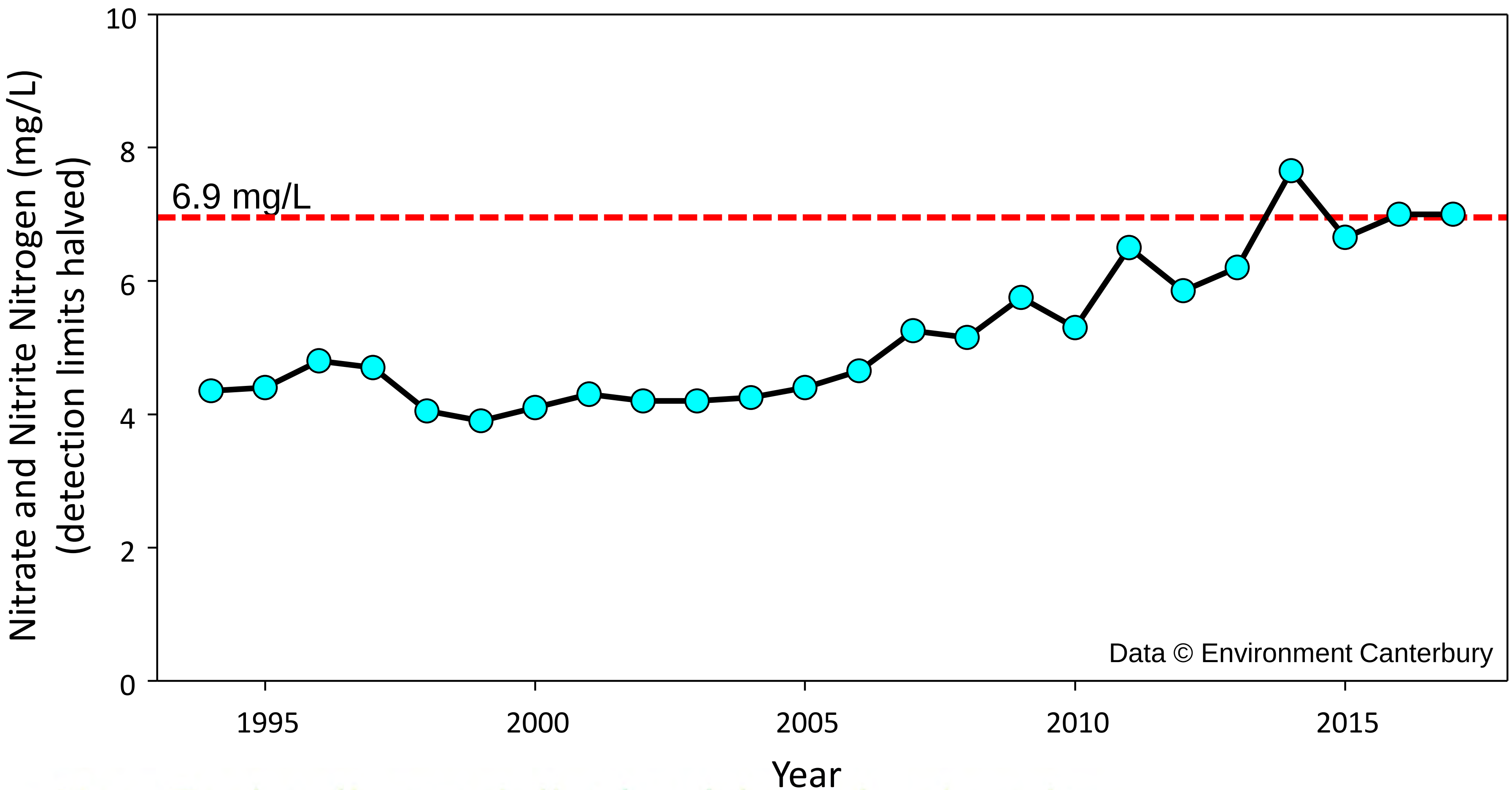
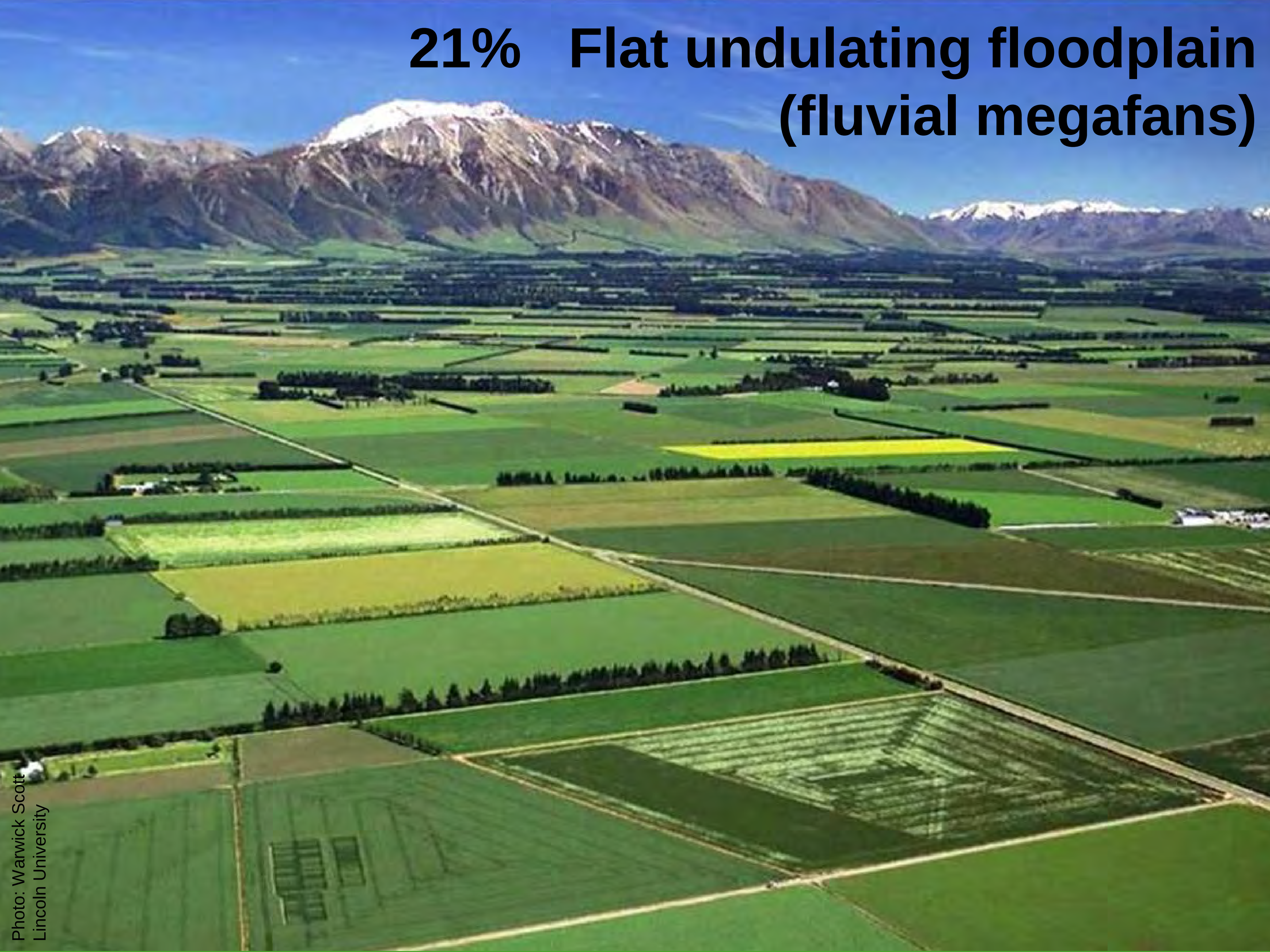


Image provided by Ken Taylor ECAN

Annual Median Nitrate +Nitrite Harts Creek



New Zealand's specialist land-based university


21% Flat undulating floodplain
(fluvial megafans)
Photo: Warwick Scott
Lincoln University

~60% of the fresh and process peas

Photo: Warwick Scott
Lincoln University

Onions for export, 4000 ha of potatoes

High values seed crops

10,000 ha clover seed for export

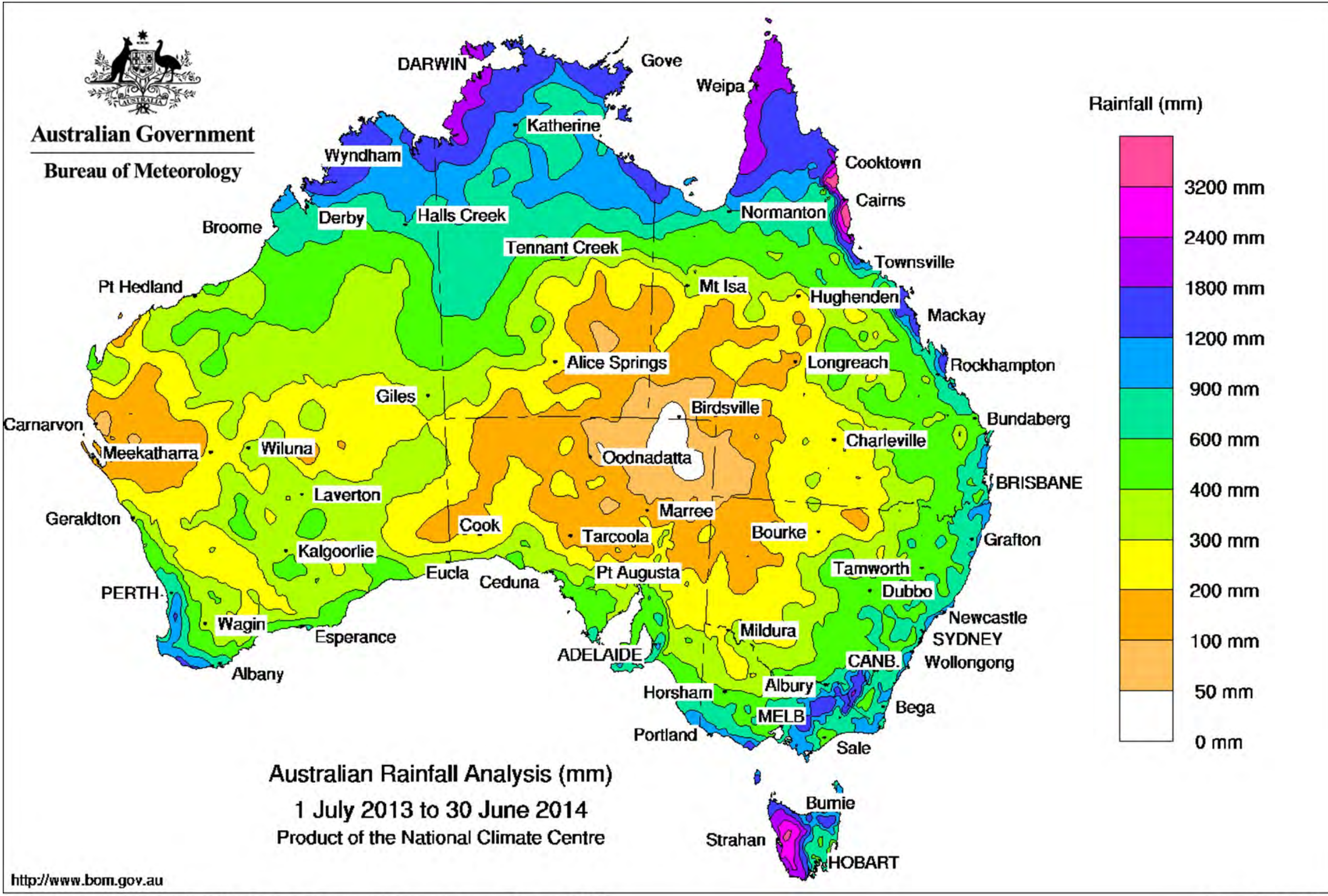
Herbage grass 1.5 - 2.5 t seed/ha

Wine production in Nth Canterbury

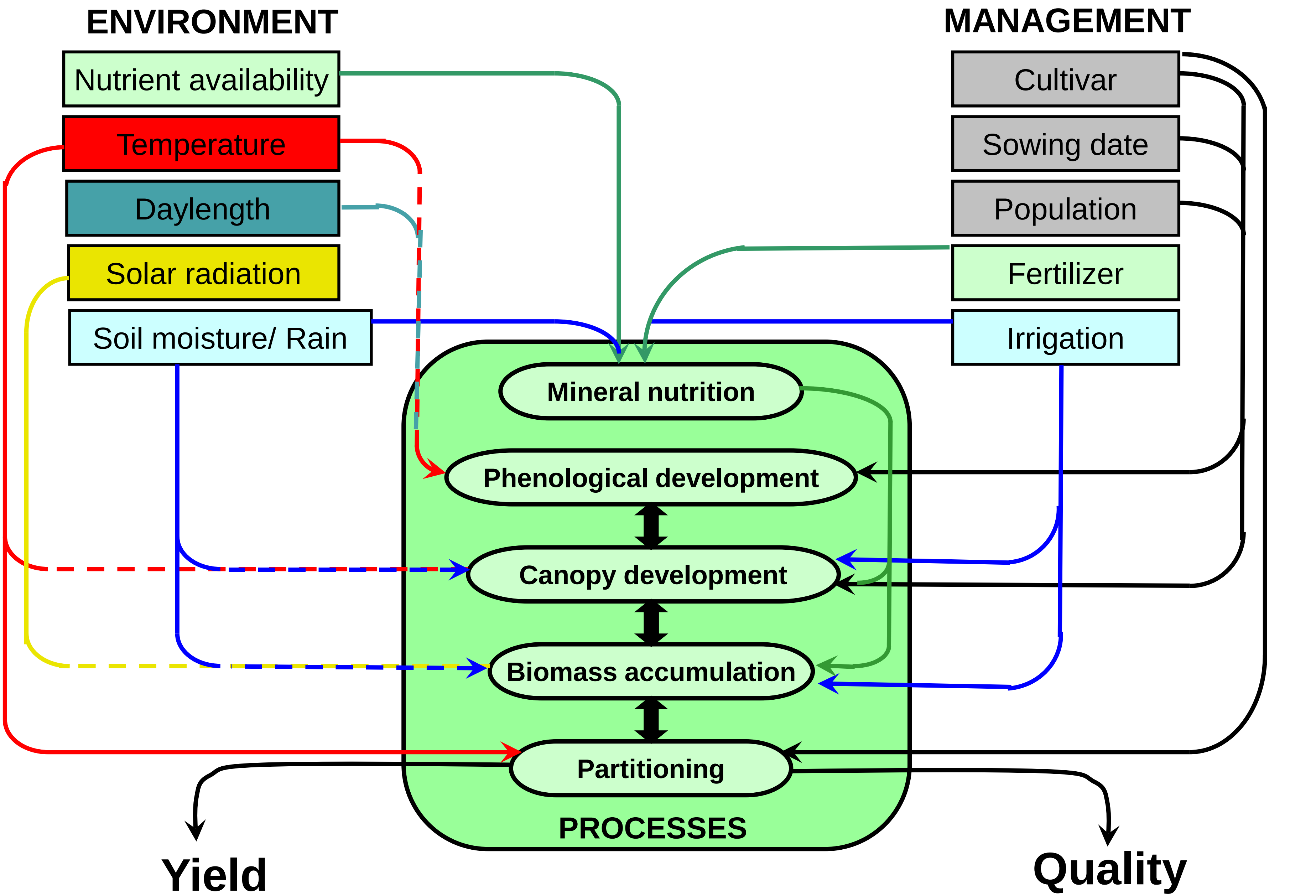
Policy & management questions

- What types of land uses, and
- How intensive can they be without exceeding a groundwater system's limits? – nitrogen mgmt
- How might land be managed to maximize profitability and remain within the N limits?

  i.e. How many dairy farms, potato farms, onion paddocks, market gardens, sheep paddocks… should be allowed on a "catchment"?



 ID code: AWAP Issued: 03/07/2014



Relationship between environment and management factors and the physiological processes that regulate crop yield and quality. (Source: Hay & Porter 2006).

Growth vs Development

Growth: an irreversible increase in DM

- function of light interception and
- photosynthesis and then
- assimilate partitioning

Development: irreversible change in the state of an organism

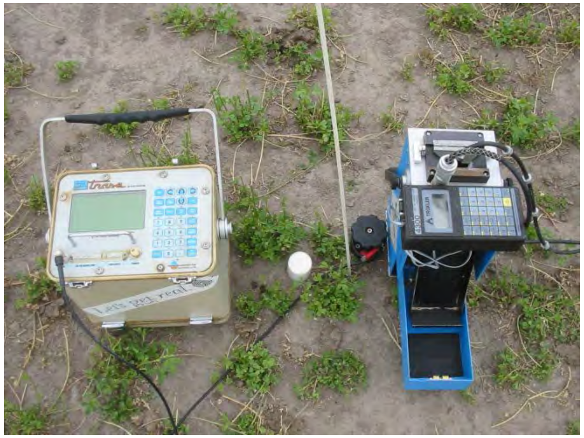
- fixed pattern and reversion is rare

e.g. silking,
pod initiation,
dough development

Measurements

Light environment

Soil moisture



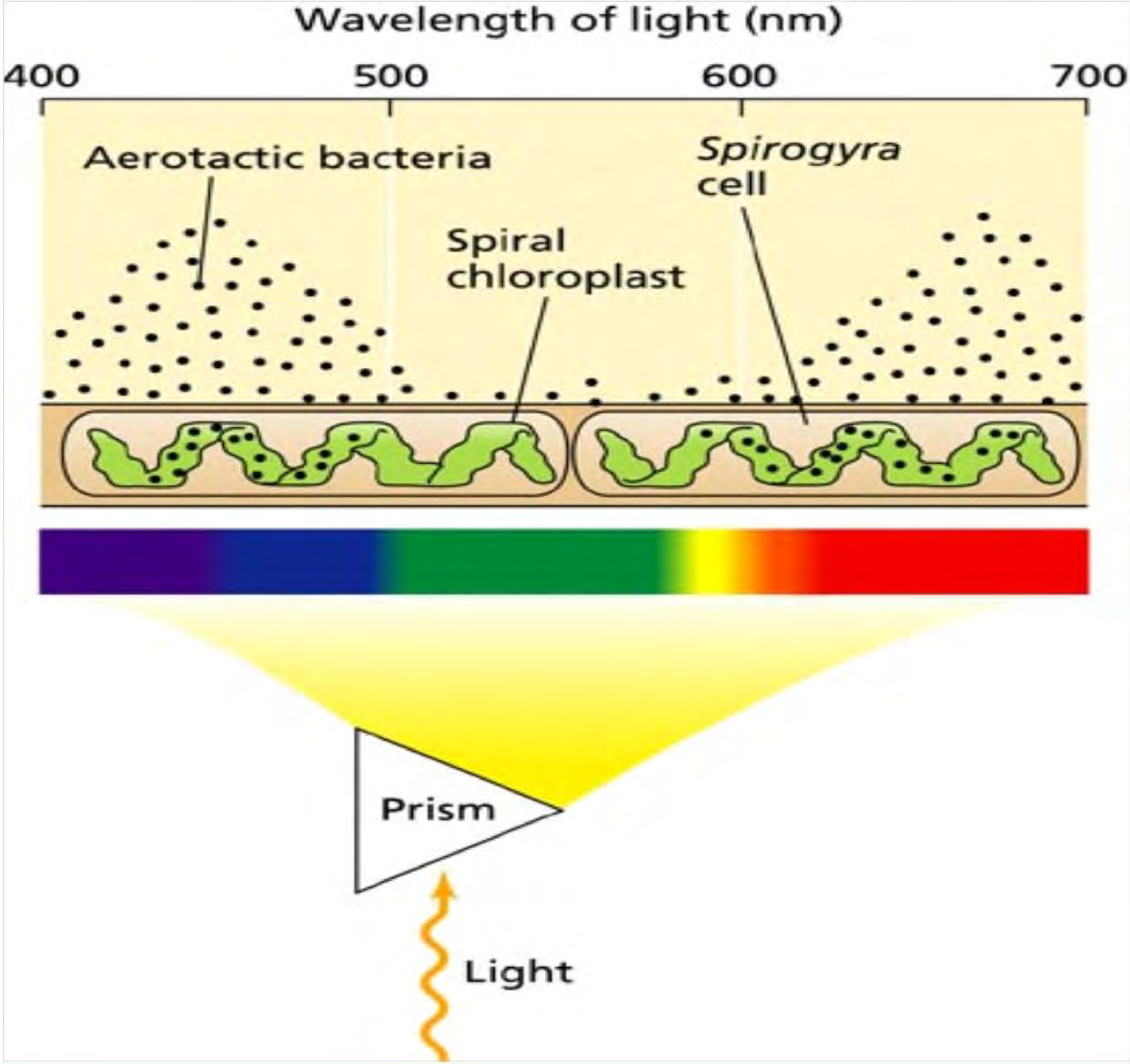
Chemical Analysis:

-N (shoots and roots)
-Starch in roots
-Soluble sugars in roots

Temperature

- Air and soil

Photosynthesis


Wavelength of light (nm)
400
500
600
700
Aerotactic bacteria
Spirogyra cell
Spiral chloroplast
Prism
Light

The canopy:
the energy capture device

Crop Growth and Yield

1) **C = E*Q**

C = daily rate of DM prod.

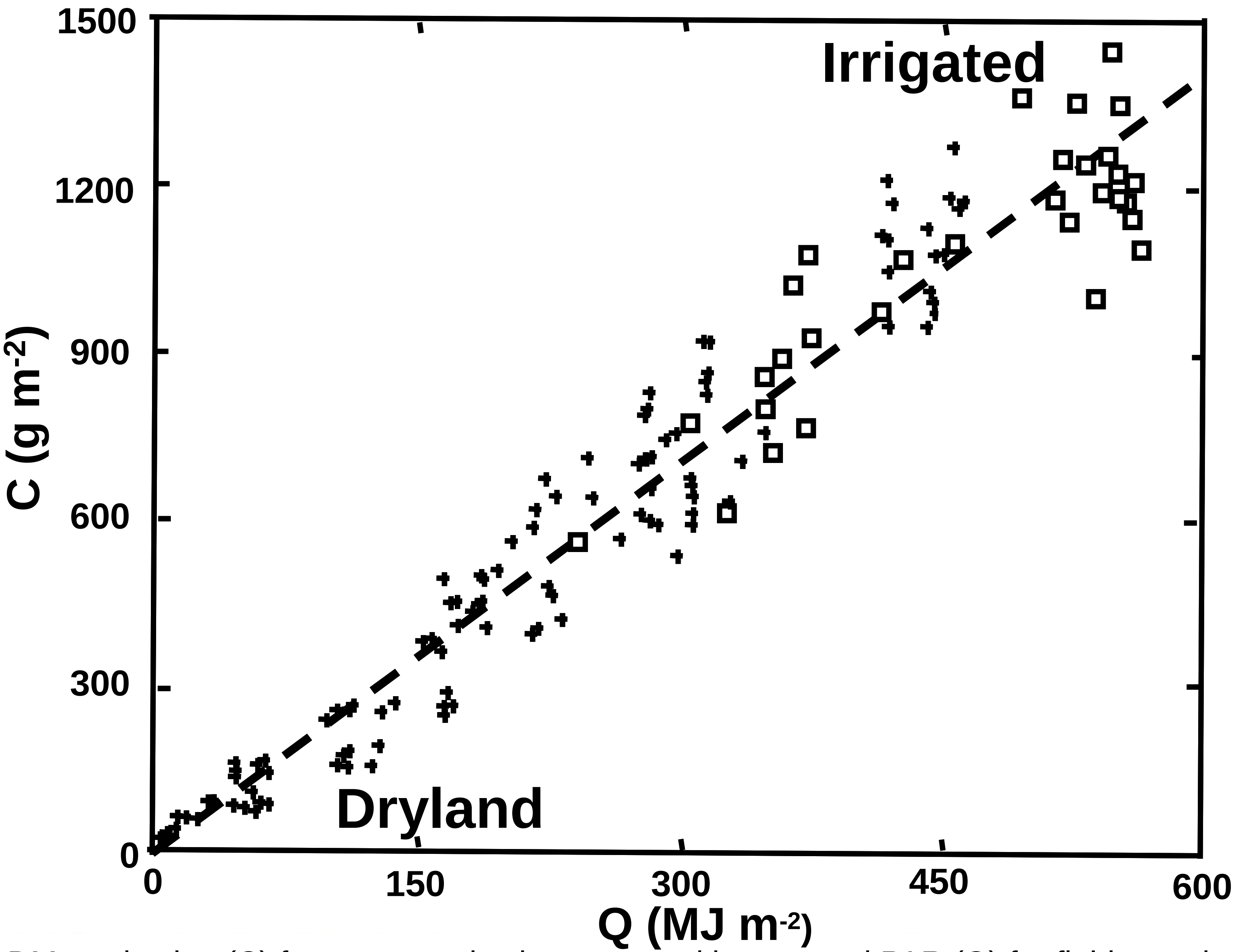
E = radiation use efficiency

Q = PAR intercepted

2) **Y = HI*C*dt**

Y = seed yield/unit area

HI = harvest index



Total DM production (C) from successive harvests and intercepted PAR (Q) for field peas in 5 experiments in 4 seasons with different cultivars, sowing times and irrigation treatments.

The form of the regression is: 2.36±0.03 g DM/MJ PAR (R^2=0.97). Wilson 1987

Light

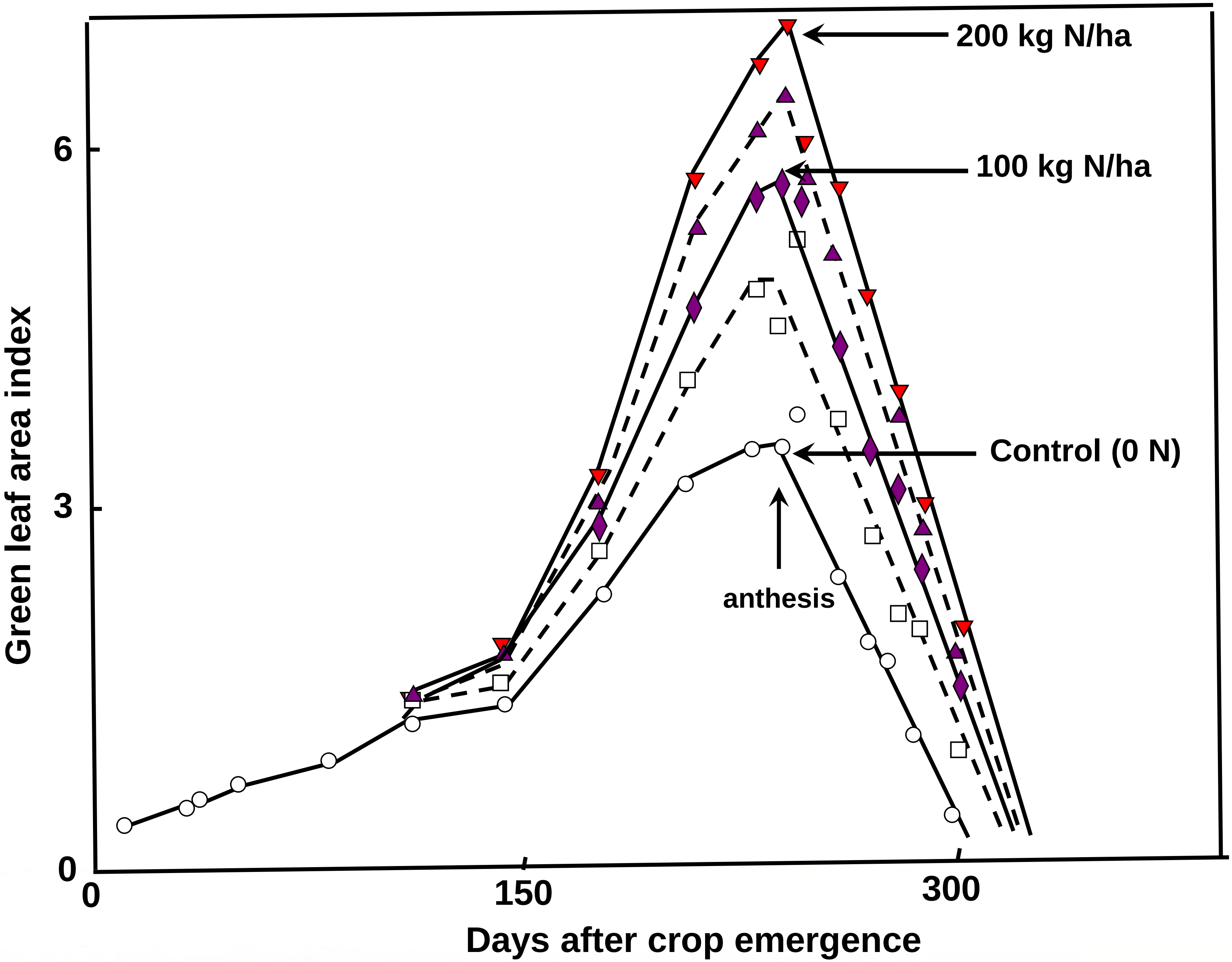
- photosynthesis to produce CHO's for growth.

- Photosynthetically active radiation (PAR) is in the visible range (400-700nm).

- Conversion of PAR to DM

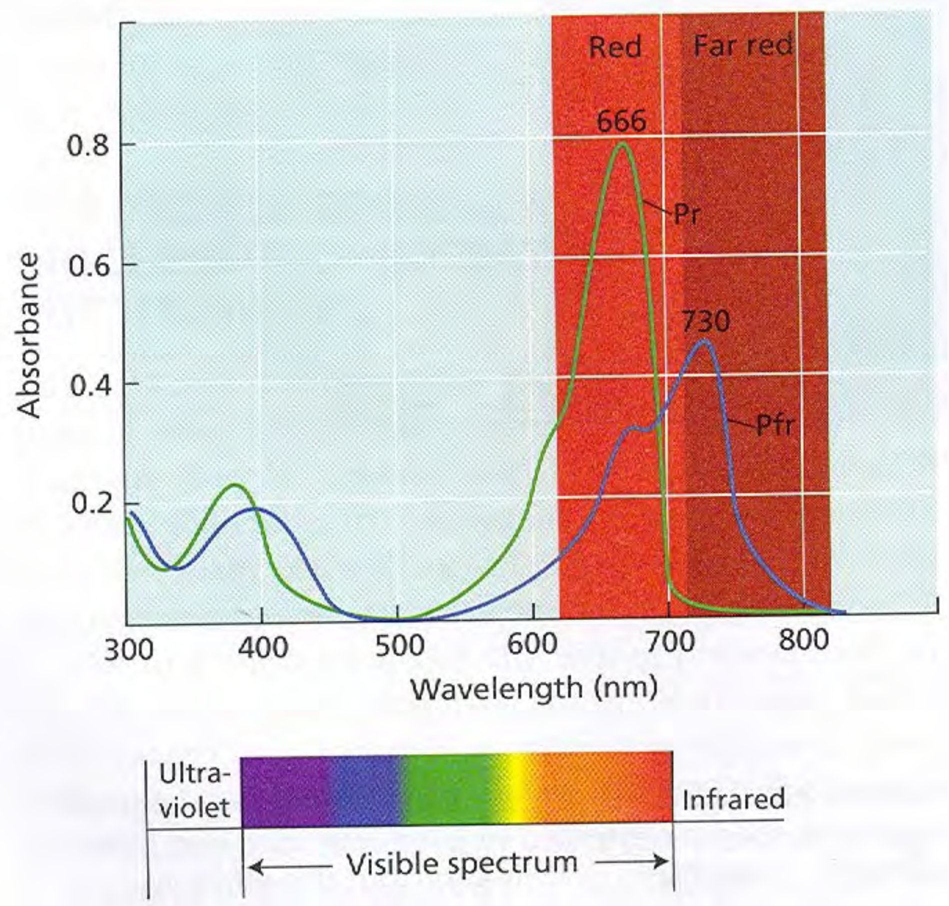
~2.5 g DM /MJ/m^2 for C3 plants

~3.8 g DM /MJ/m^2 for C4 plants


200 kg N/ha
100 kg N/ha
Control (0 N)
anthesis
Green leaf area index
6
3
0
0
150
300
Days after crop emergence

Light

- **Complex & dynamic sign**
- **Quantity of light**
  - photons falling /area/time
- **Quality of light**
  - plant responses



Plant development

A) Vegetative

- Emergence and - temperature
- Leaf appearance rates (phyllochron)- temperature

B) Reproductive

- Time of flowering (anthesis), Temperature and photoperiod
- Duration of grain fill -temperature

Driven by temperature modified by photoperiod and vernalization

Temperature

- Tt = Thermal time (°Cd)

$$= \frac{Tmax + Tmin}{2} - T_b$$

- Growing degree days (GDD)
- Heat units (HU)

Sowing to emergence

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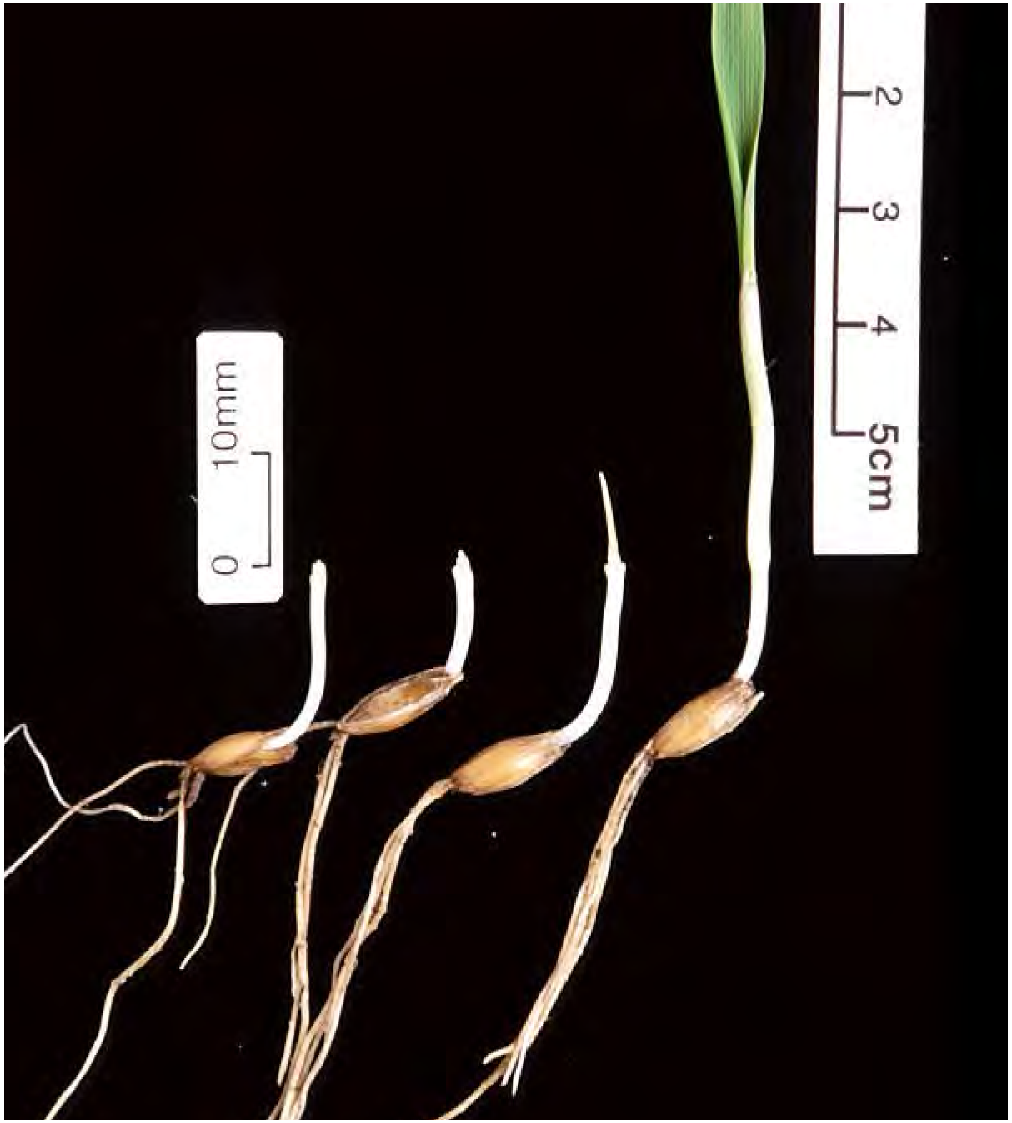

Thermal time

- **soil temperature**

~ 125-150 °Cd

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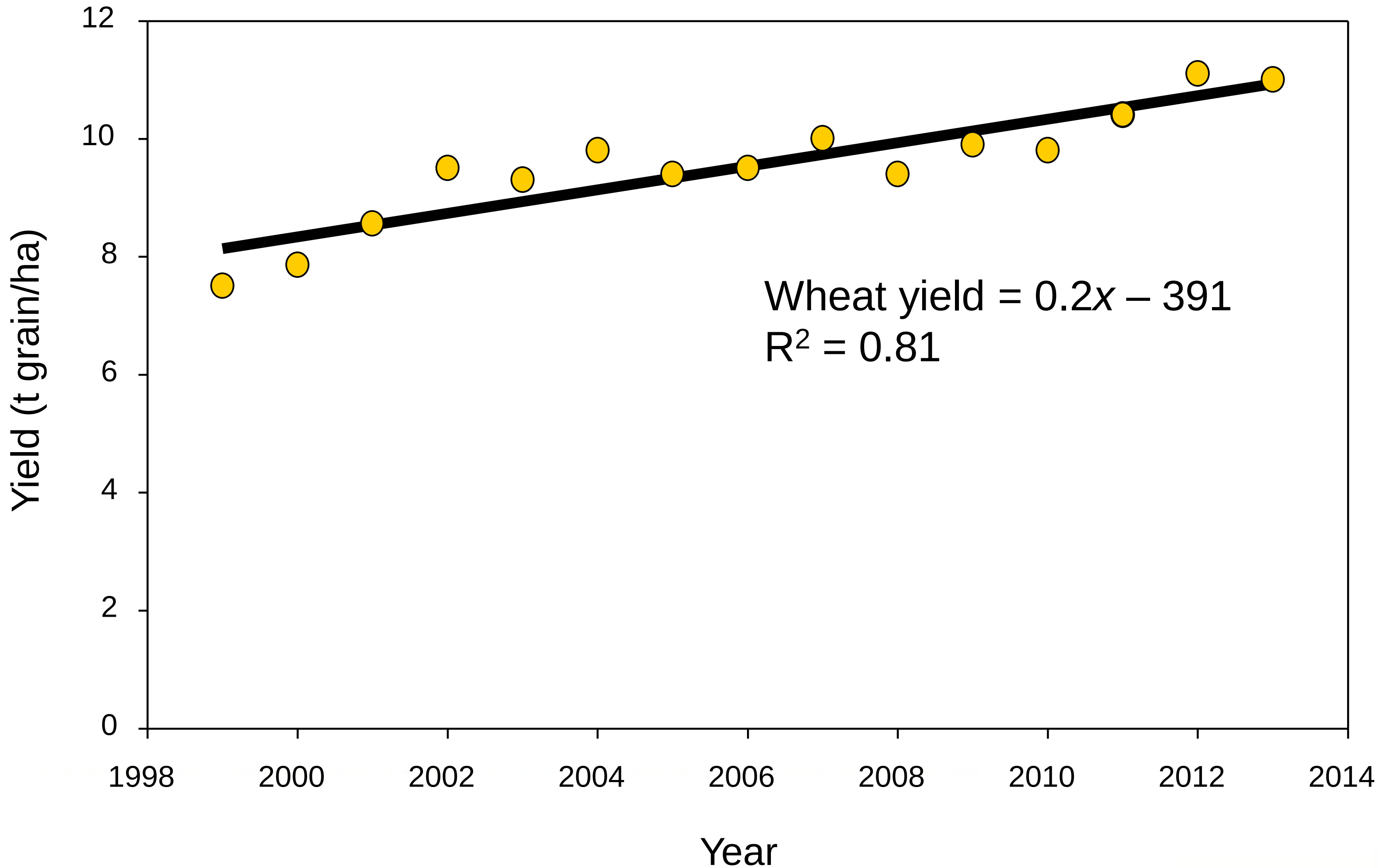
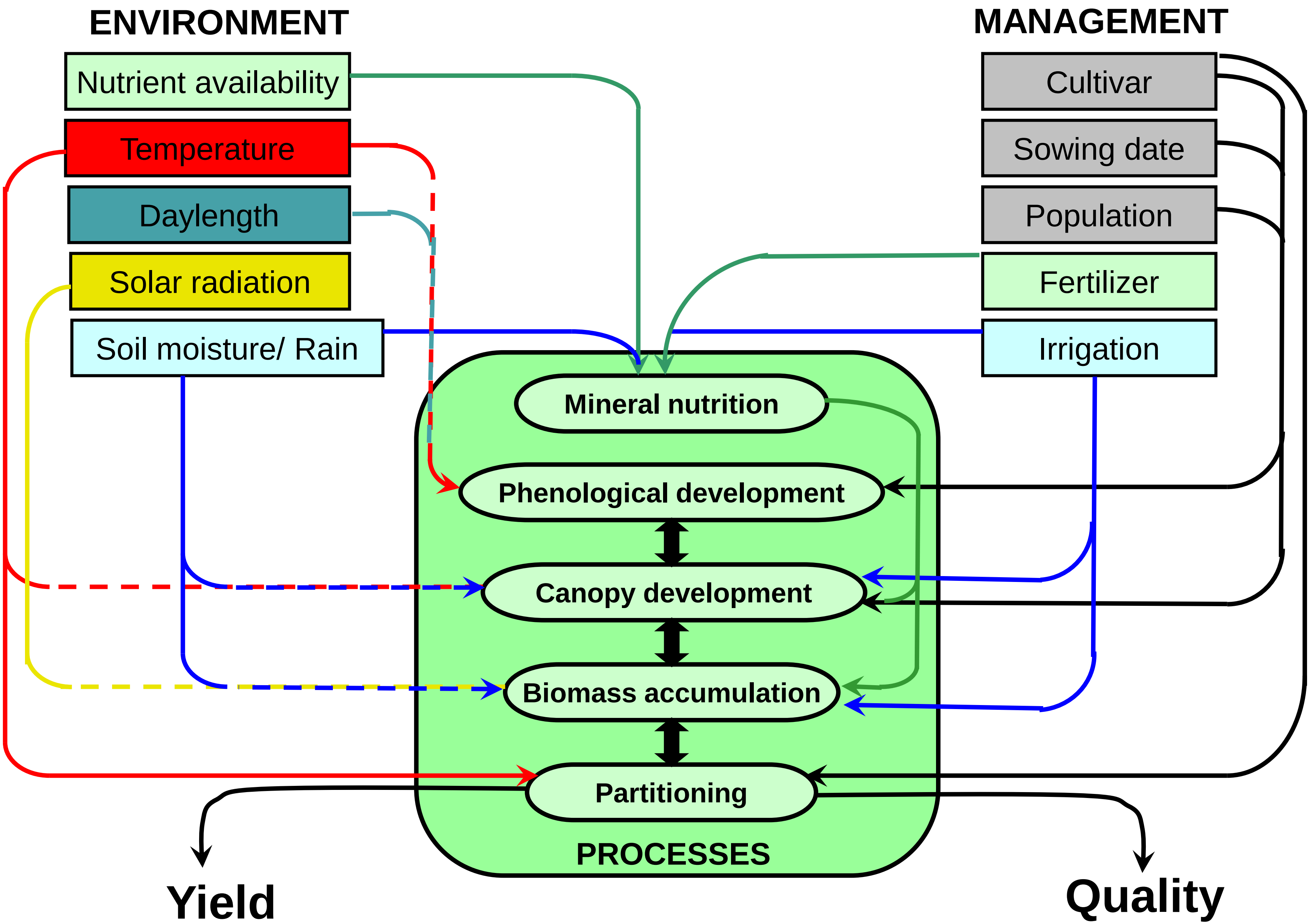
Grain-filling: constant in thermal time – air temperature


Wheat 15 t/ha; 40,000 ha
Barley 13 t/ha; 40,000 ha

Wheat grain yields in Canterbury



Source: Cereal performance trials
FAR, Canterbury



Relationship between environment and management factors and the physiological processes that regulate crop yield and quality. (Source: Hay & Porter 2006).

Olsen P<6

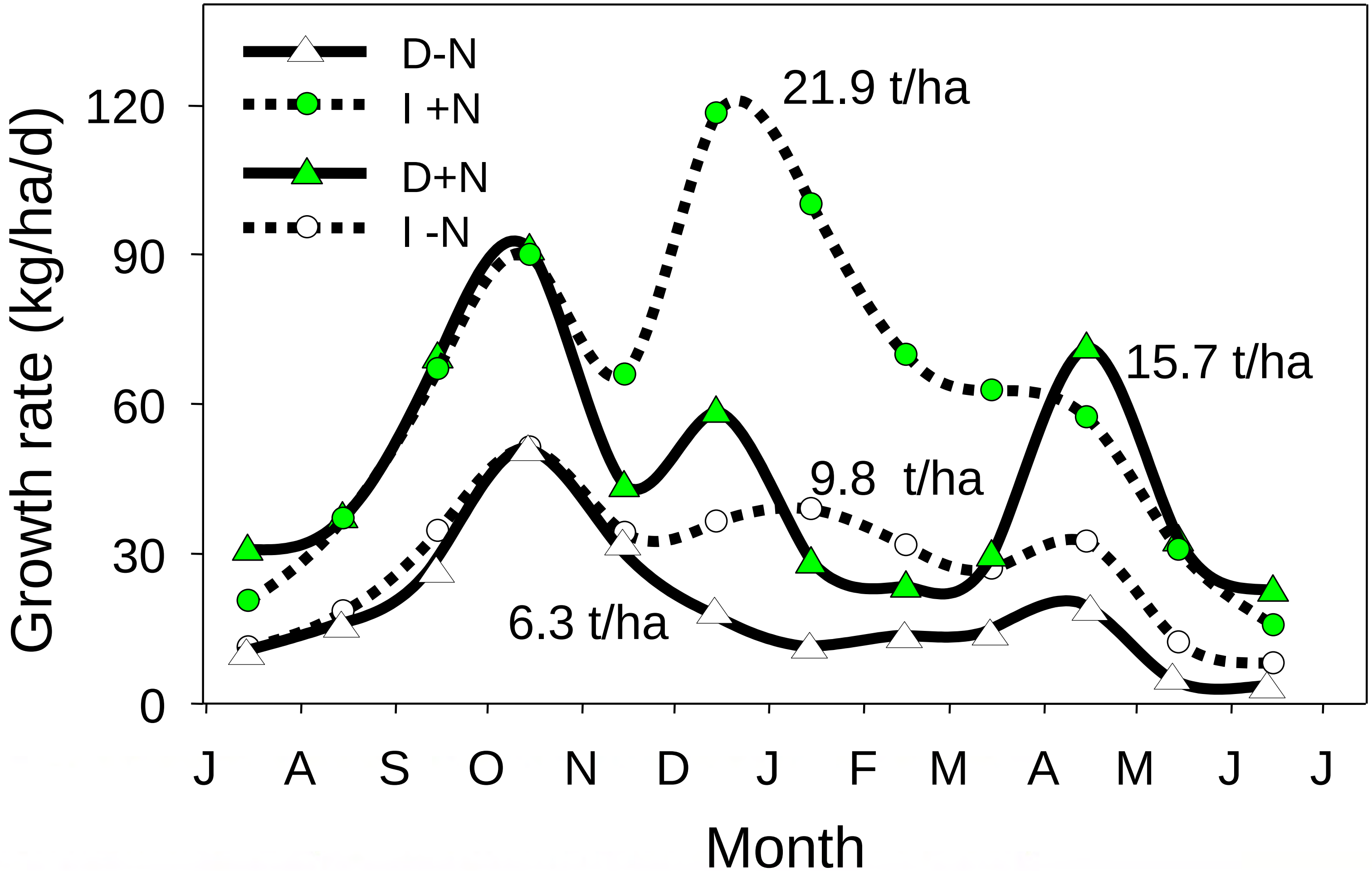
Olsen P>20

Drilling seed with fertiliser
Direct drilling = seed + fertiliser

Kearney et al 2010

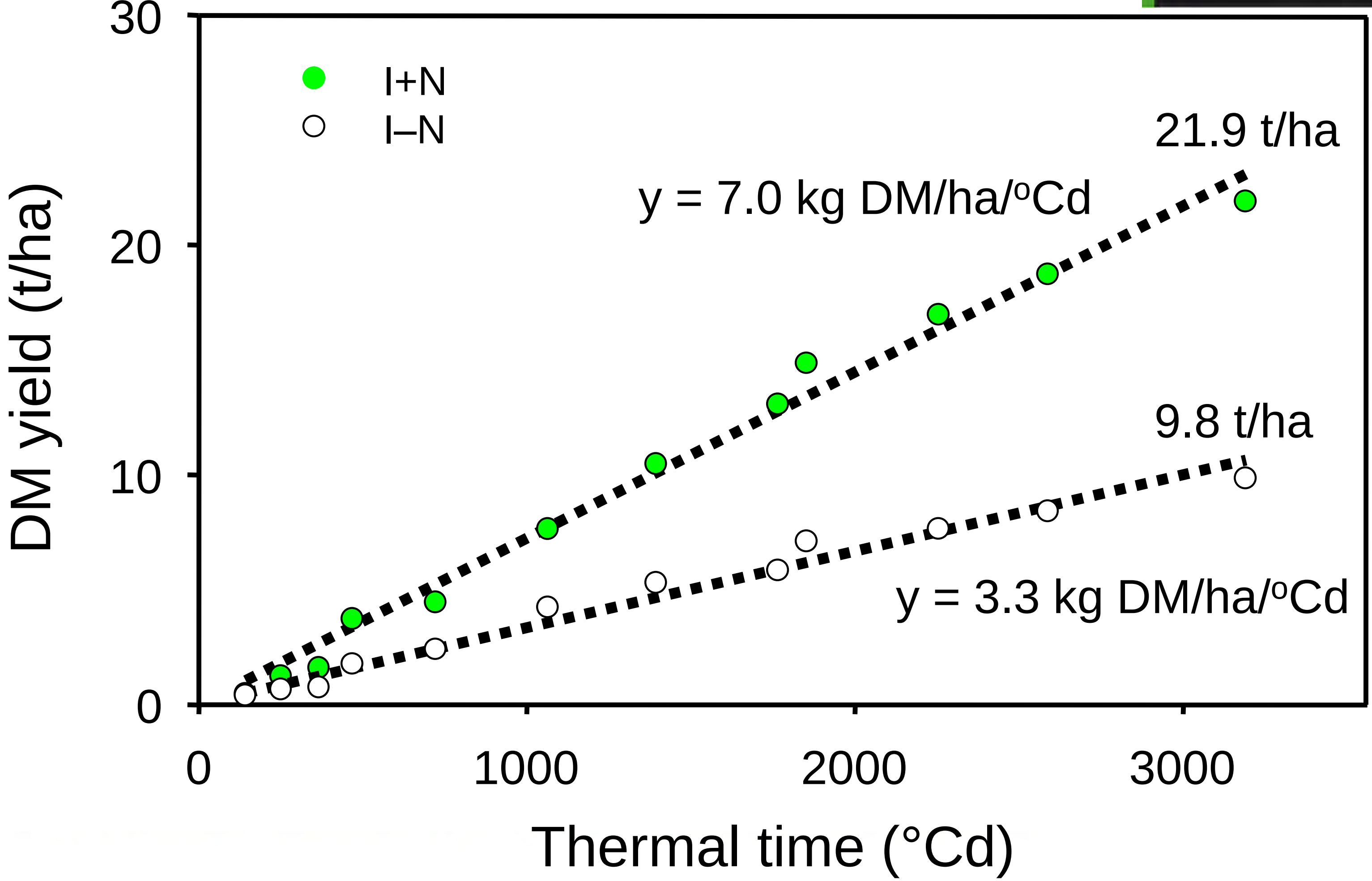
Experiment site

Growth rates (2 year means)




Winter
⇒ temperature response
Photo: K. Pollock
Lincoln University

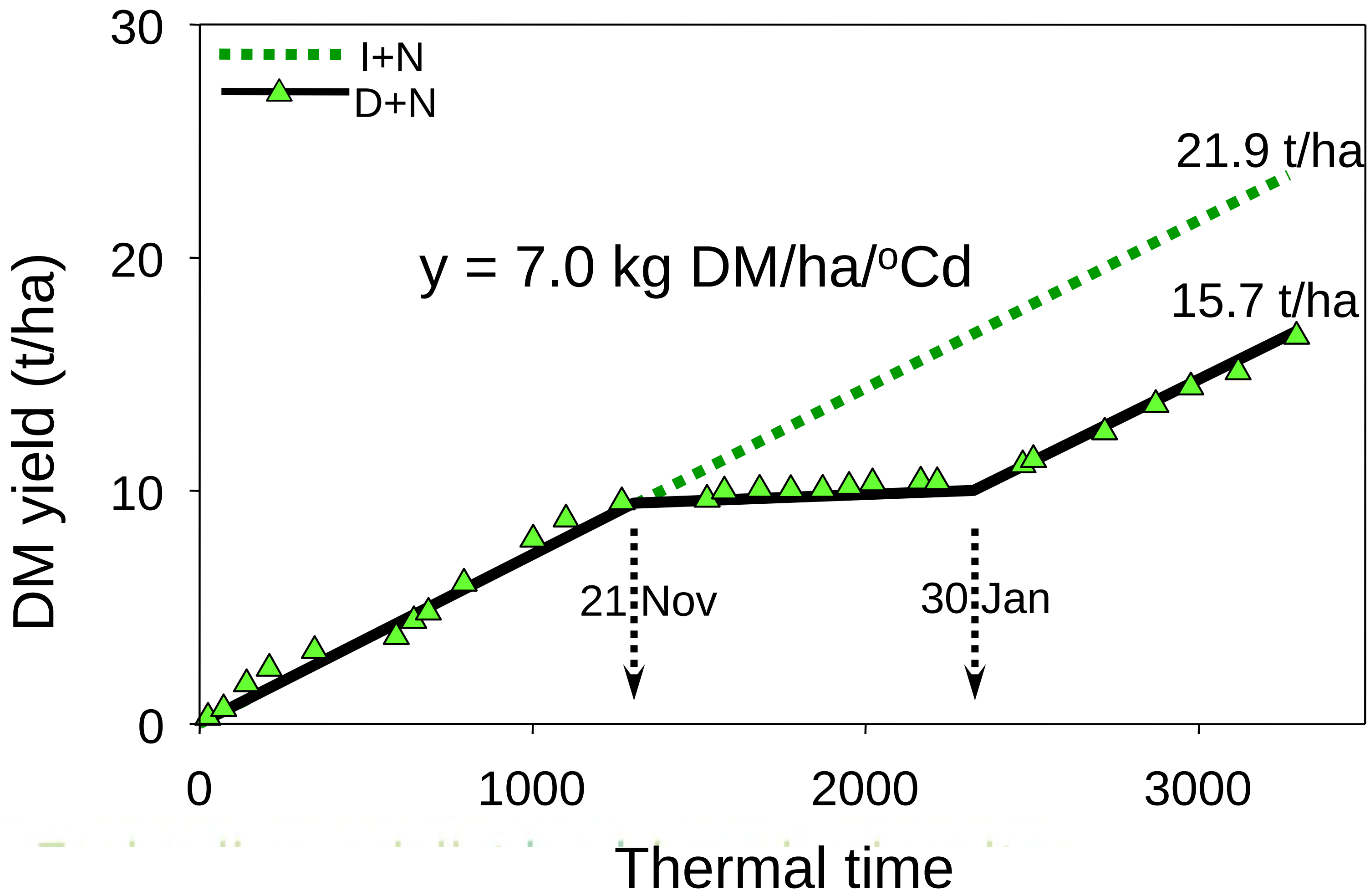
DM yield response to thermal time
(T_b = 3°C)



Mills et al. 2006

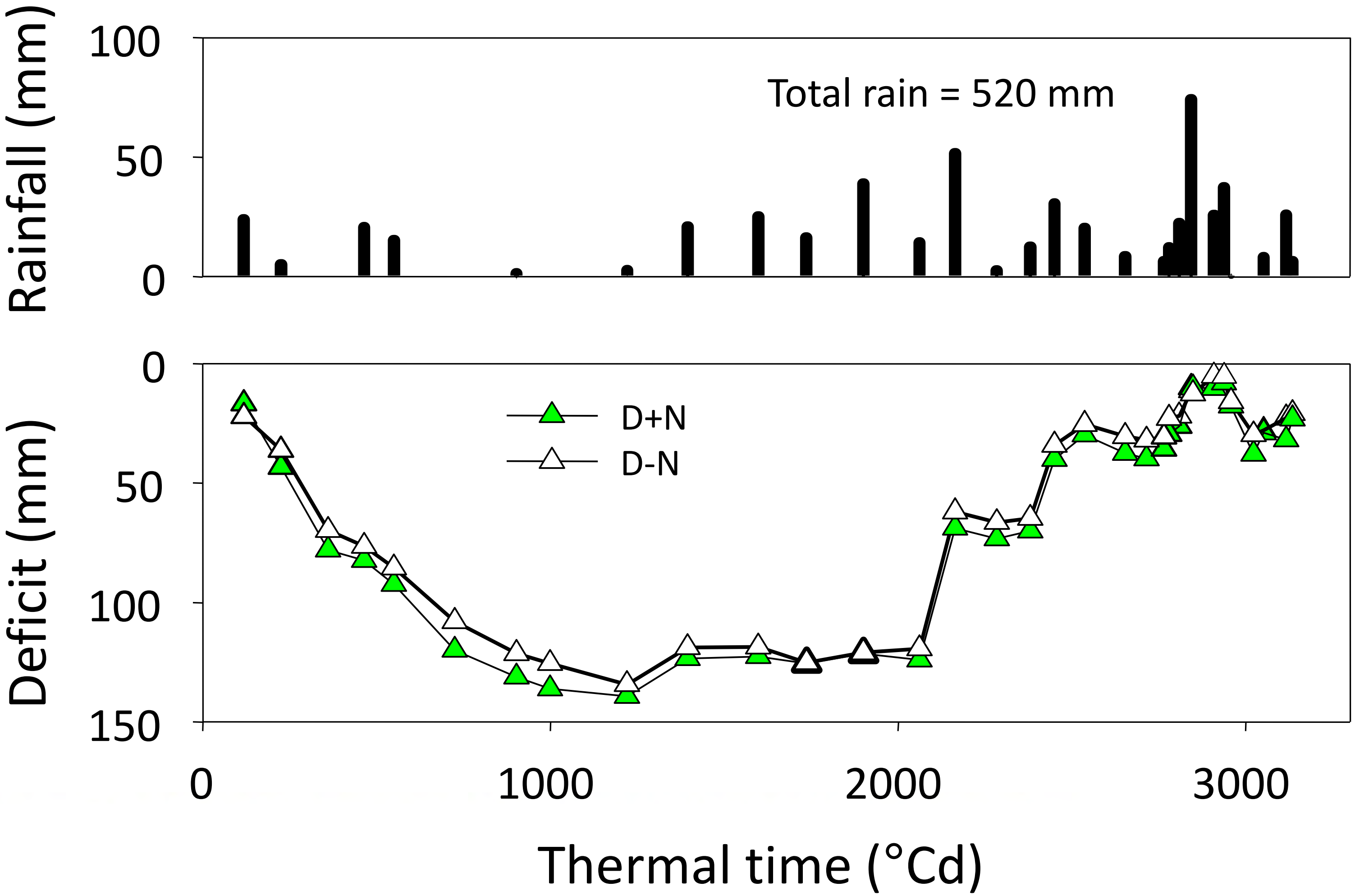
Summer ⇒ moisture response

Water stress effect on yield



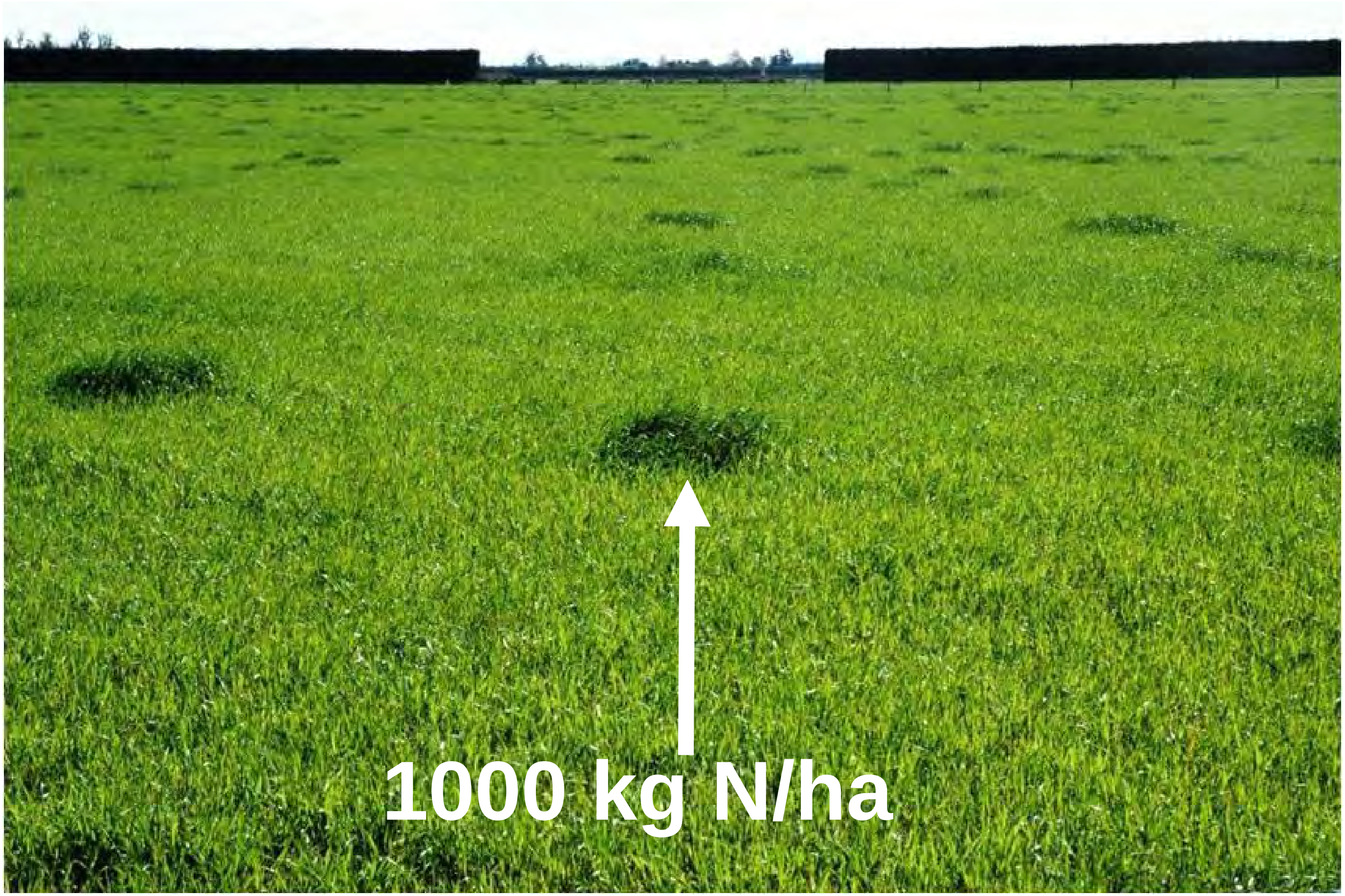
Mills et al. 2006

Soil moisture deficit 2003/04

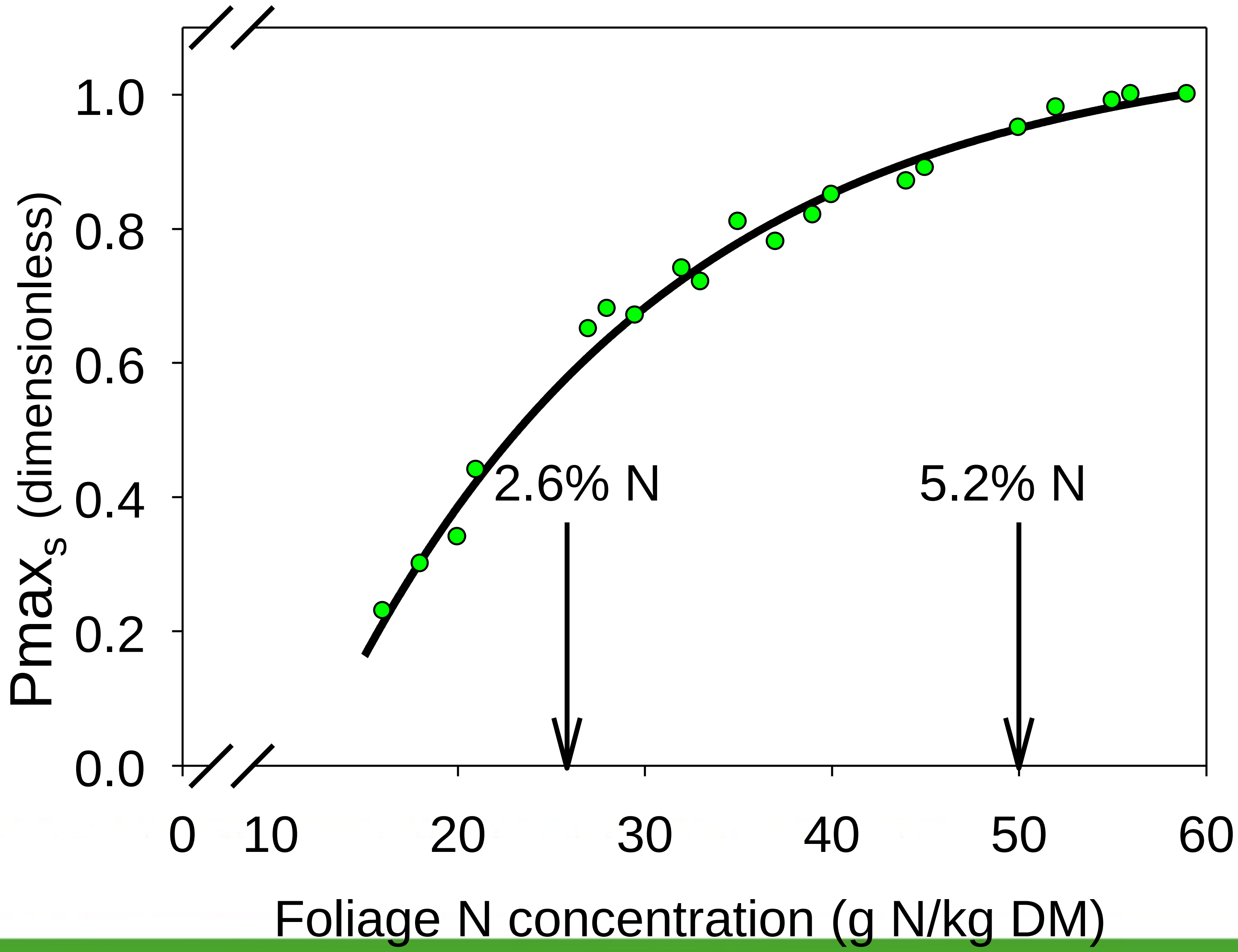


Mills 2007

Nitrogen deficient pasture – inefficient user of water

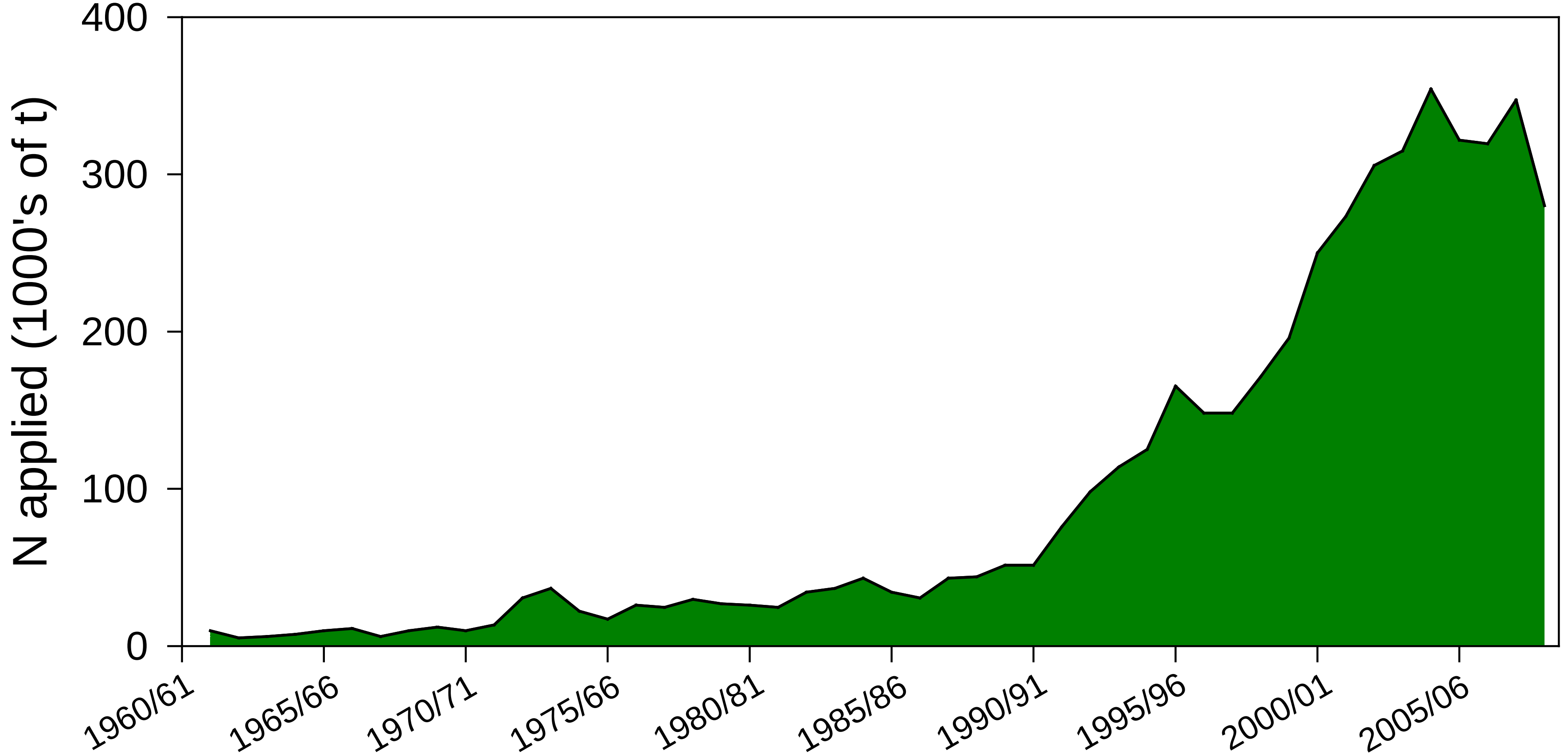


Plant vs animal requirements



Peri et al. 2002

Nitrogen fertiliser use



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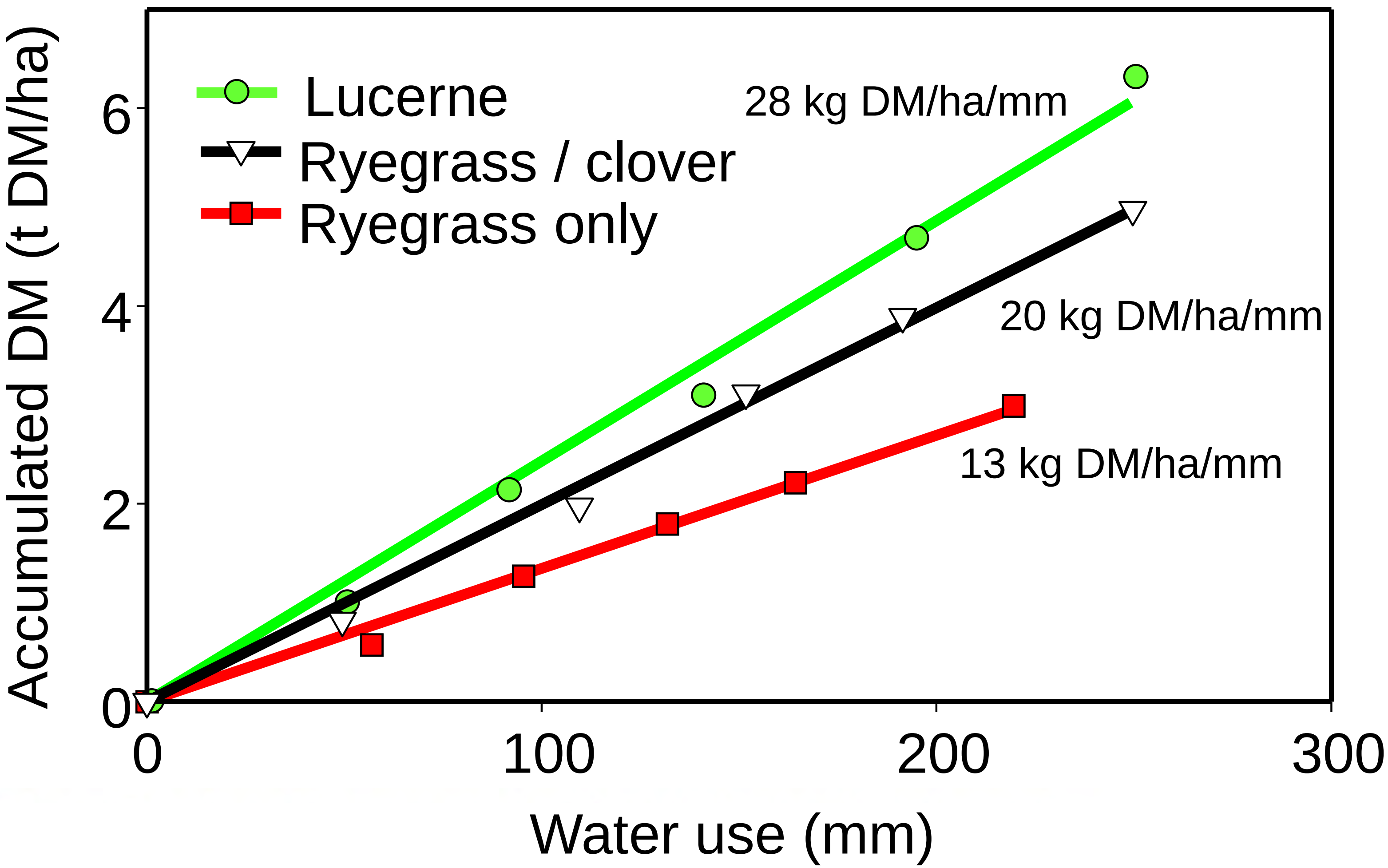
Source: New Zealand Fertiliser Manufacturers' Research Association

How can we increase WUE on-farm?

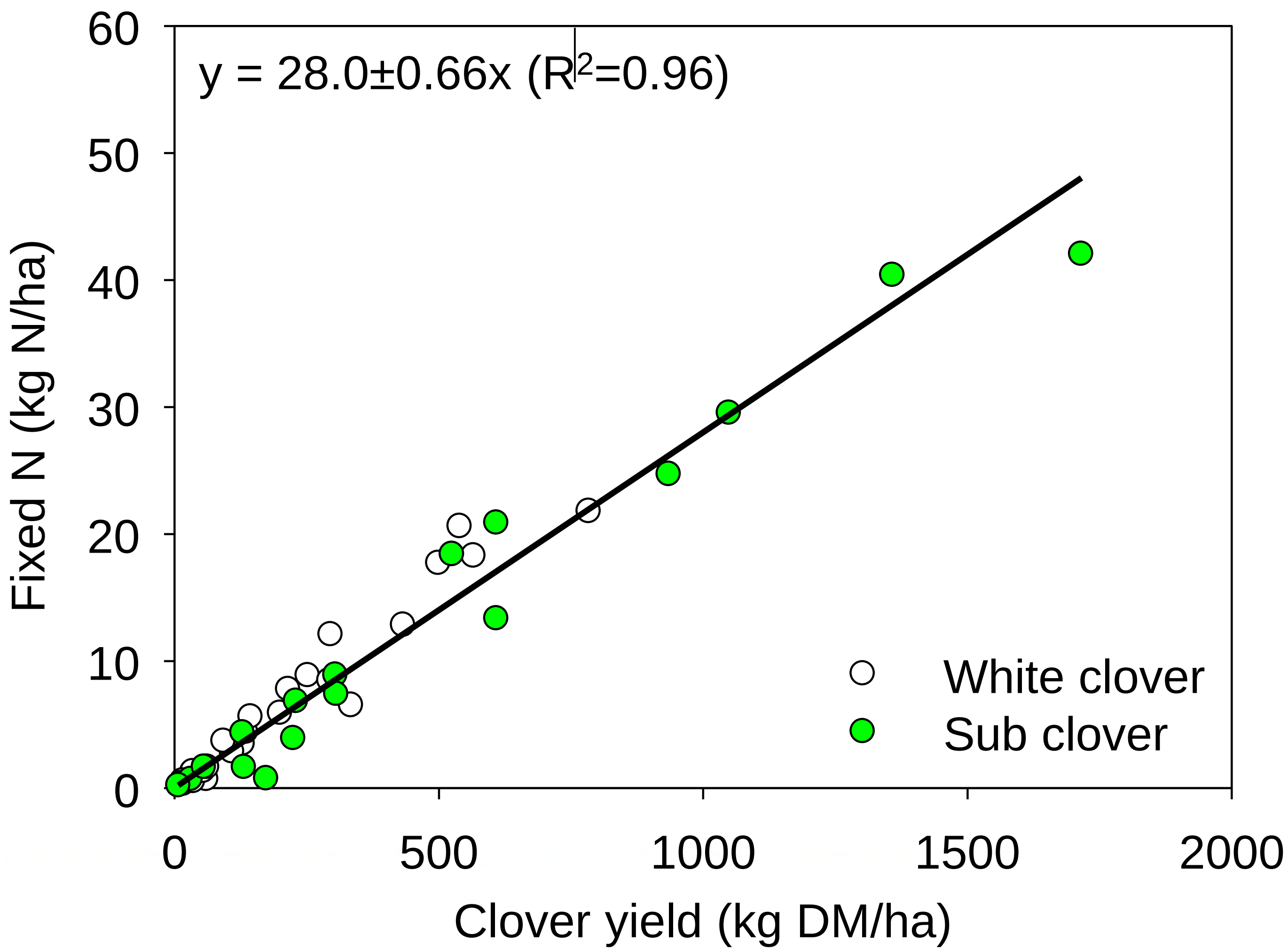
Spring WUE: legume = (nitrogen)



Moot et al. 2008

'Rosabrook' subterranean clover

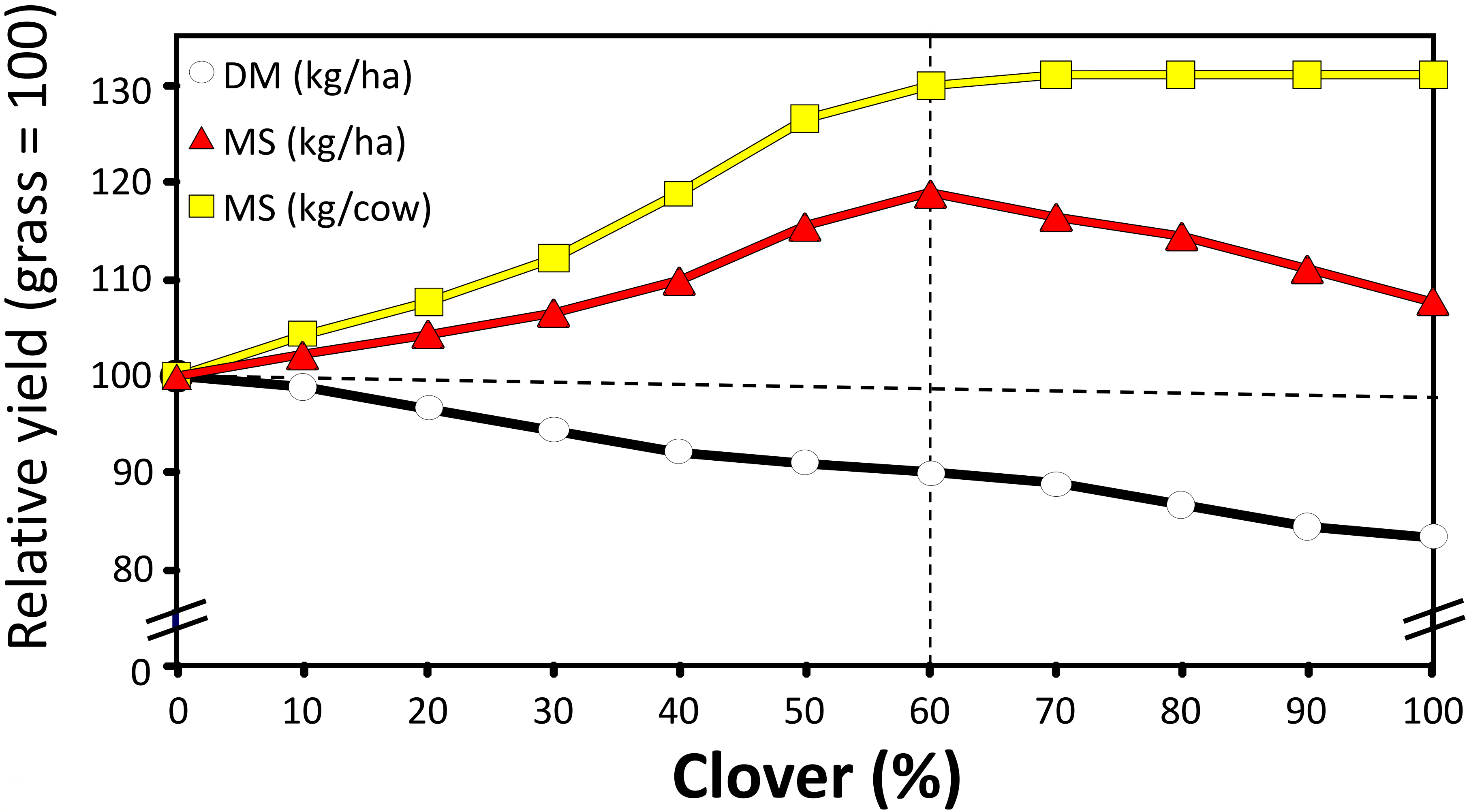
Biological N fixation



Lucas et al. 2010

Sheep prefer 70% legume, 30% grass

Clover content & milksolids production



Sheep prefer 70% legume, 30% grass


Russell lupin grazing trial at Sawdon Station
High aluminium soils
Black et al. 2014

Conclusions

- Light interception drives dry matter production
- Temperature (air and soil) affect crop development
- NTW water affect leaf area expansion and Ps.
- Spring gives highest WUE
- Agronomists role is to balance nitrogen and water
- WHICH LEGUME? – When to use urea?
- Optimize production with minimal footprint

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Acknowledgements for data/graphs

- Environment Canterbury (ECAN) for Harts Creek data (data ©ECAN)
- New Zealand Fertiliser Association for the nitrogen fertiliser data

Websites/Social Media presence

Lincoln University Dryland Pastures Website:
http://www.lincoln.ac.nz/dryland

Lincoln University Dryland Pastures Blog:
https://blogs.lincoln.ac.nz/dryland/

YouTube: https://www.youtube.com/DrylandPastures

Facebook: https://www.facebook.com/DrylandPasturesResearch