Lincoln University
Te Whare Wānaka o Aoraki
AOTEAROA • NEW ZEALAND

Agronomy of crops and pastures
Hamilton, Victoria 24th July 2014

Derrick Moot




Photo: Dr W.R. Scott

Photo of Dr W.R. Scott by the remains of the Famous Gouse Pub, Lincoln, NZ

63%   Mountain and hill country

Photo: Dr W.R. Scott

13% Inland basins

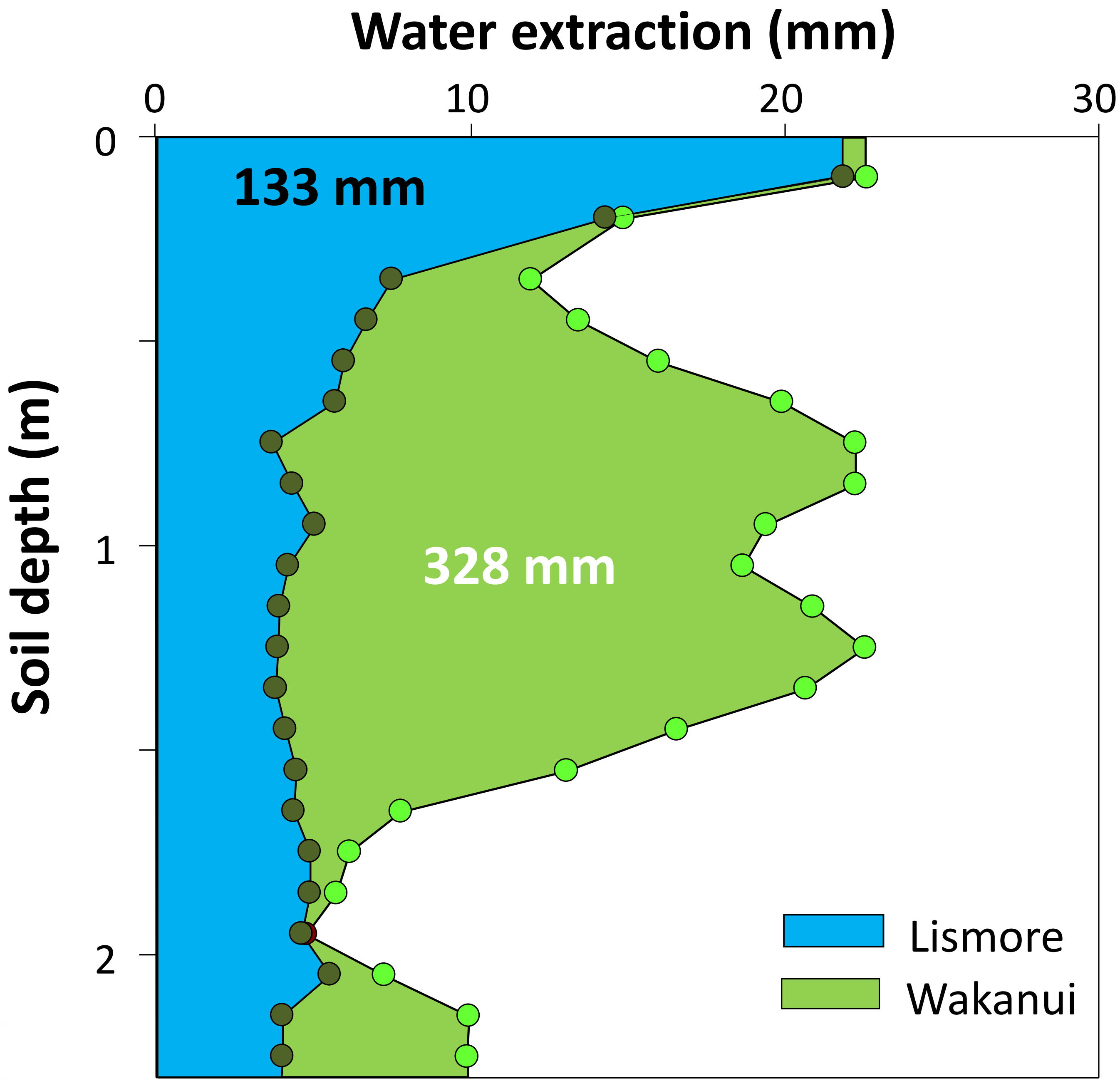
Photo: Brown & Naish, GNS


High variability over short spaces

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

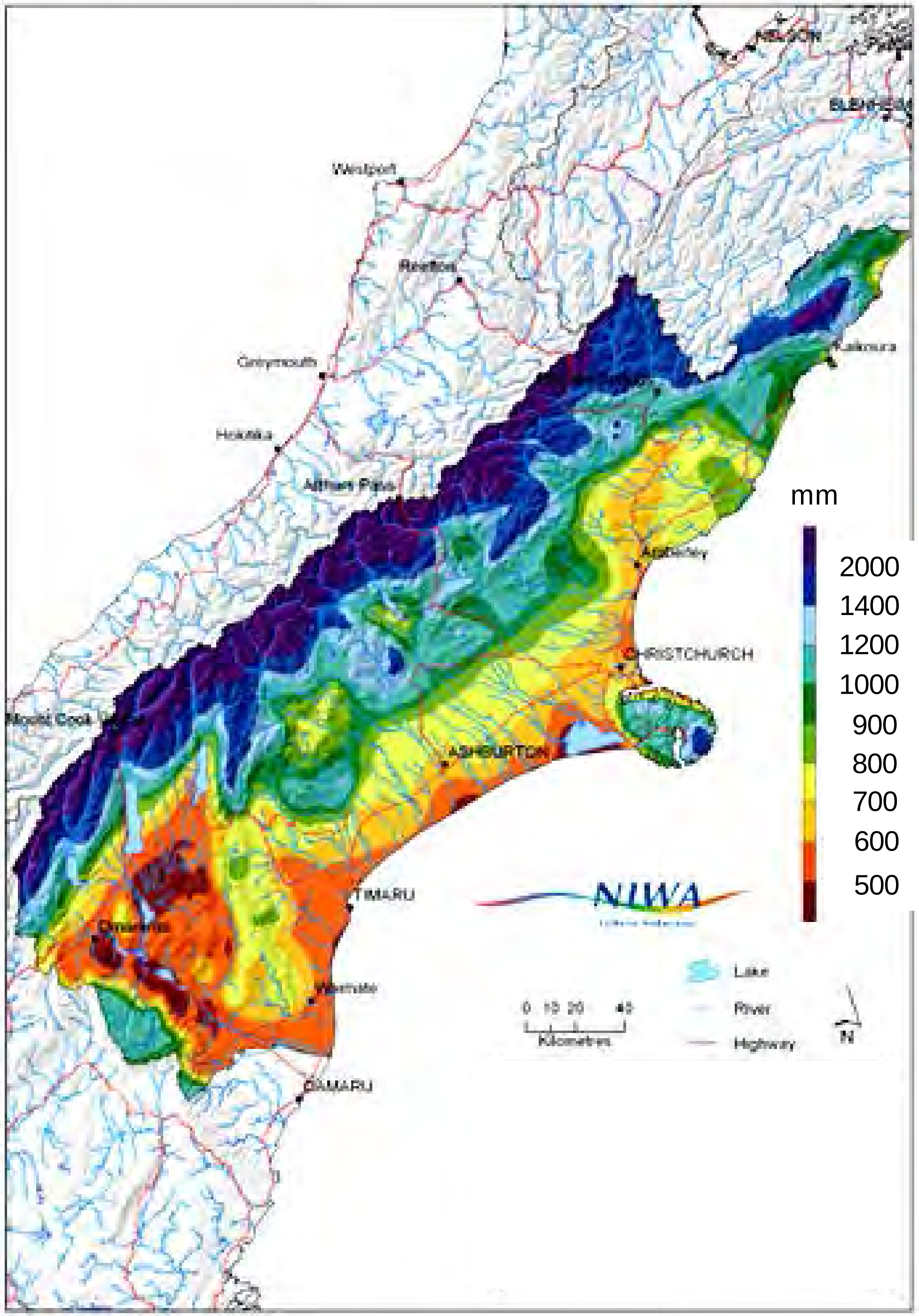
Photo: supplied Lincoln
University Soils Department

Soil water extraction - Wakanui



Soil water extraction

Deep Wakanui soil has 200 mm more available water



Climate

Median rainfall (mm)
(1971-2000)

Source: Climate Explorer
NIWA, 2010

Unimproved scrub land on light soils

Dairy pasture

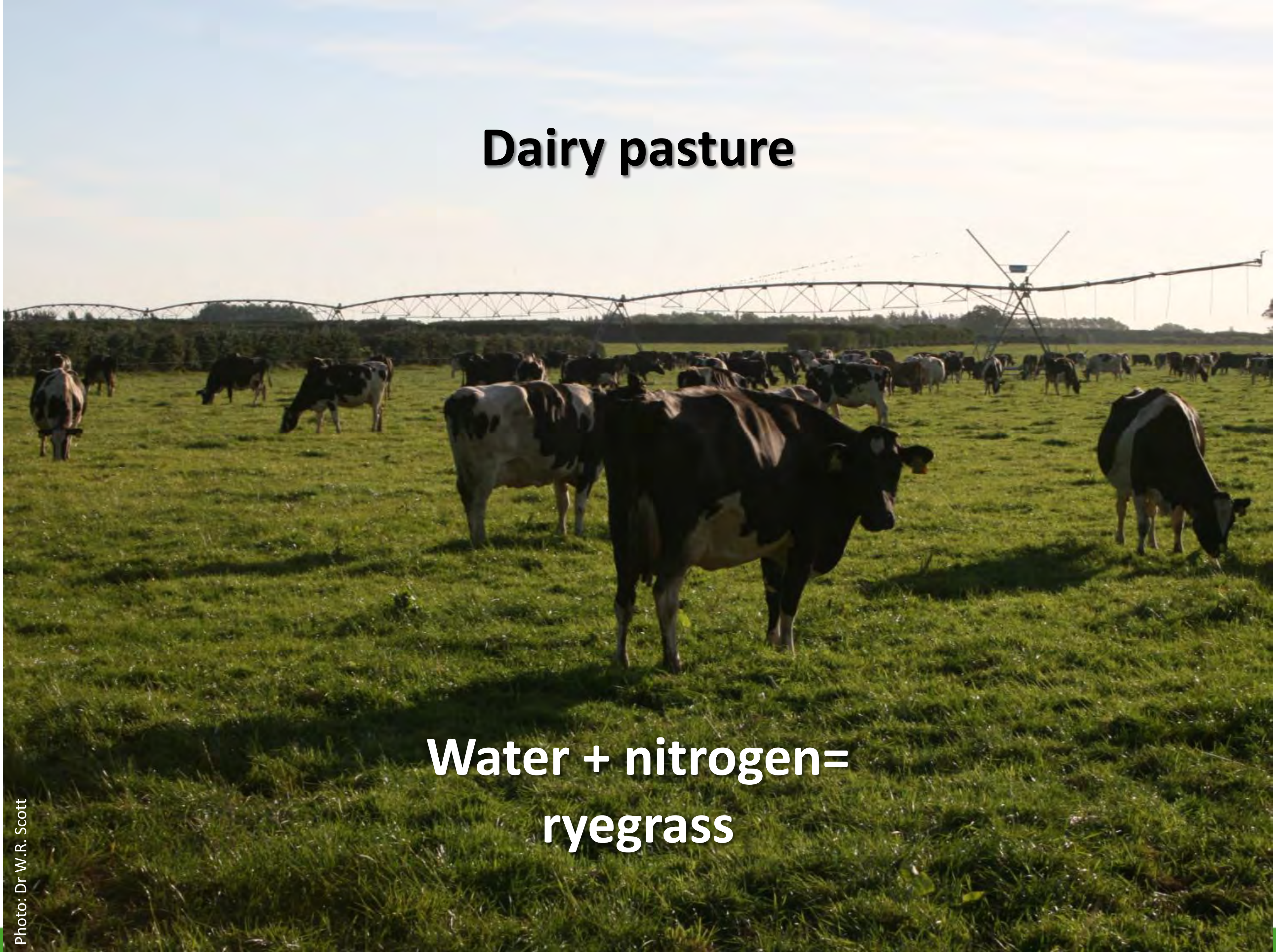
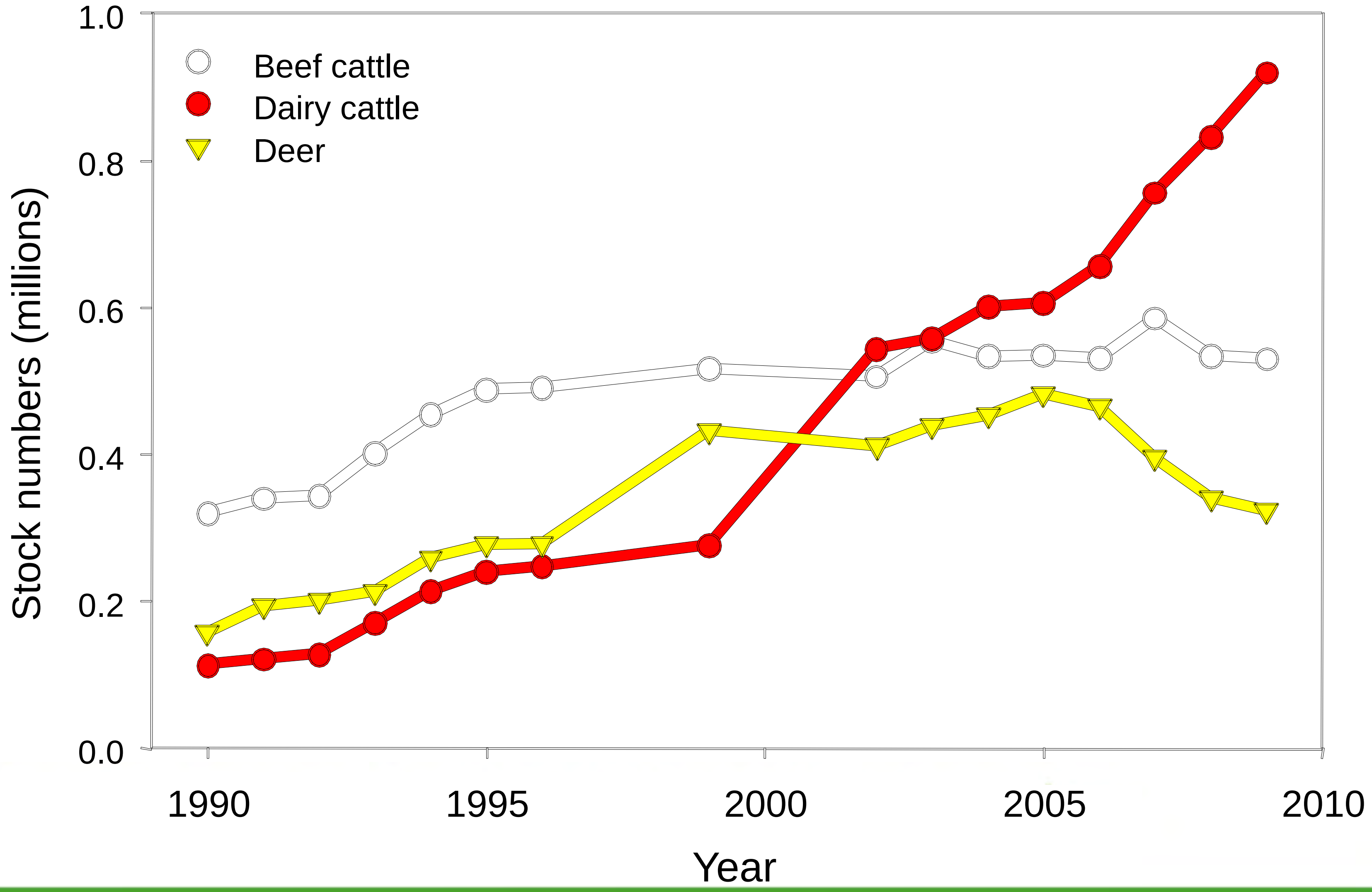


Photo: Dr W.R. Scott

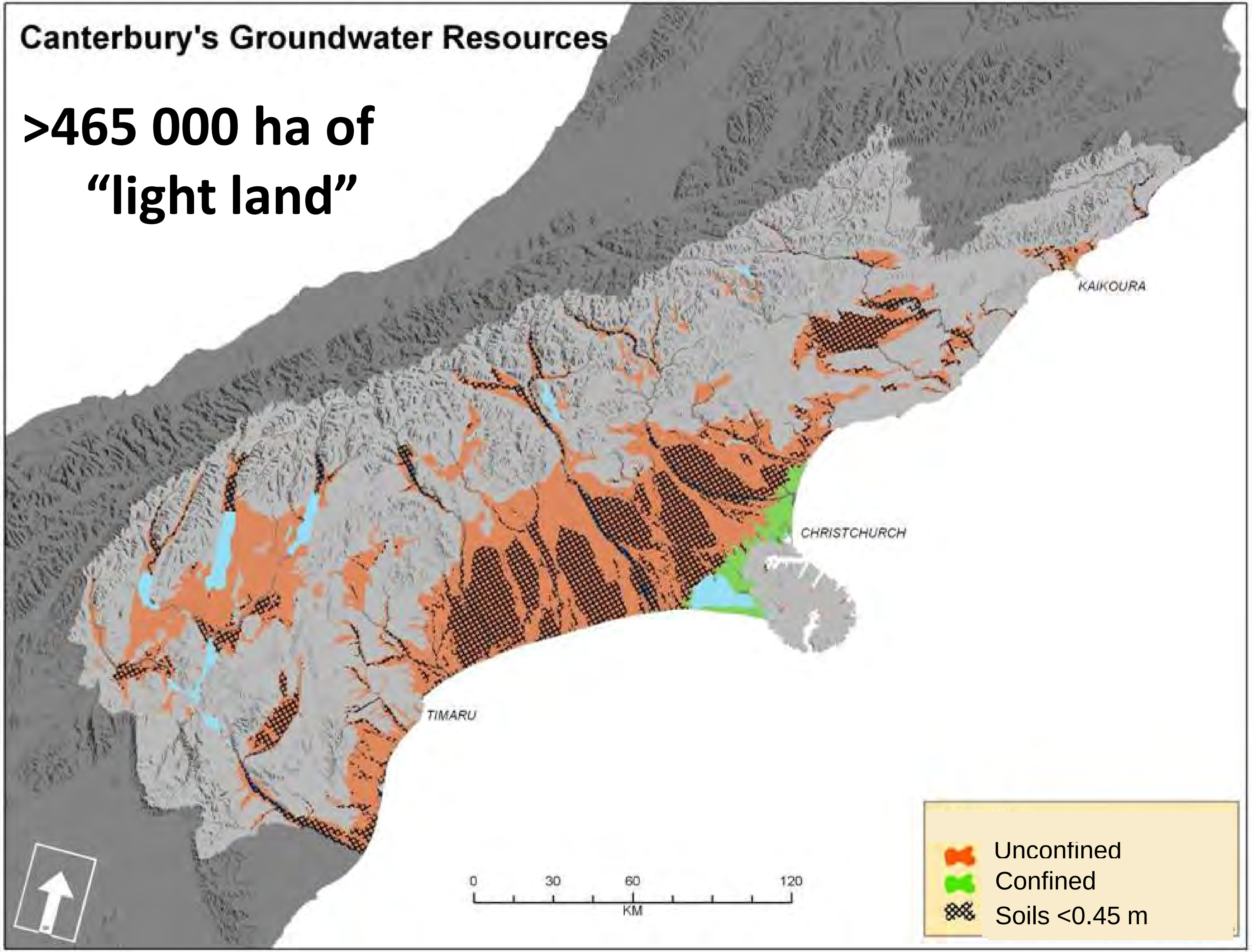
Water + nitrogen= ryegrass

The population...deer & cattle



Source: Department of Statistics

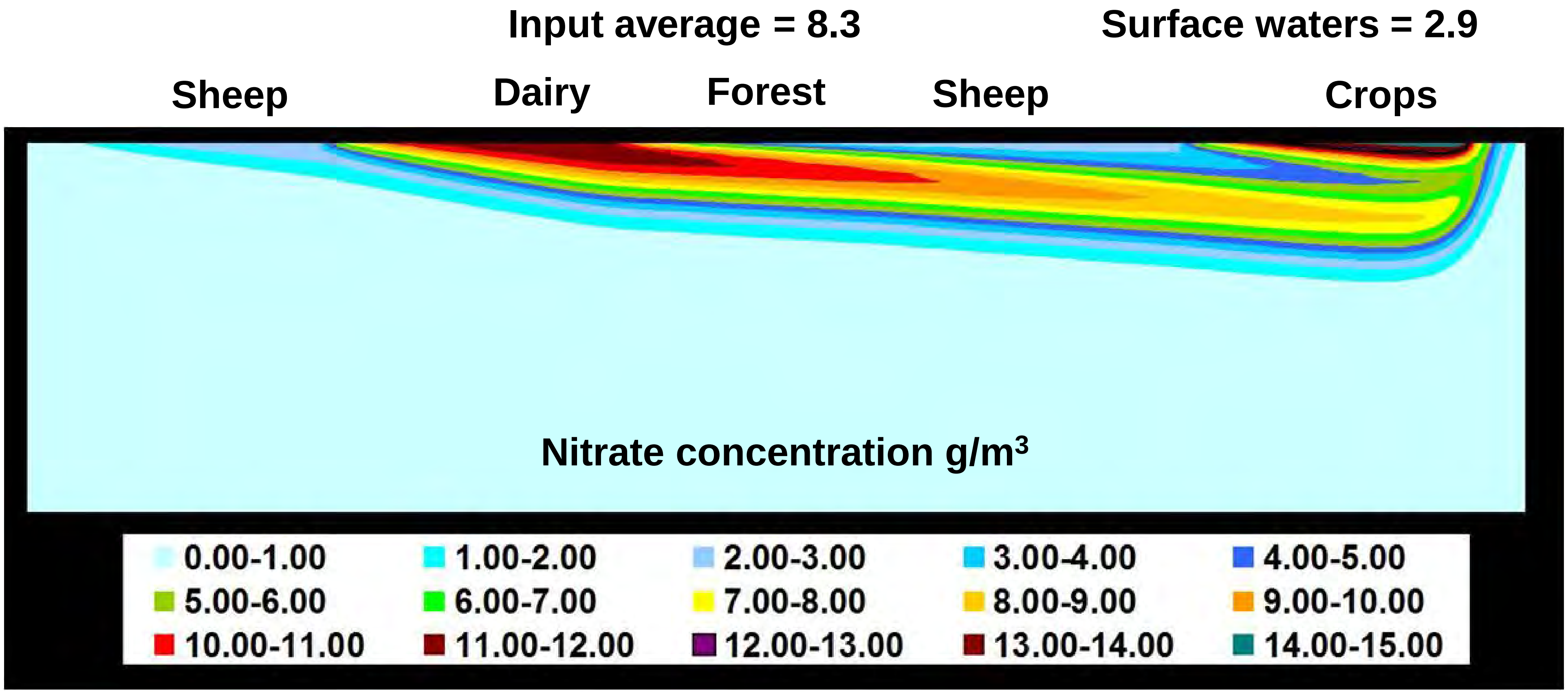
>465 000 ha of "light land"



Source: Ken Taylor ECan


Photo: Dr D.J. Moot

Introduction of dairy farming changes the amount & distribution of nitrate in the aquifer.



Bidwell *et al.*, 2009

21% Flat undulating floodplain (fluvial megafans)

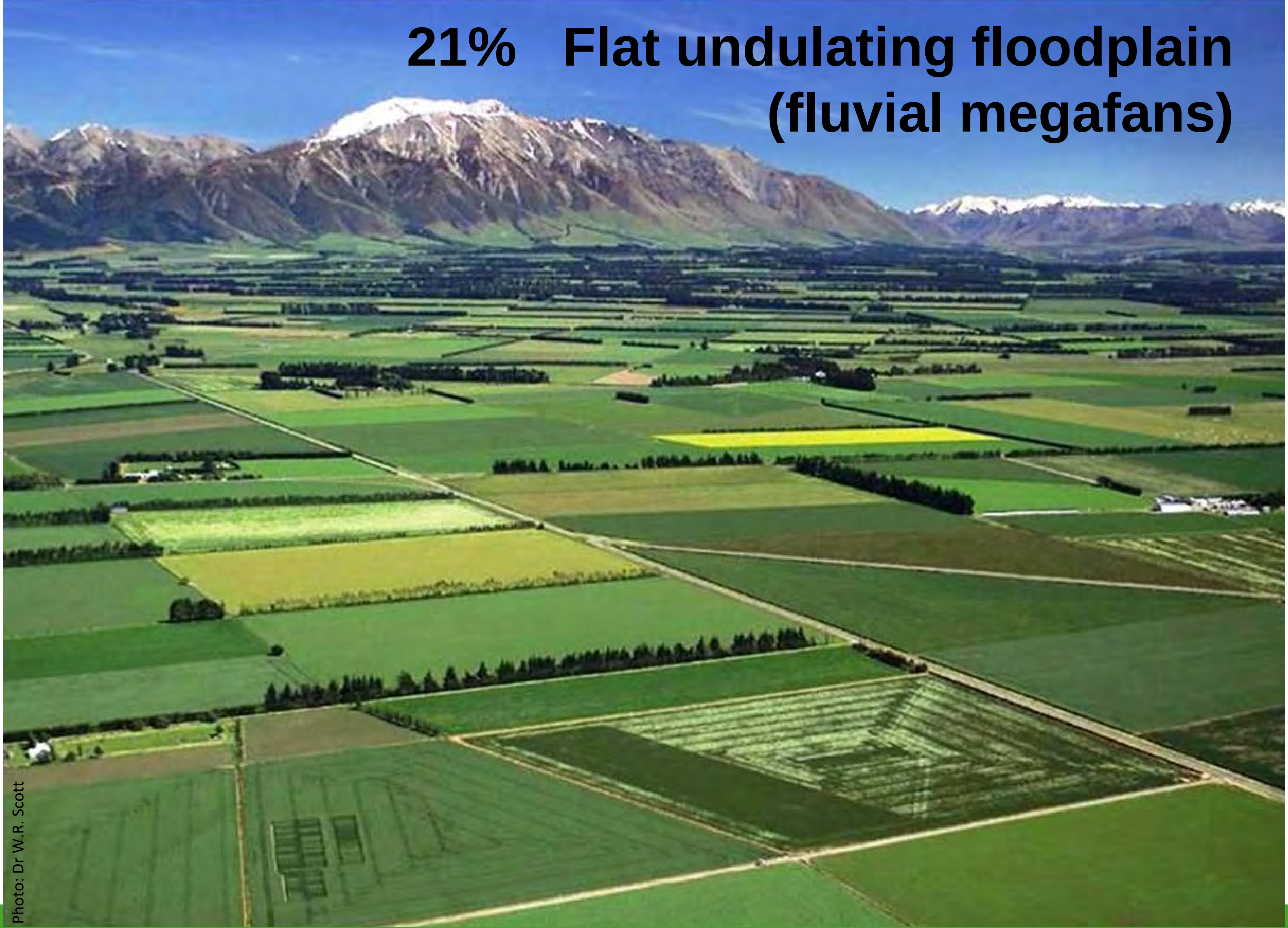


Photo: Dr W.R. Scott

~60% of the fresh and process peas

Photo: Dr W.R. Scott

Onions for export, 4000 ha of potatoes

High values seed crops

10,000 ha clover seed for export

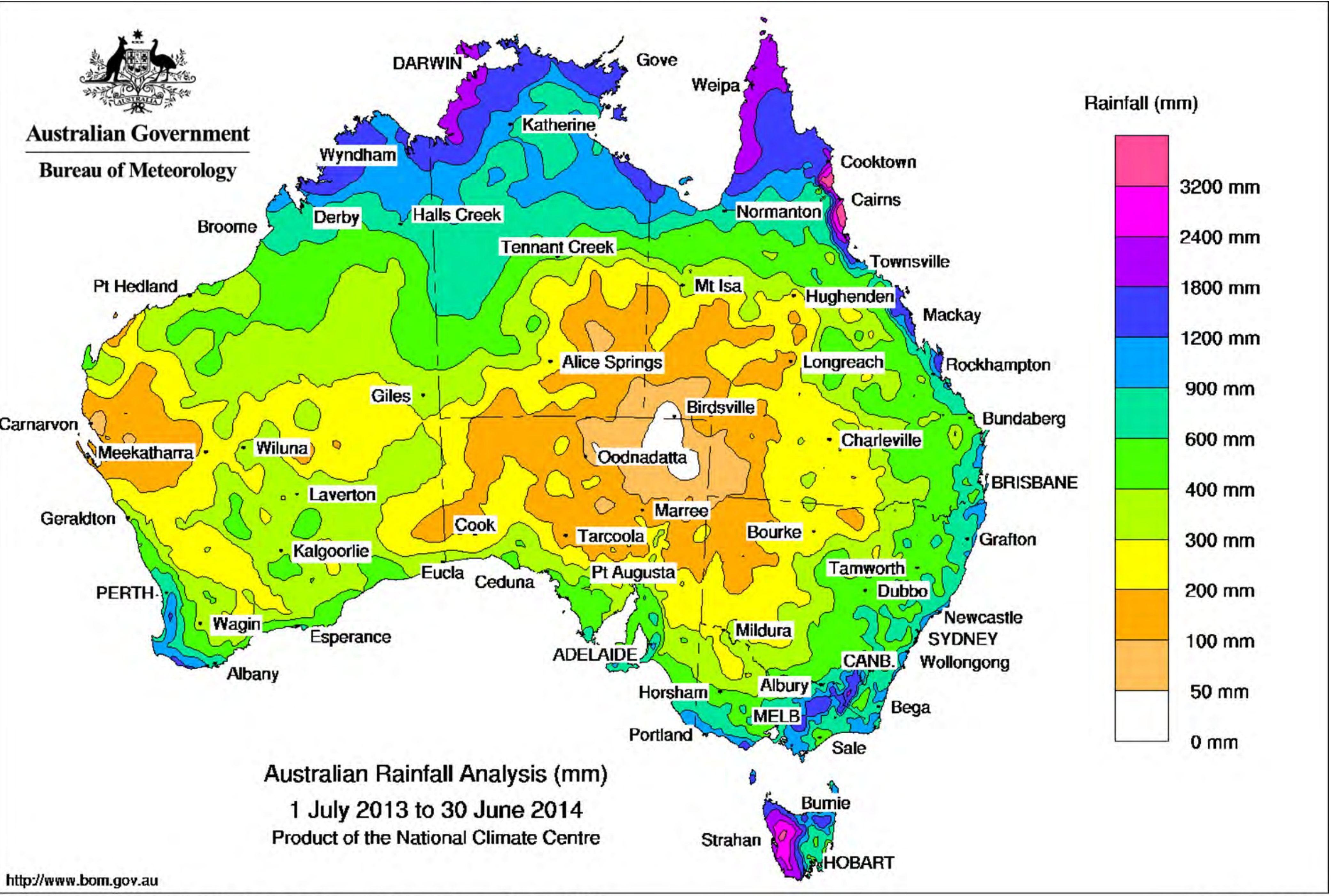
Herbage grass 1.5 - 2.5 t seed/ha

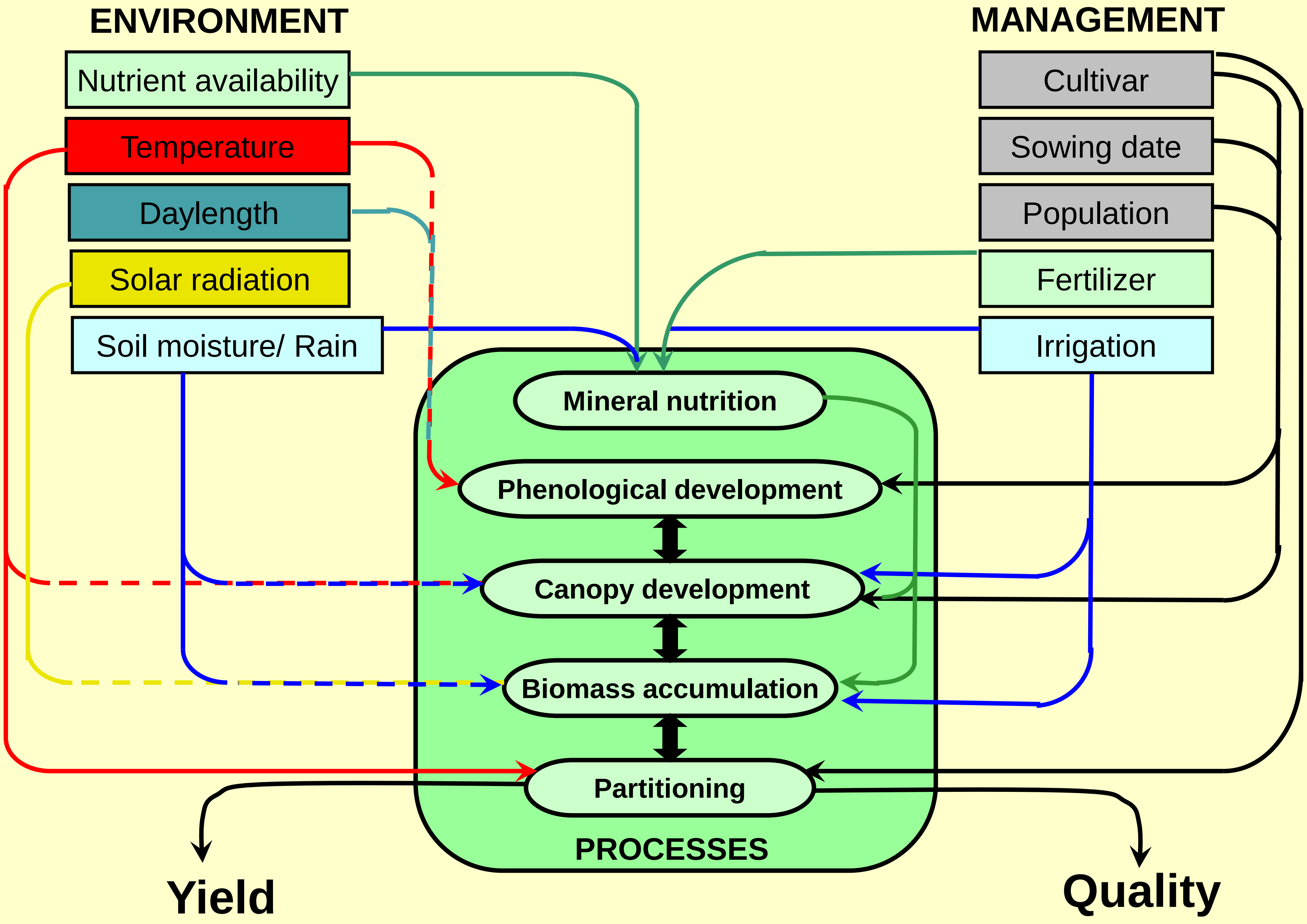
Wine production in Nth Canterbury

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"?


Australian Government
Bureau of Meteorology
Australian Rainfall Analysis (mm)
1 July 2013 to 30 June 2014
Product of the National Climate Centre
Rainfall (mm)
3200 mm
2400 mm
1800 mm
1200 mm
900 mm
600 mm
400 mm
300 mm
200 mm
100 mm
50 mm
0 mm
DARWIN
Gove
Weipa
Katherine
Wyndham
Cooktown
Cairns
Normanton
Derby
Halls Creek
Broome
Tennant Creek
Townsville
Pt Hedland
Mt Isa
Hughenden
Mackay
Alice Springs
Longreach
Rockhampton
Giles
Birdsville
Bundaberg
Carnarvon
Charleville
Meekatharra
Wiluna
Oodnadatta
BRISBANE
Laverton
Marree
Geraldton
Cook
Tarcoola
Bourke
Grafton
Kalgoorlie
Tamworth
Eucla
Ceduna
Pt Augusta
Dubbo
PERTH
Newcastle
SYDNEY
Wagin
Esperance
Mildura
ADELAIDE
CANB.
Wollongong
Albany
Horsham
Albury
Bega
MELB
Portland
Sale
Burnie
Strahan
HOBART
http://www.bom.gov.au



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

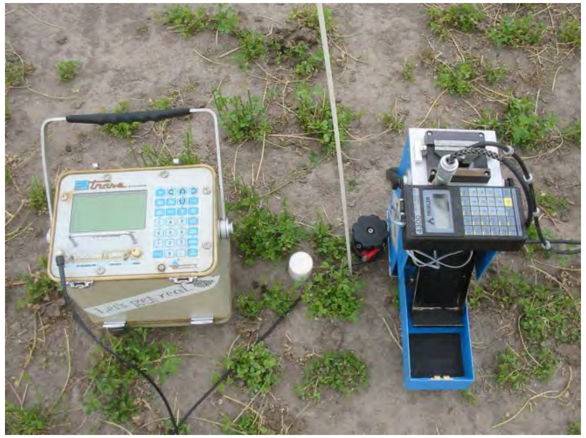
Measurements

Light environment

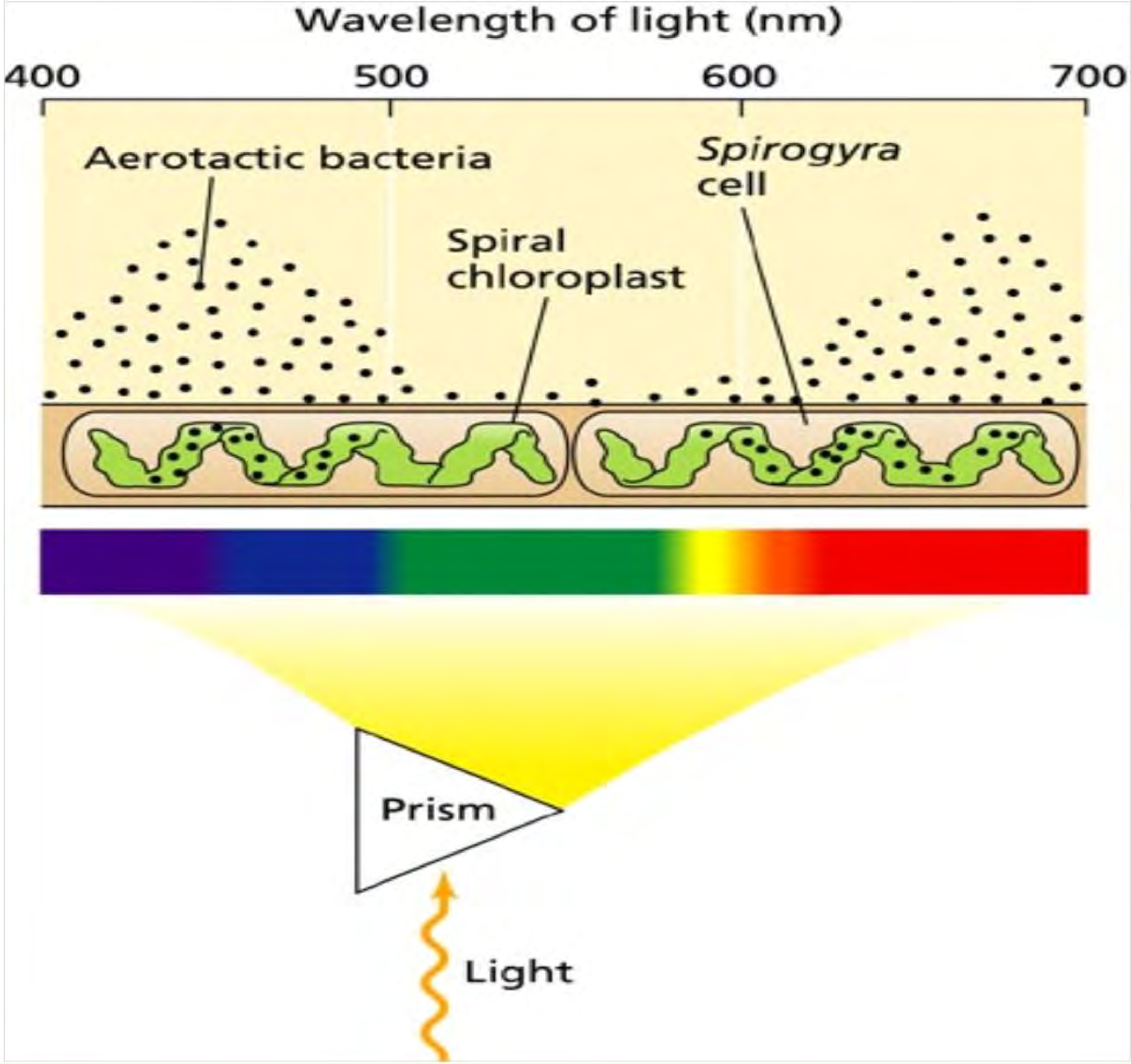
Chemical Analysis:
-N (shoots and roots)
-Starch in roots
-Soluble sugars in roots

Temperature
- Air and soil

Soil moisture



Photosynthesis



Taiz & Zeiger, 2010

The canopy:
the energy capture device

Crop Growth and Yield

1) **C = E*Q**

C = daily rate of DM prod.

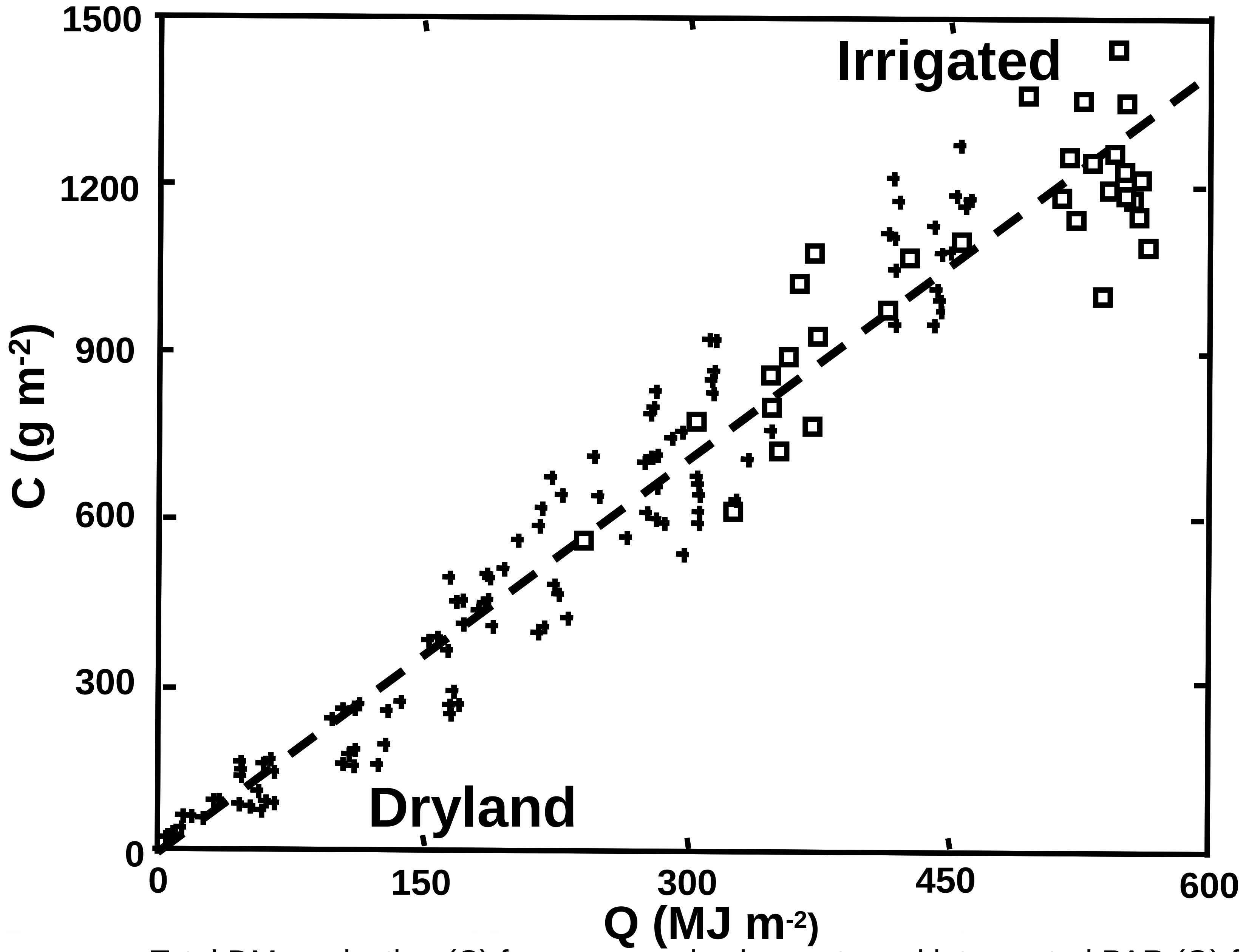
E = radiation use efficiency

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). Source: Wilson 1987

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Light

- photosynthesis to produce CHO's for growth.

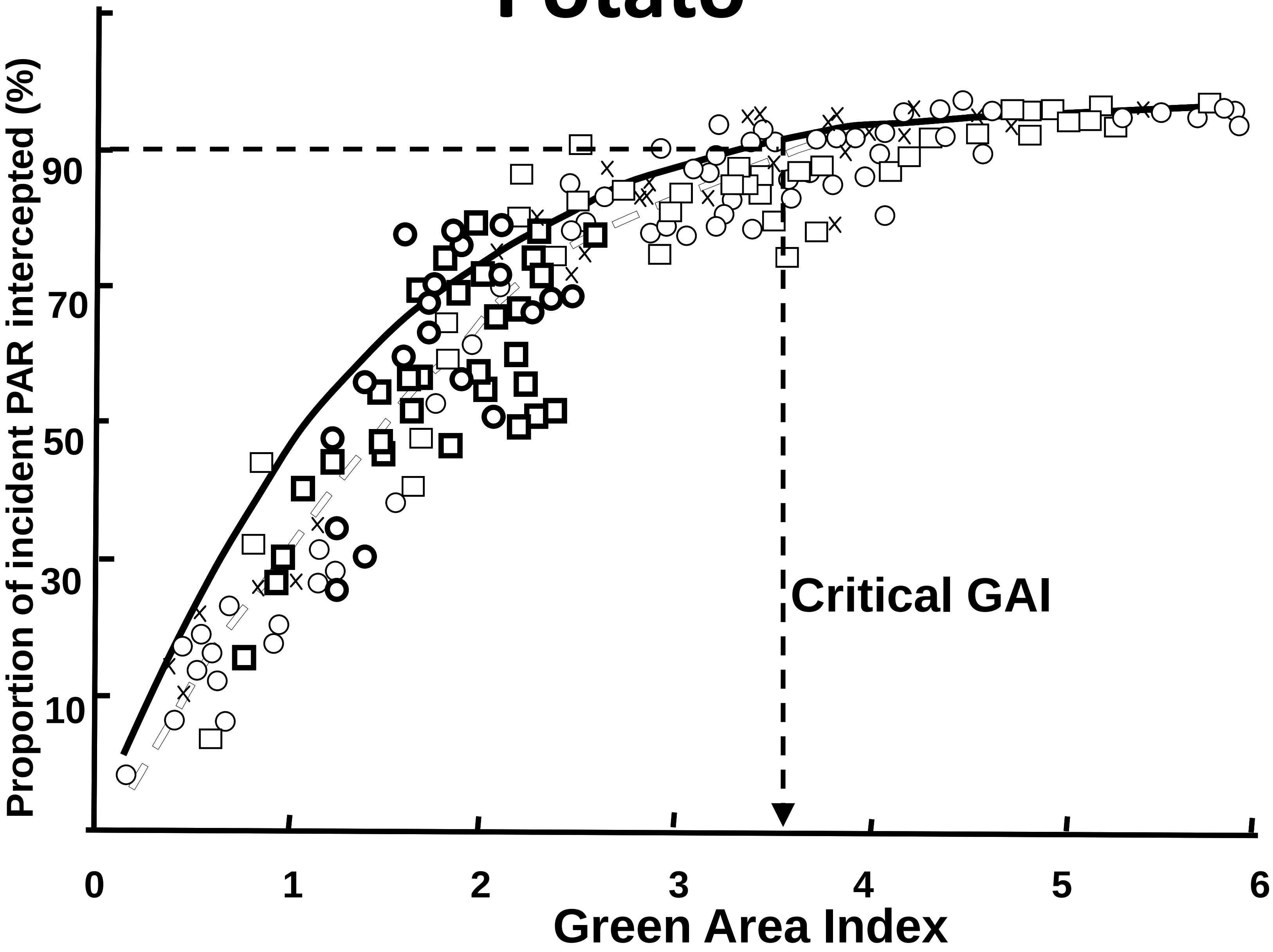
- Photosynthetically active radiation (PAR) is in the visible range (400-700nm).

- 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

Potato



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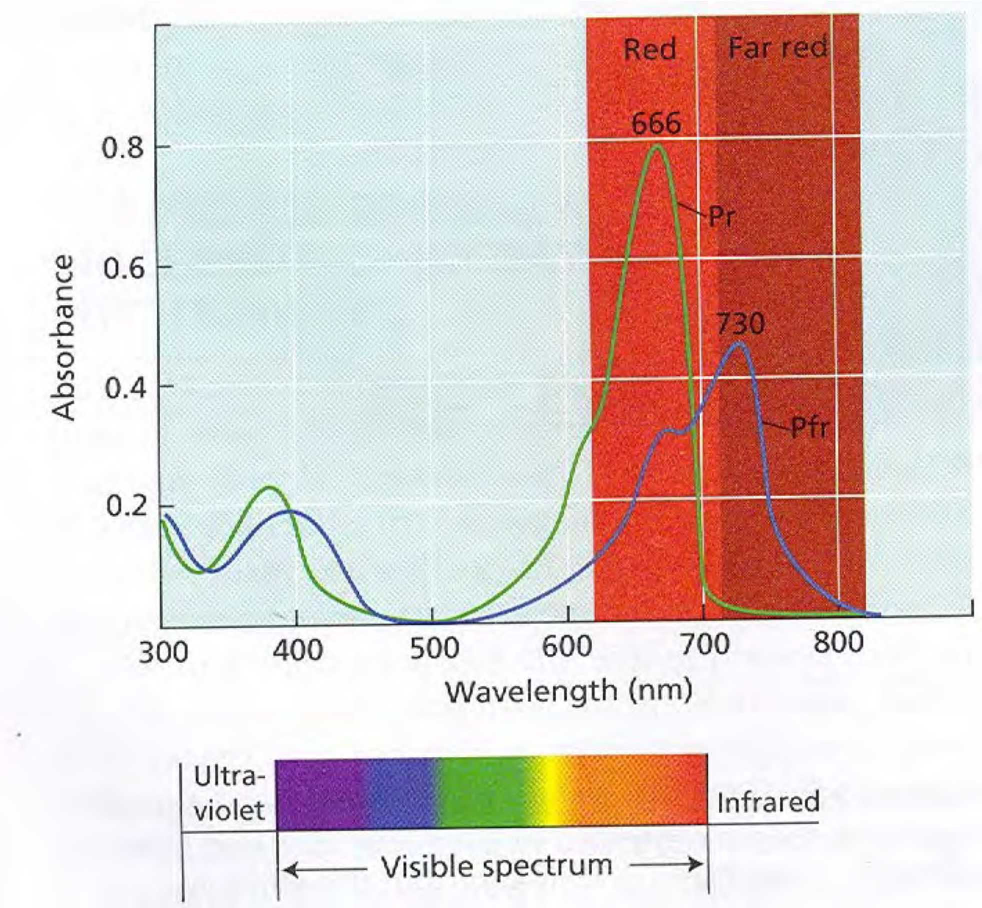
(Source: Khurana & McLaren 1982)

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

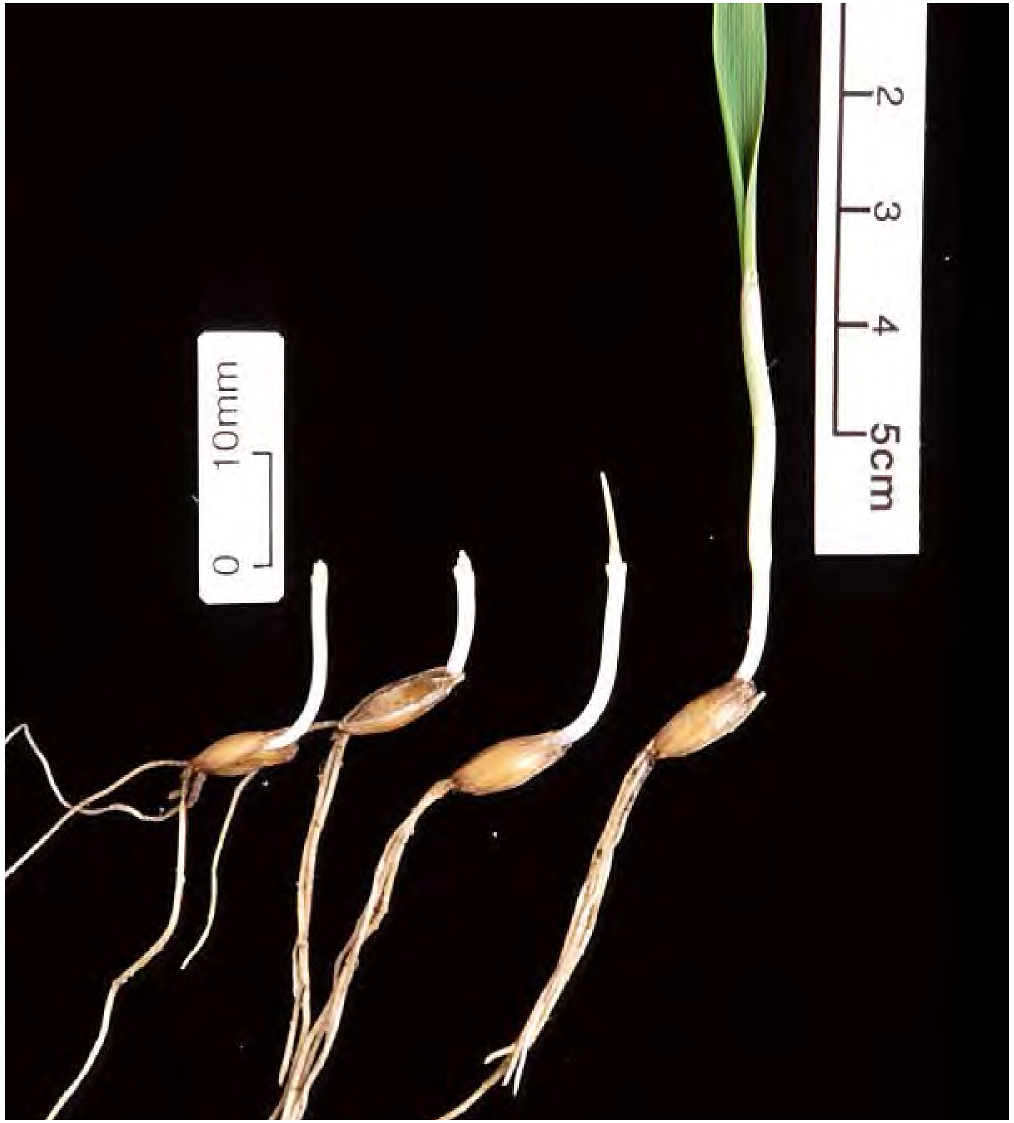
Temperature

- Tt = Thermal time (°Cd)

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

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

Sowing to emergence



Thermal time

- **soil temperature**

~ 125-150 °Cd

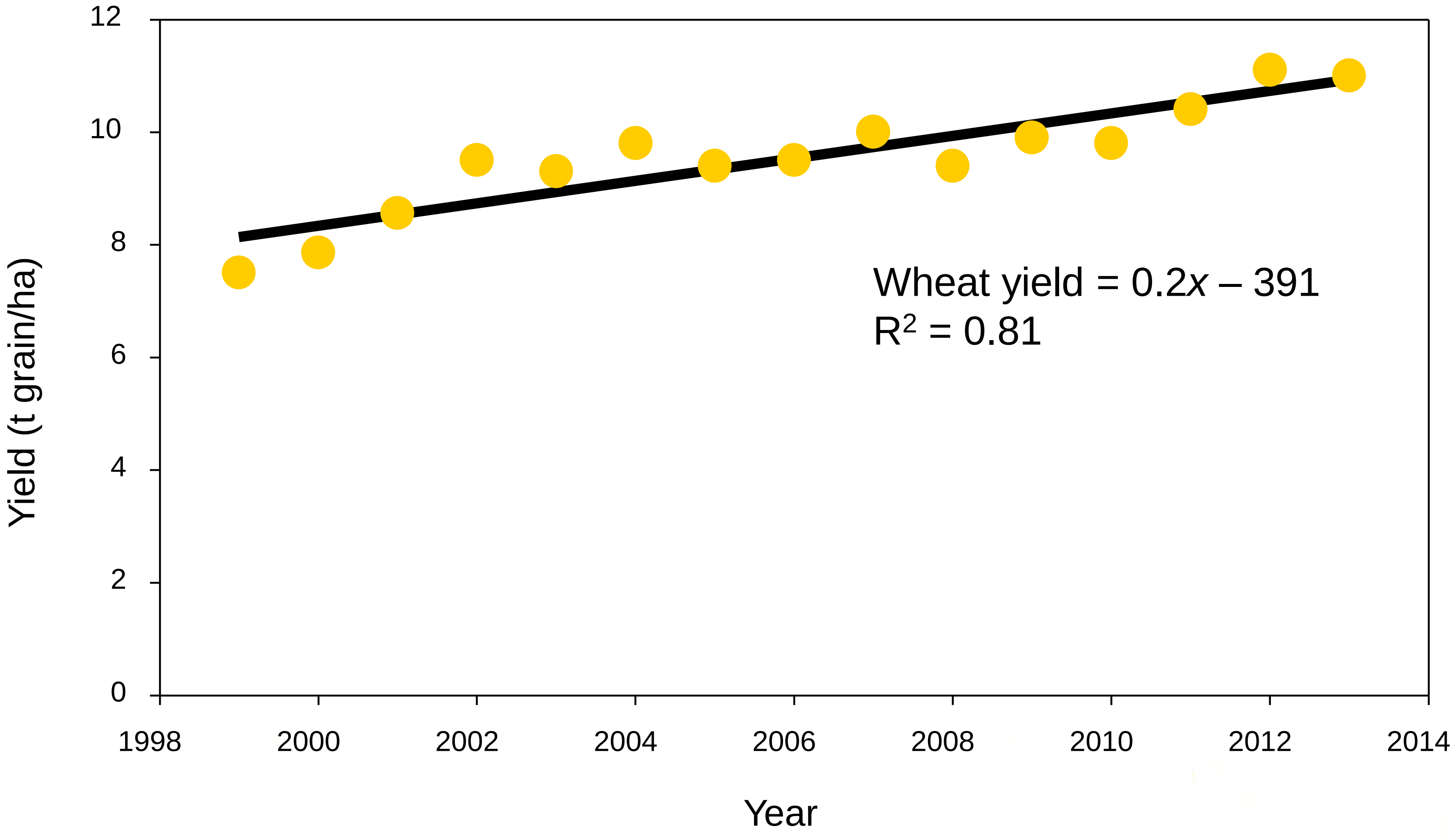

Photo: Dr W.R. Scott

Grain-filling: constant in thermal time – air temperature

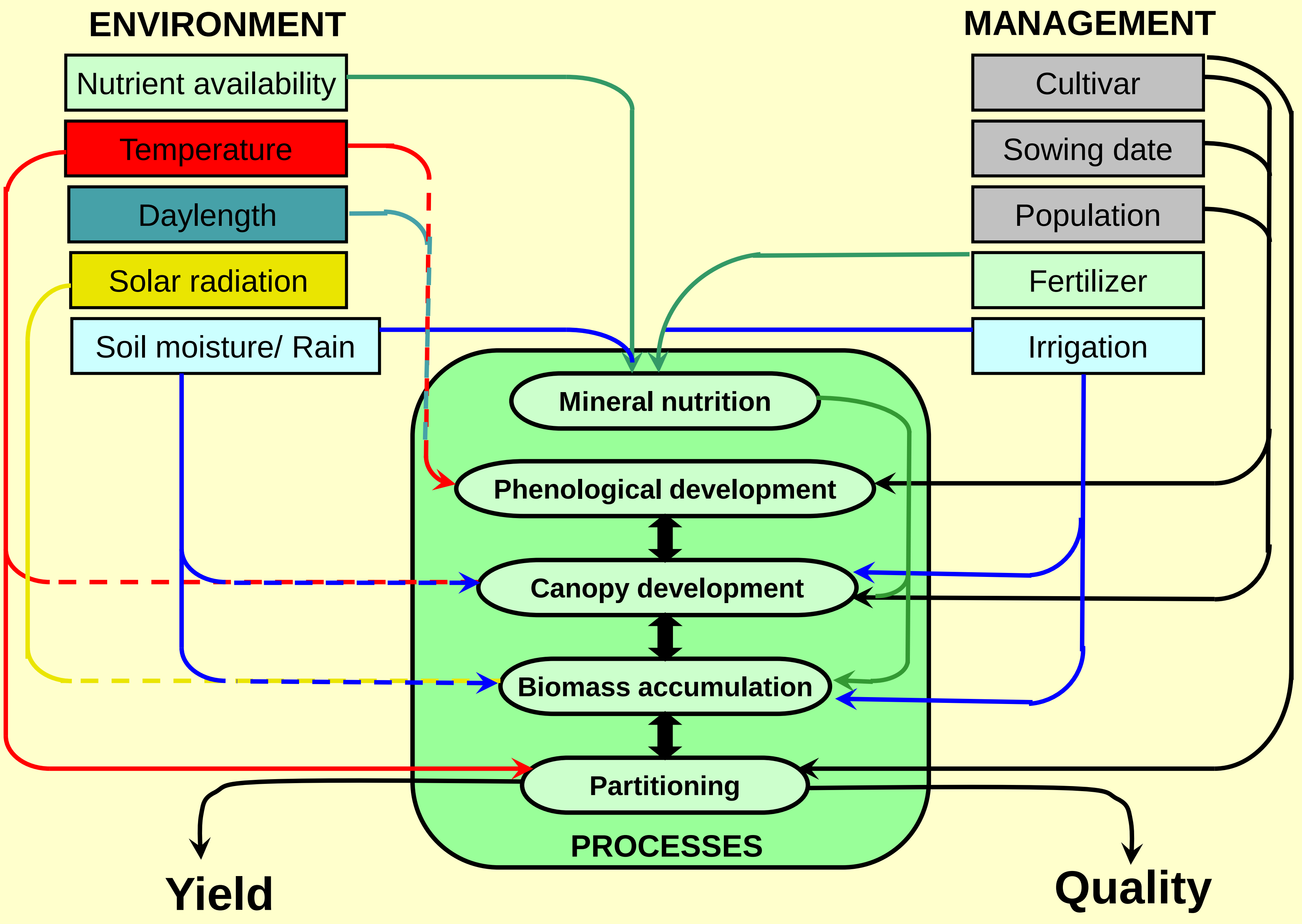
Wheat 15 t/ha; 40,000 ha
Barley 13 t/ha; 40,000 ha

Photo: Dr W.R. Scott

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

Photo: A.L. Fletcher

Olsen P>20

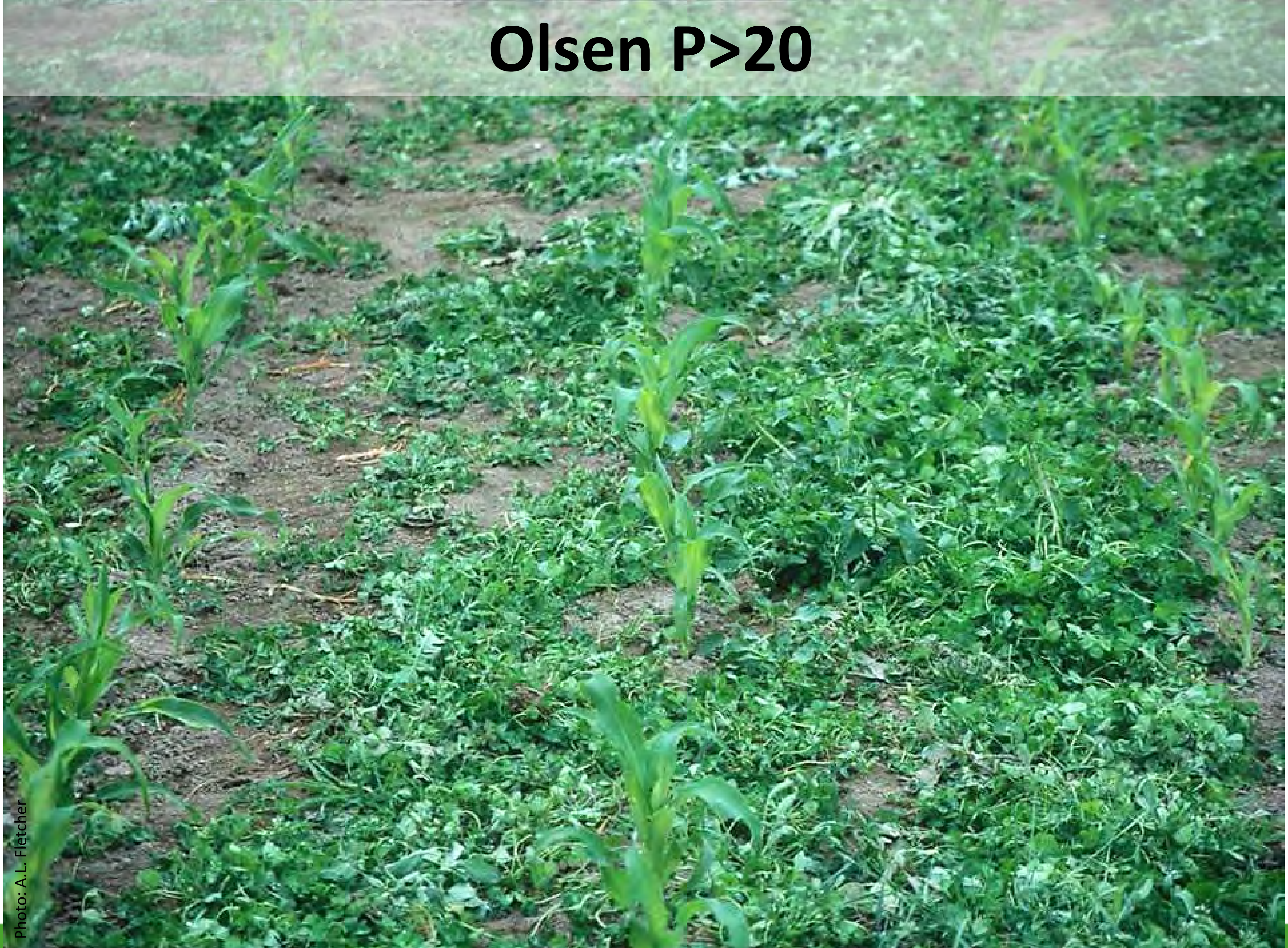
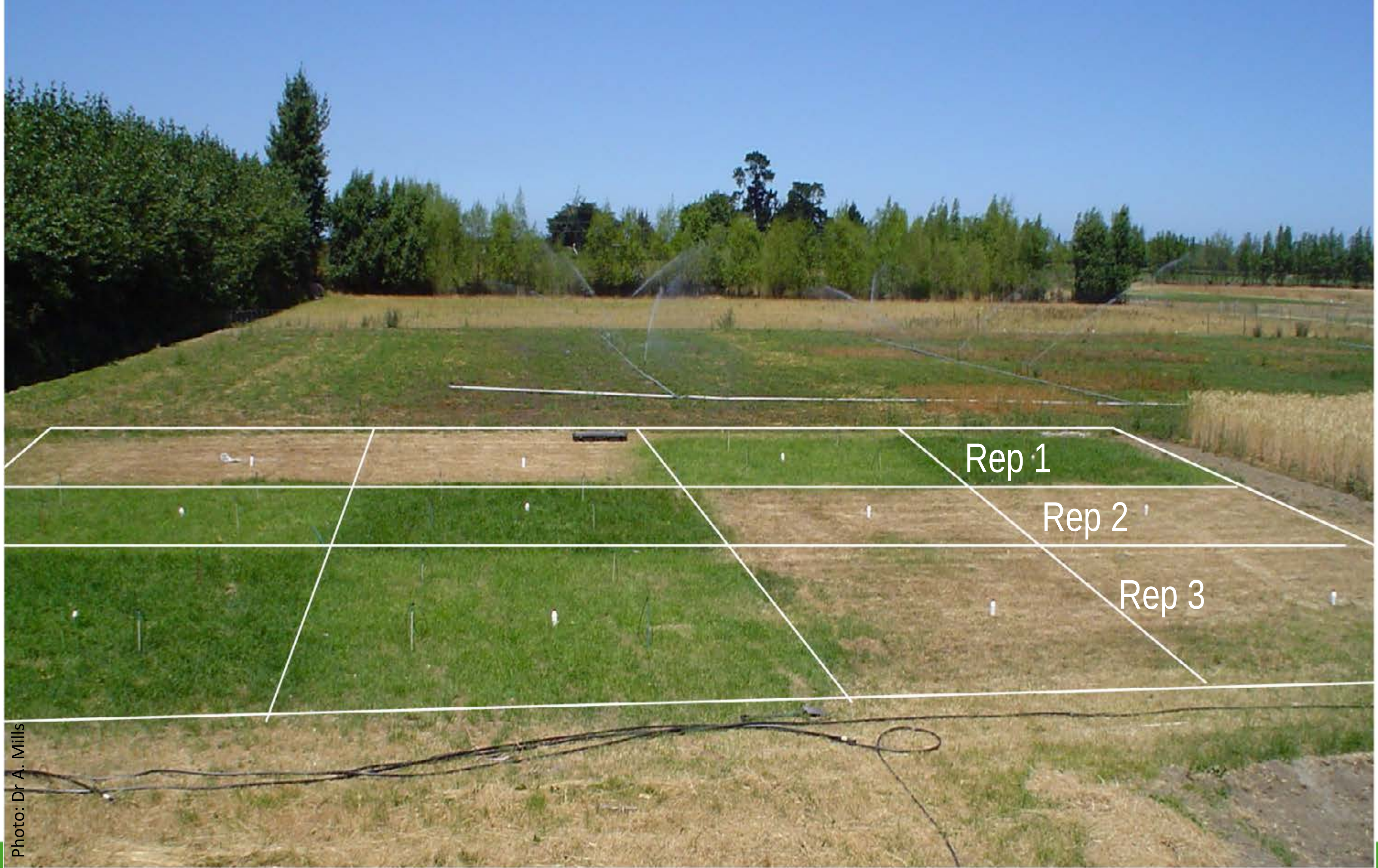


Photo: A.L. Fletcher

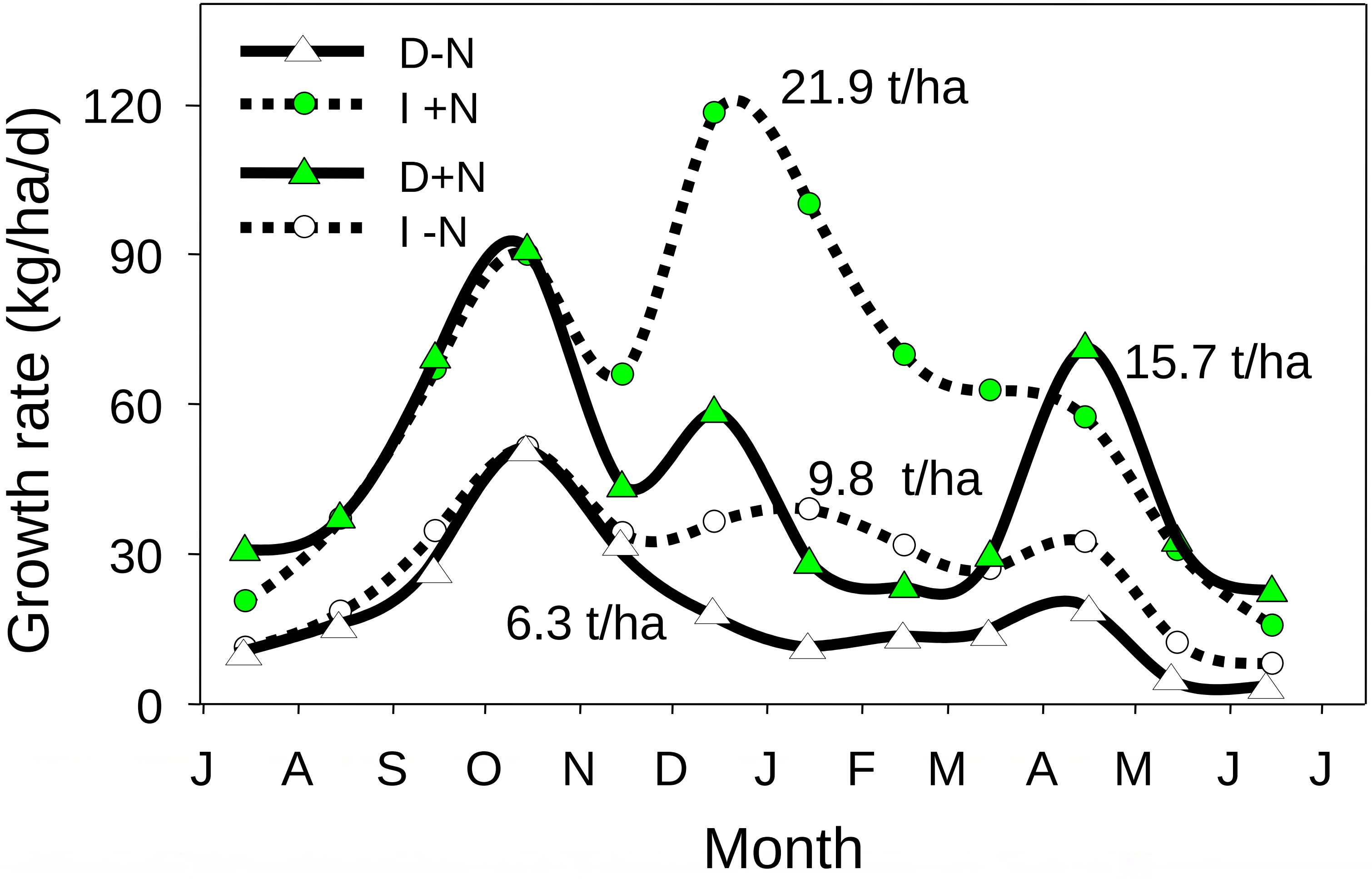
Drilling seed with fertiliser

Direct drilling = seed + fertiliser

Experiment site



Growth rates (2 year means)



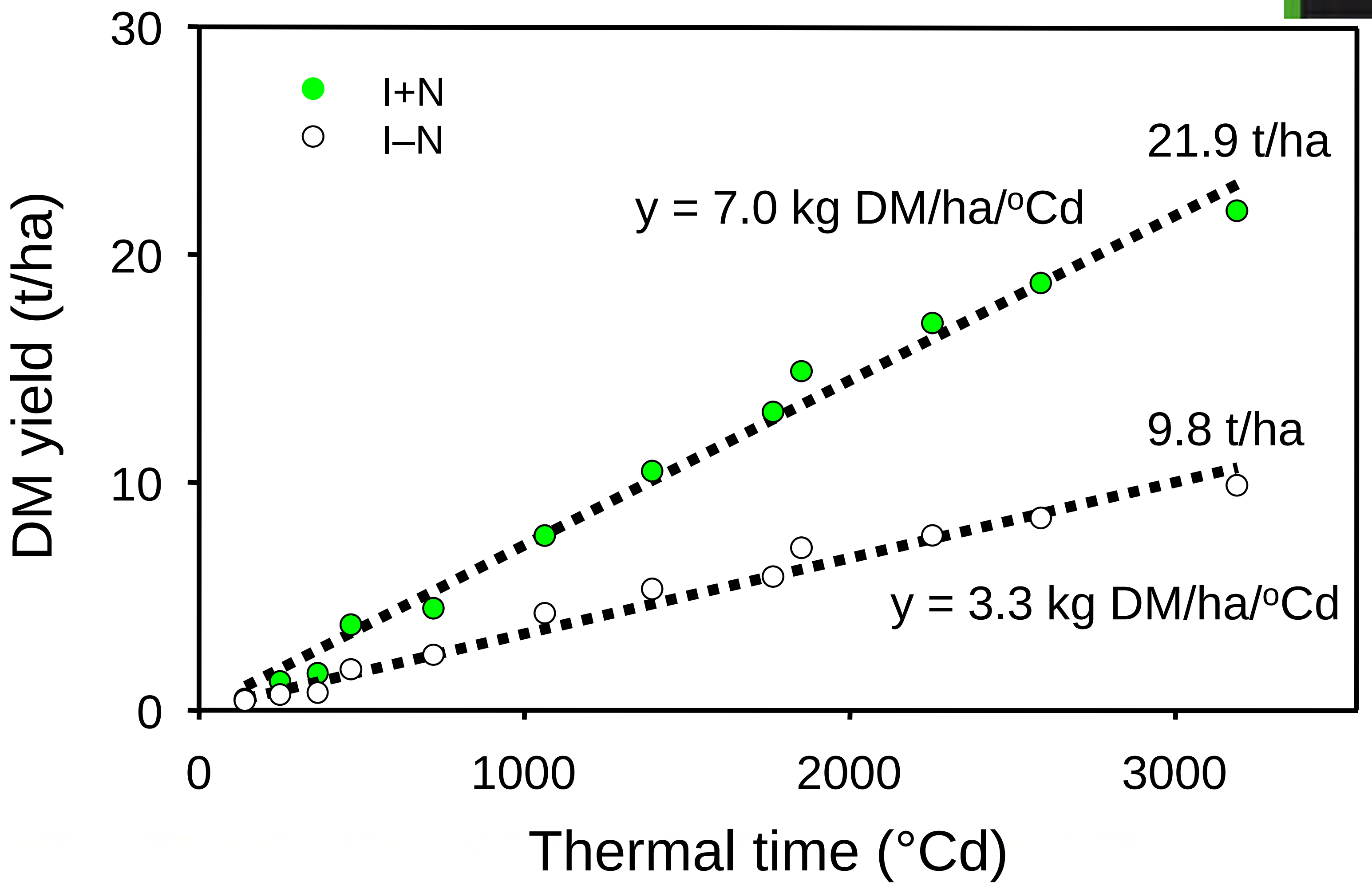
Mills *et al*. 2006

Photo: Dr K.M. Pollock

Winter

⇒ temperature response

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

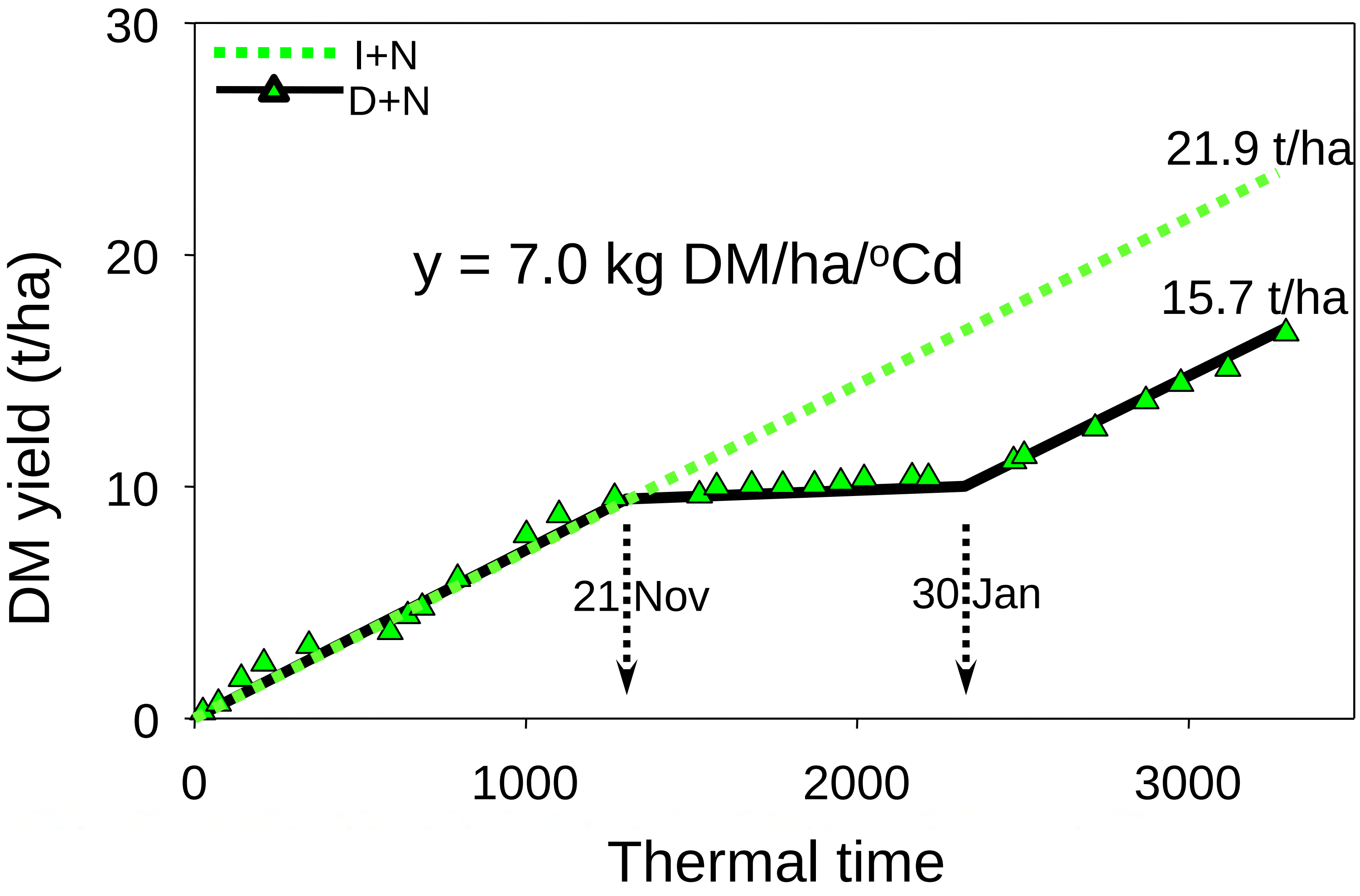


Mills *et al.* 2006

Summer

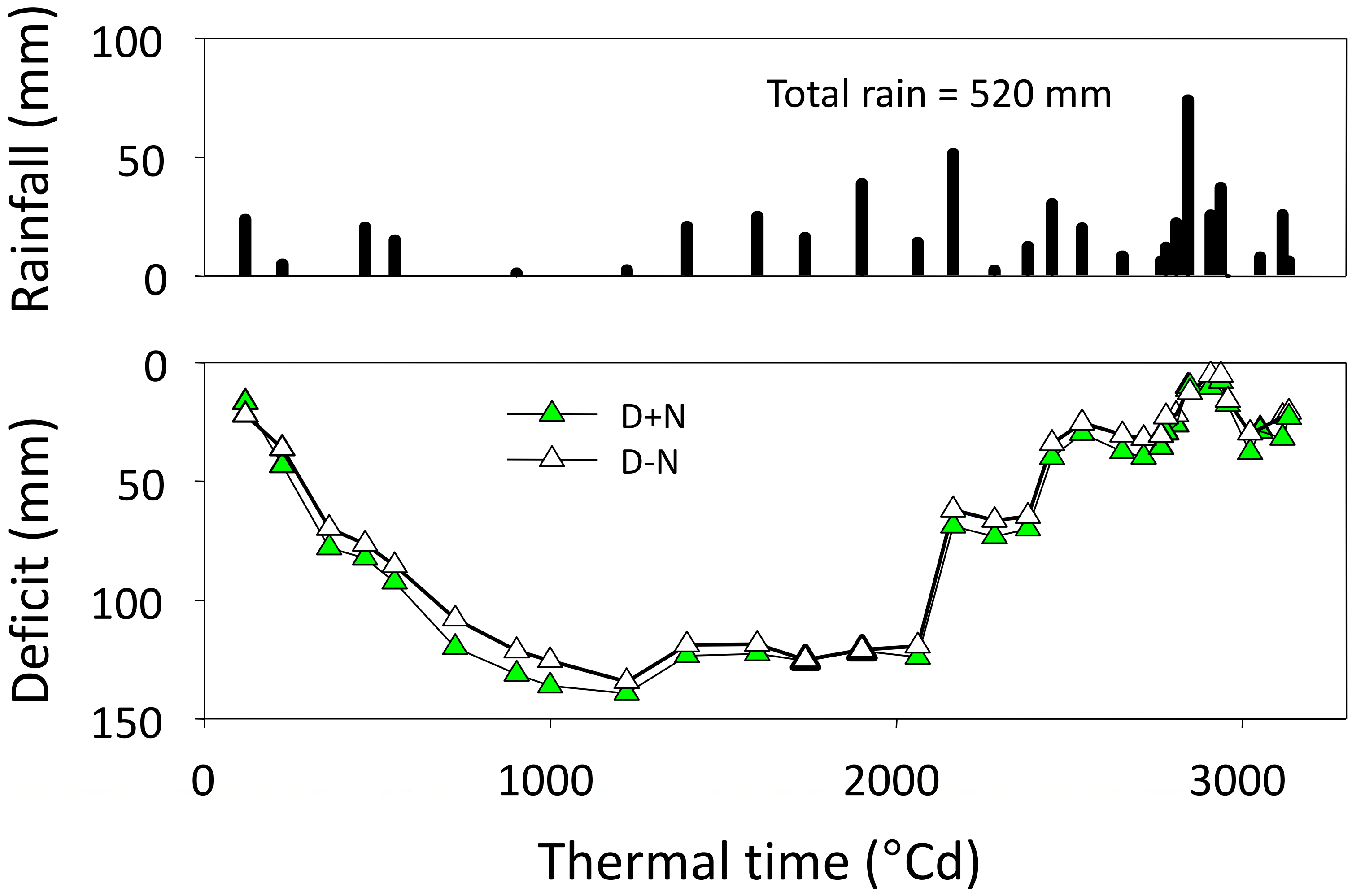
⇒ moisture response

Water stress effect on yield

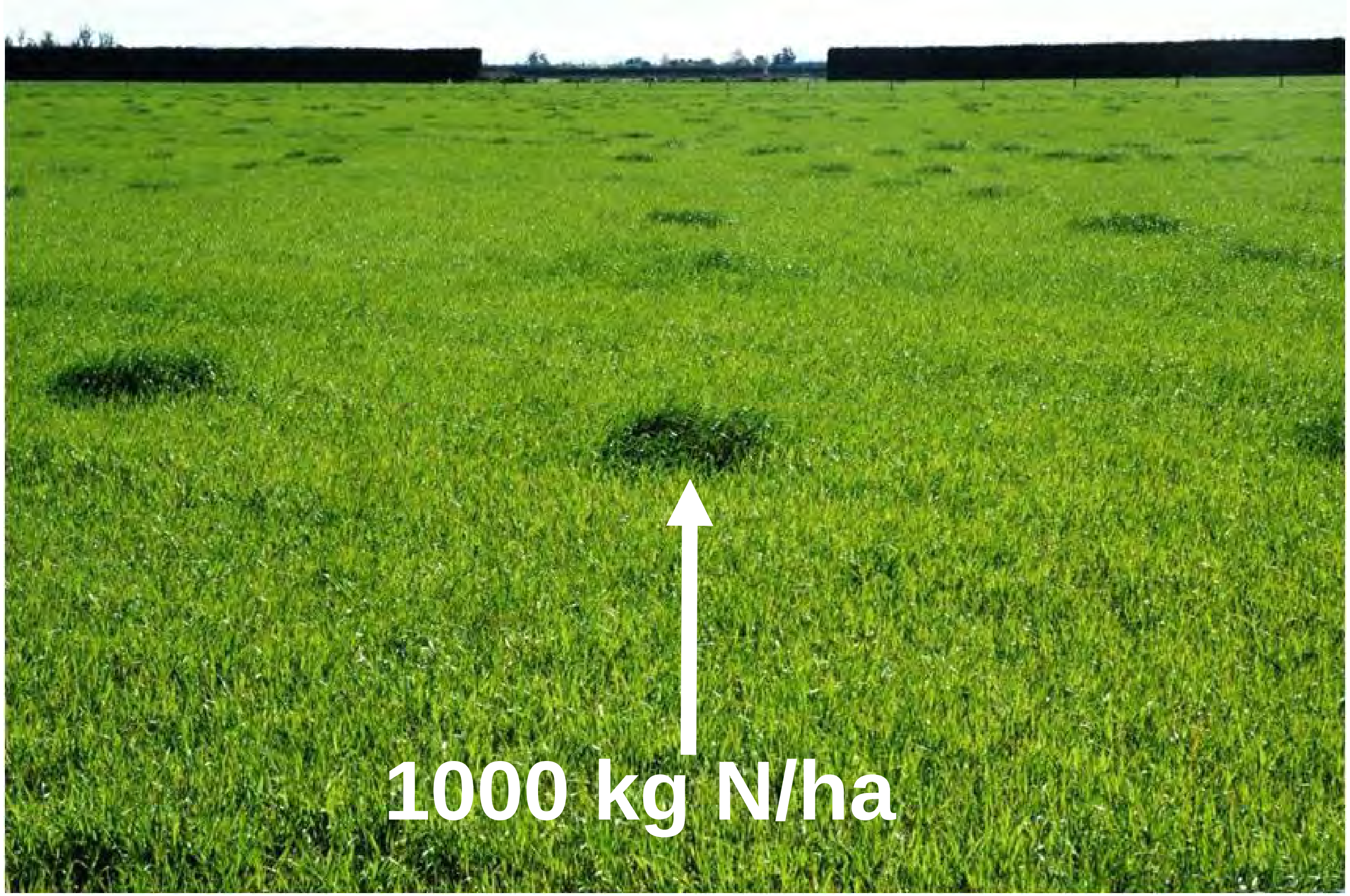


Mills *et al*. 2006

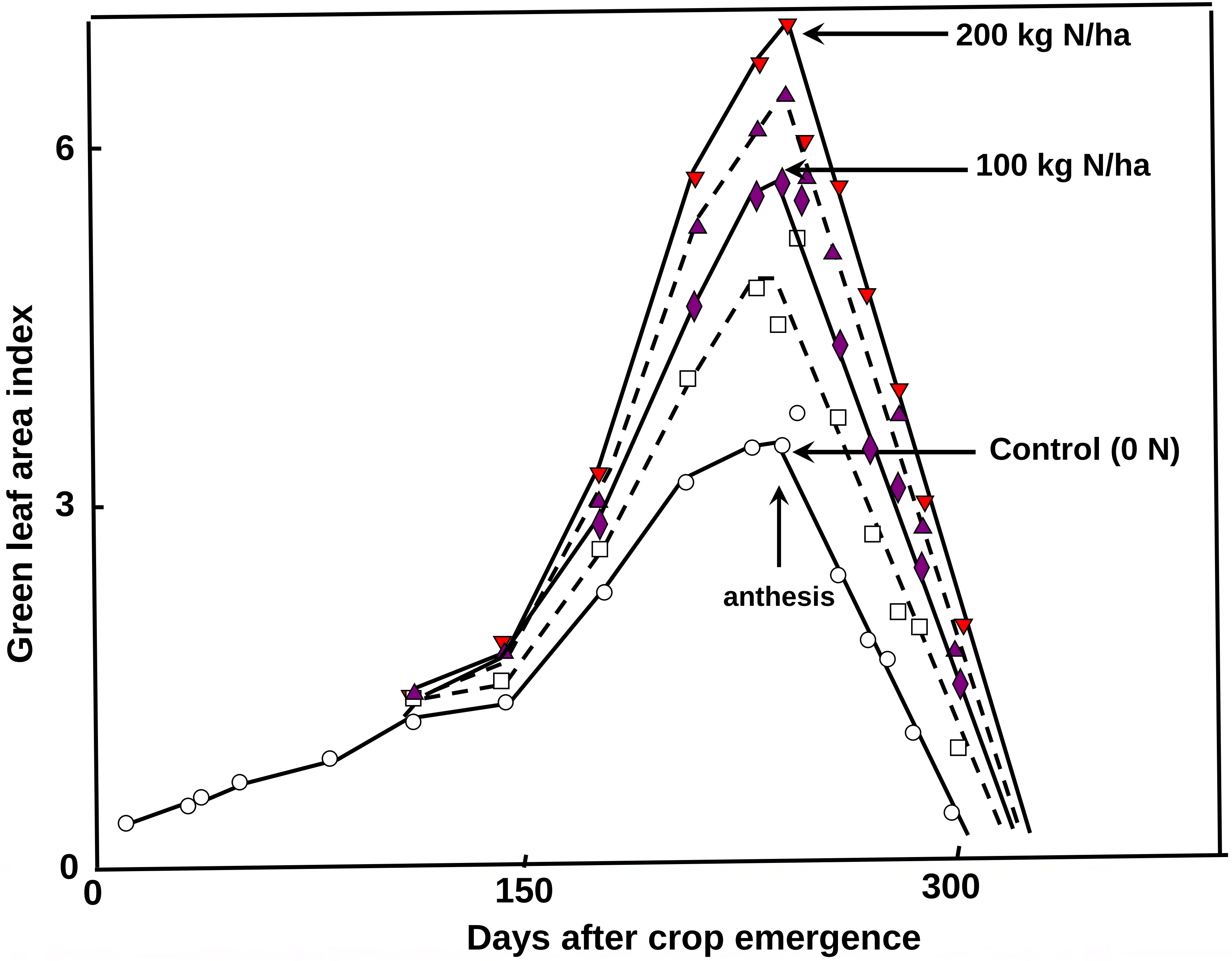
Soil moisture deficit 2003/04



Nitrogen deficient pasture
– inefficient user of water

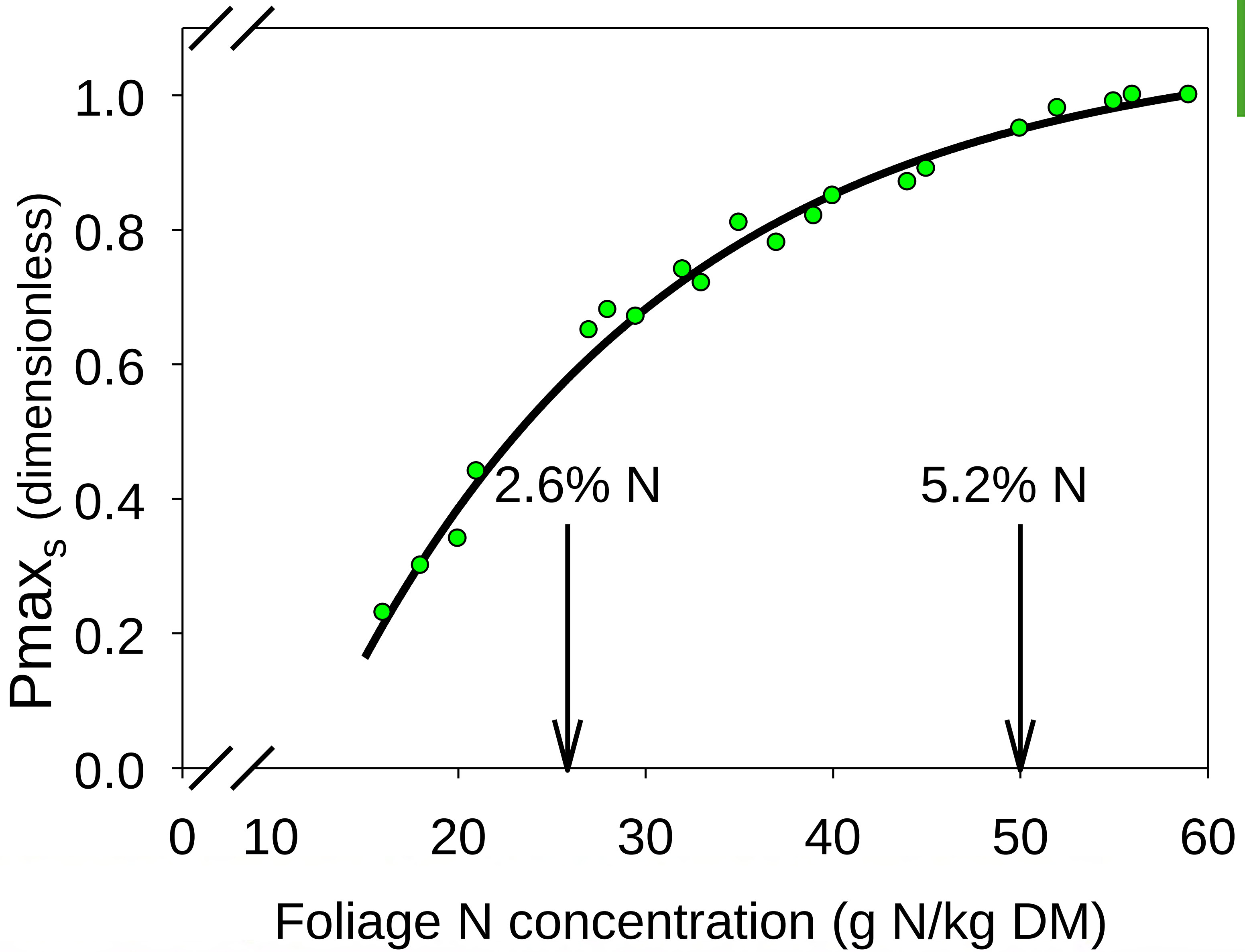


New Zealand's specialist land-based university



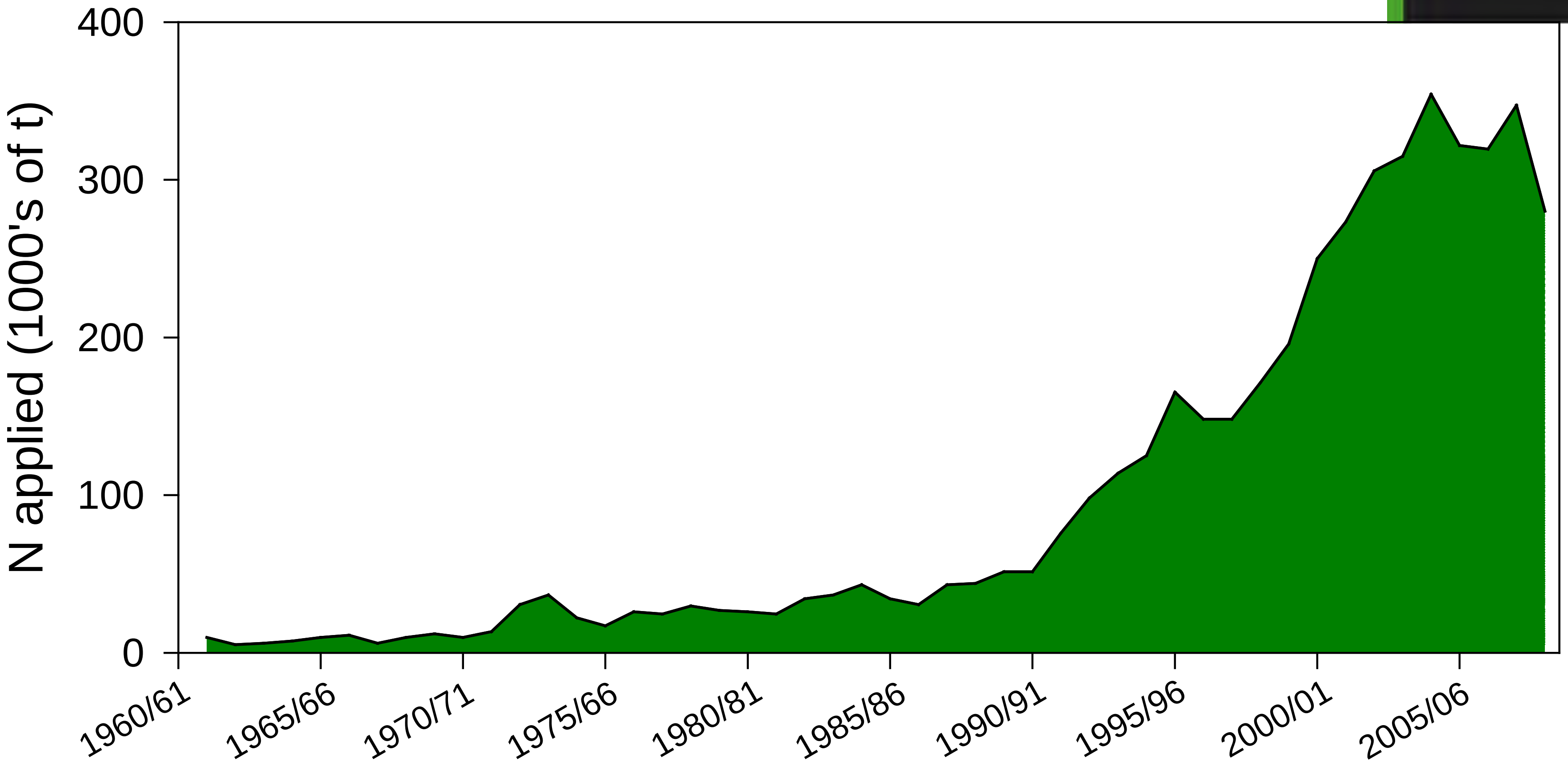
200 kg N/ha
100 kg N/ha
Control (0 N)
anthesis
Green leaf area index
6
3
0
0
150
300
Days after crop emergence

Plant vs. animal requirements



Peri *et al*. 2002

Nitrogen fertiliser use

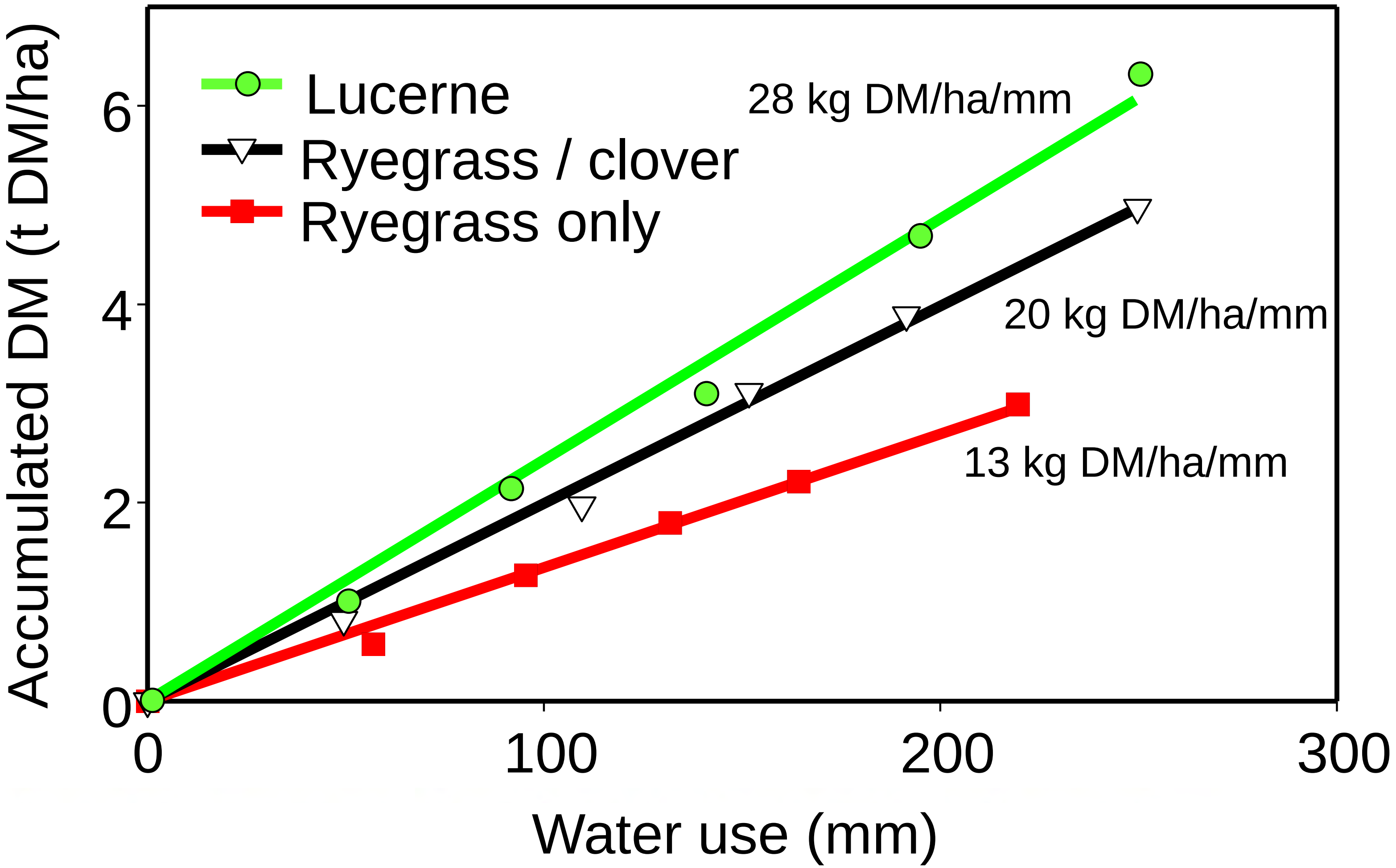


New Zealand's specialist land-based university

New Zealand Fertiliser Manufacturers' Research Association

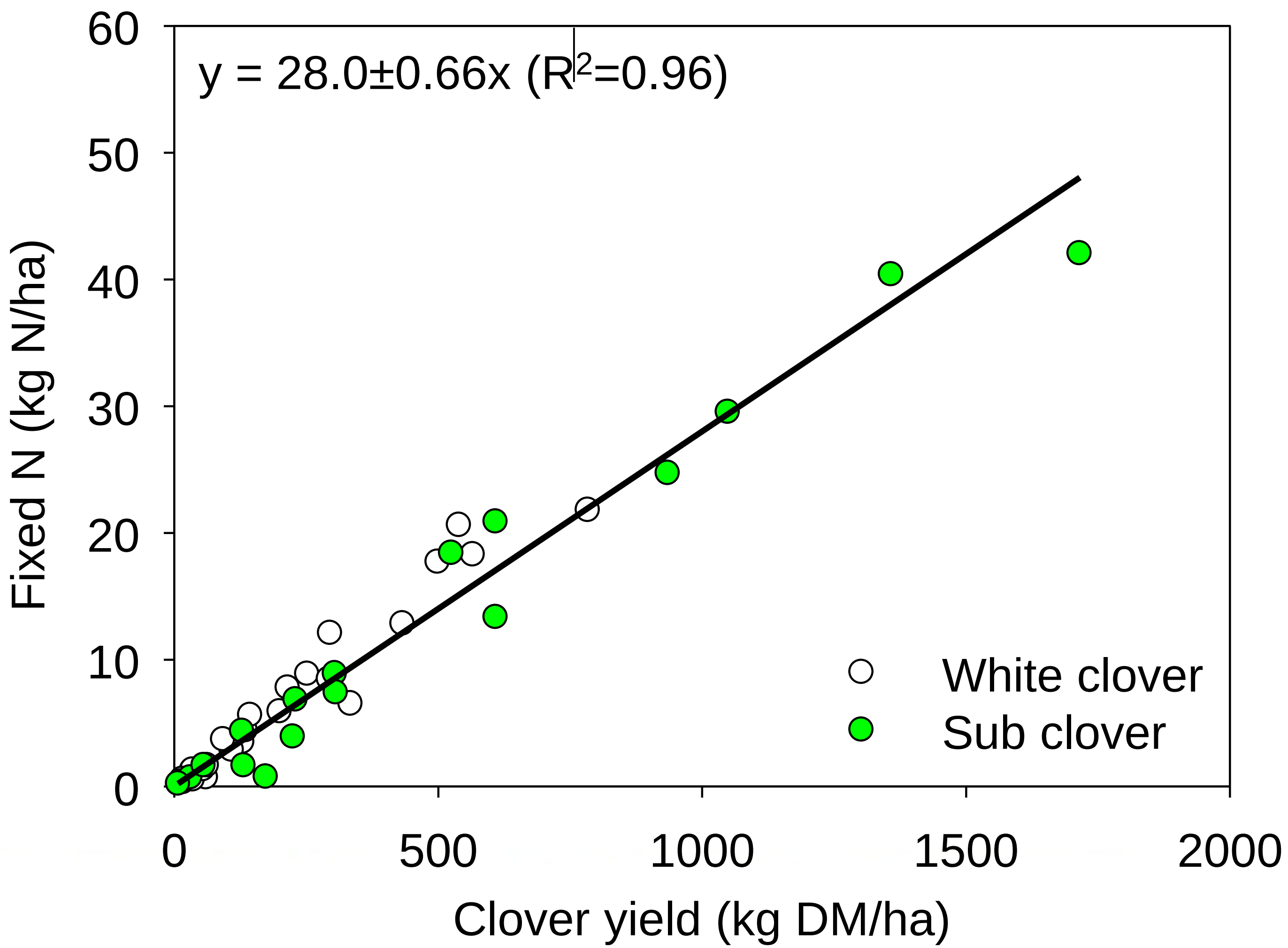
How can we increase WUE on-farm?

Spring WUE: legume = (nitrogen)



'Rosabrook' subterranean clover

Biological N fixation



Lucas *et al*. 2010

Sheep prefer 70% legume, 30% grass

Russell lupin grazing trial at Sawdon Station

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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Dryland pastures blog: http://www.lincoln.ac.nz/conversation/drylandpastures/

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