Wagga Wagga NSW 29th July 2014

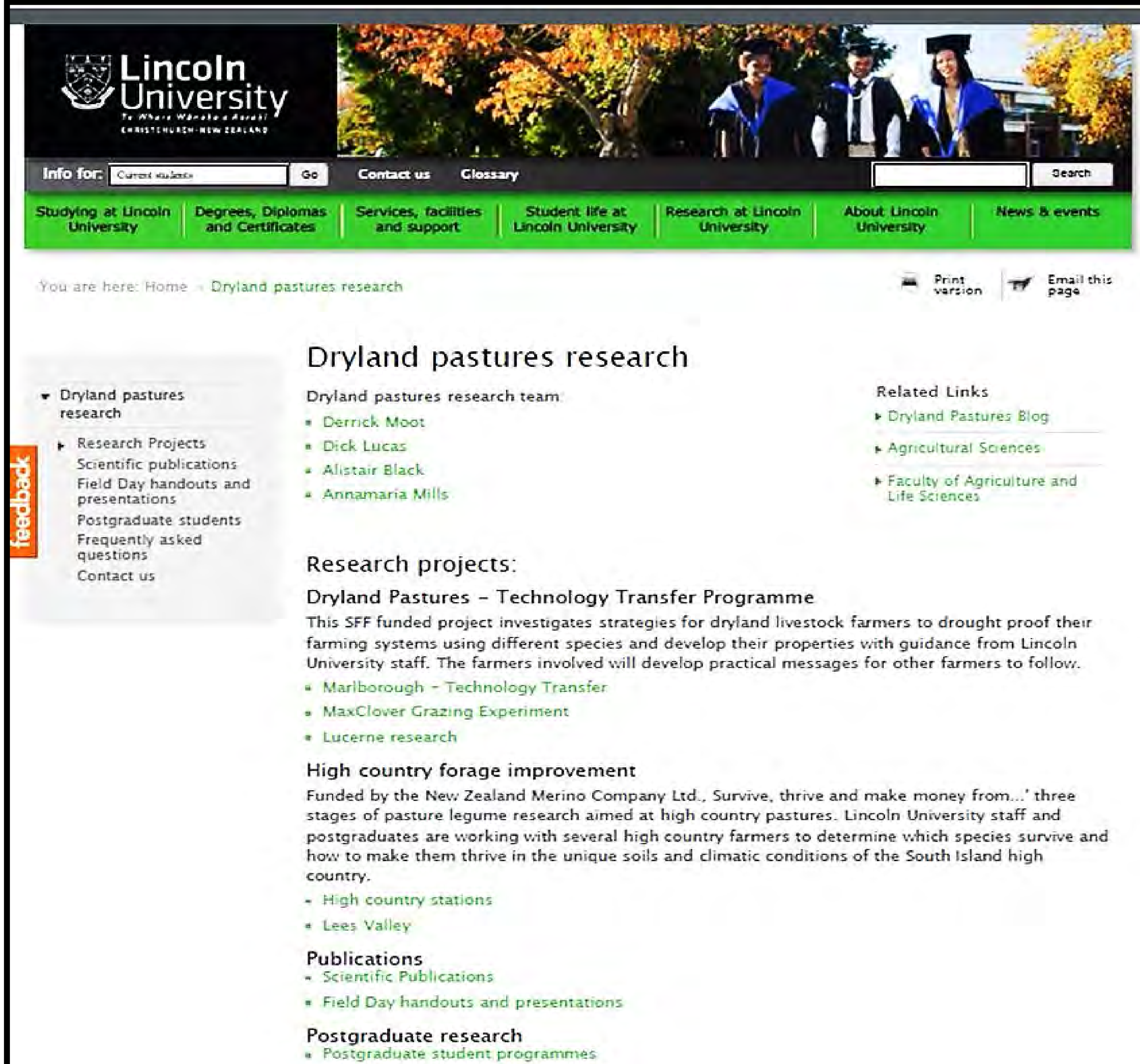
Agronomy of crops and pastures

Derrick Moot

The website…

Info on:

- Current projects
- Field day presentations
- Scientific publications
- FAQs
- Postgraduate study



www.lincoln.ac.nz/dryland

Photo: Dr W.R. Scott

Photo: of Dr W.R. Scott
Outside The Famous Gouse pub in Lincoln

63%   Mountain and hill country

13% Inland basins

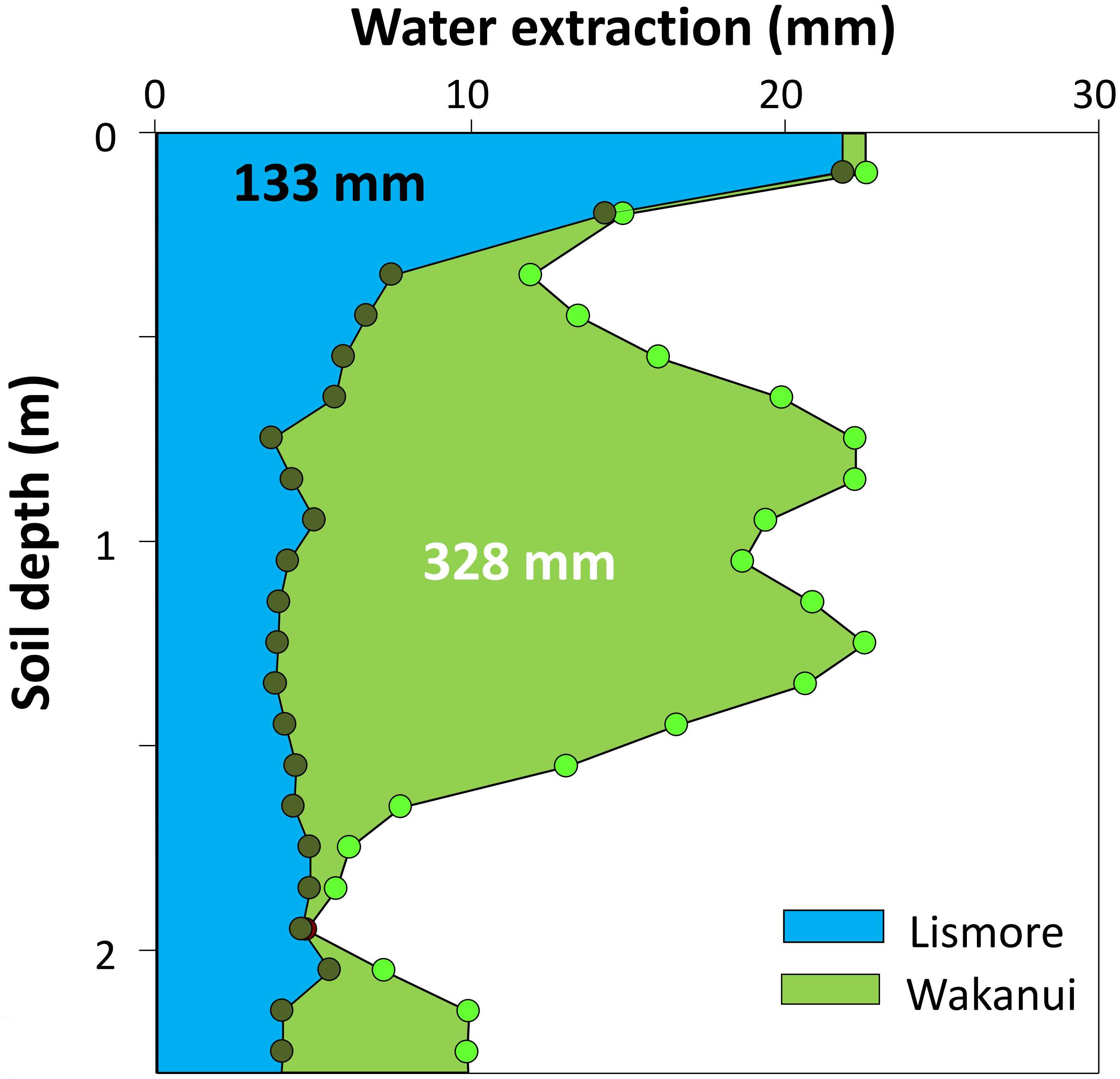
Source: Brown & Naish, GNS


High variability over short spaces

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

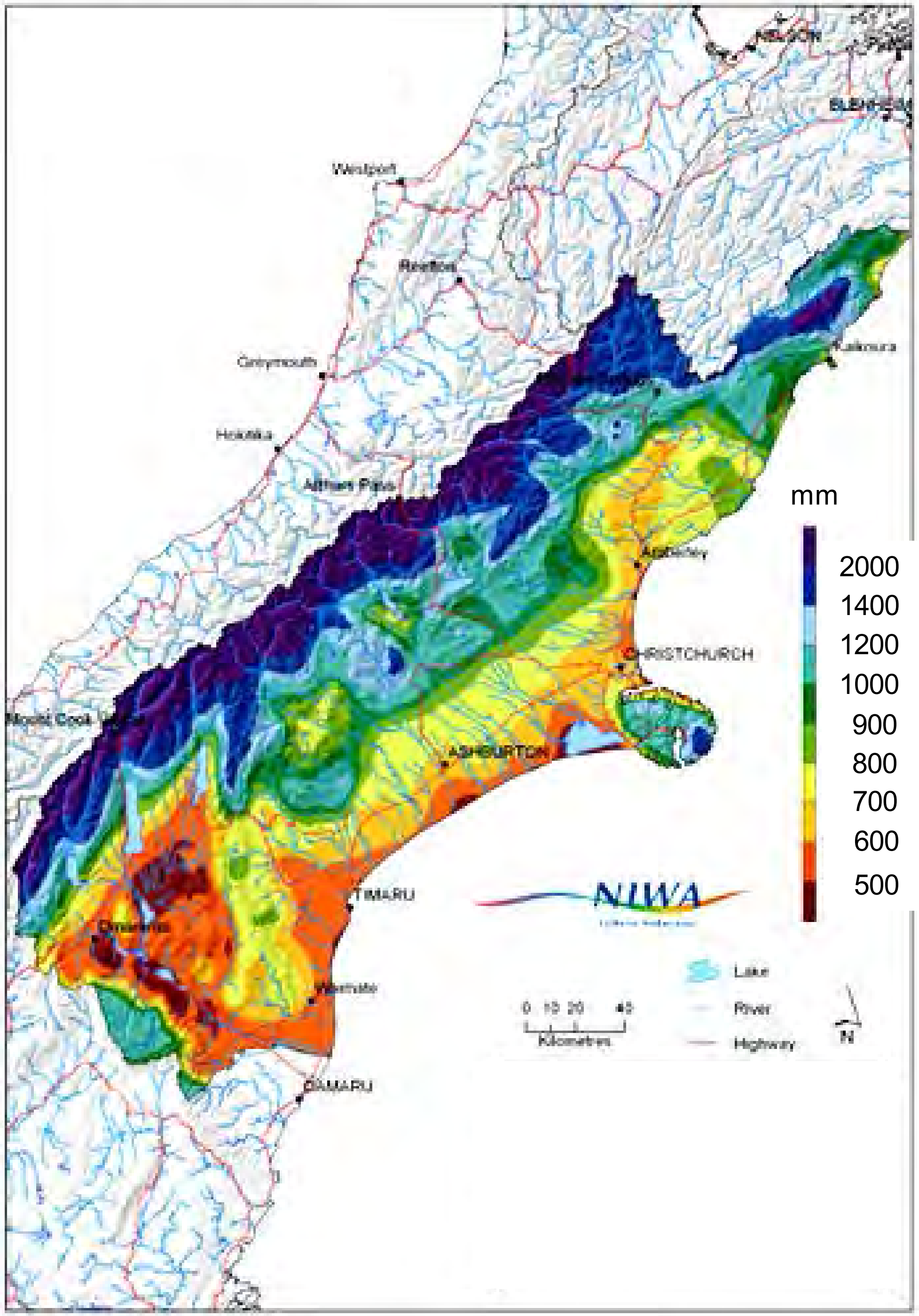
Photo: Lincoln University Soils Department

Soil water extraction - Wakanui



Soil water extraction

Deep Wakanui soil has 200 mm more available water

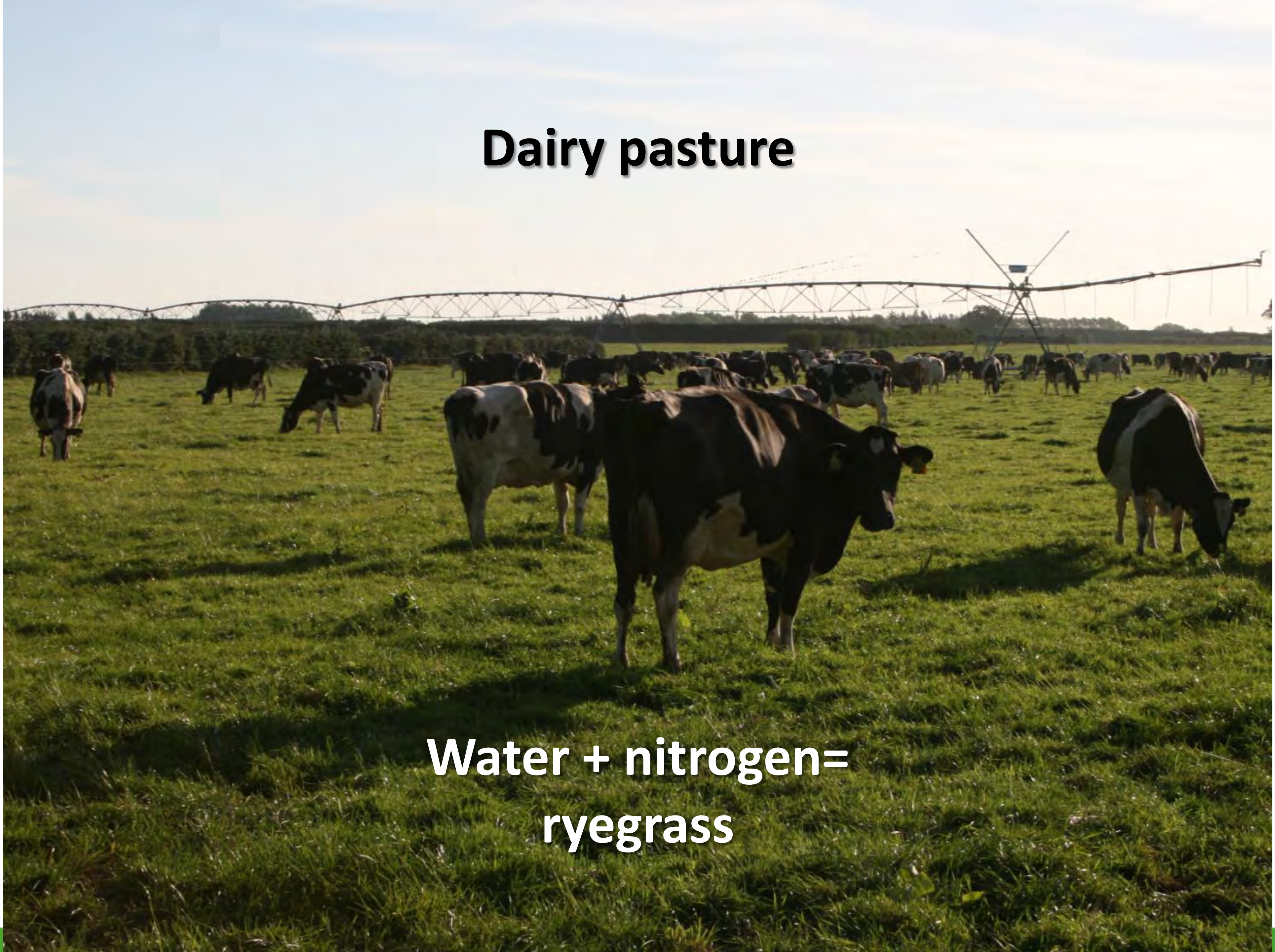


Climate

Median rainfall (mm) (1971-2000)

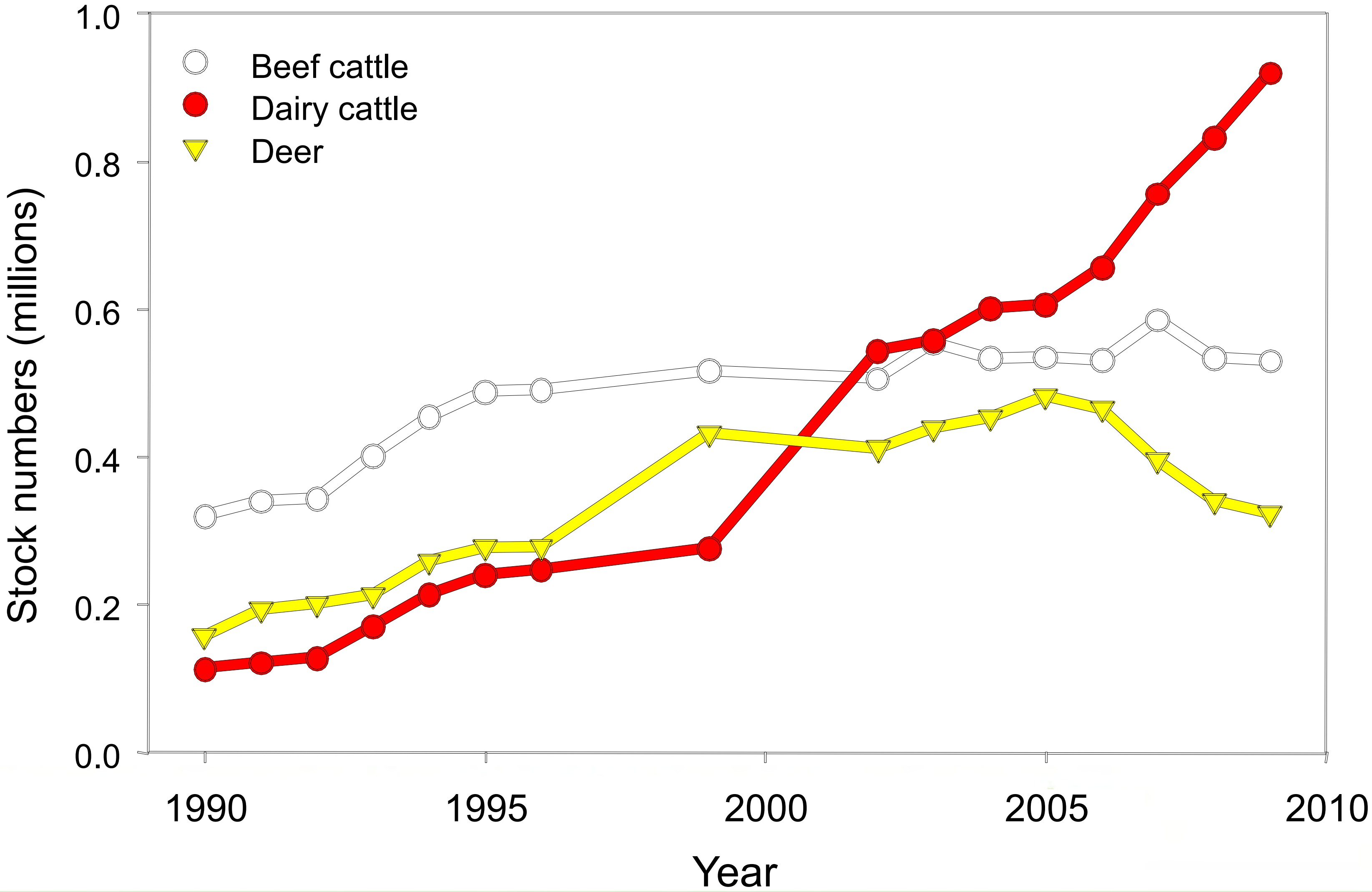
Source: Climate Explorer
NIWA, 2010

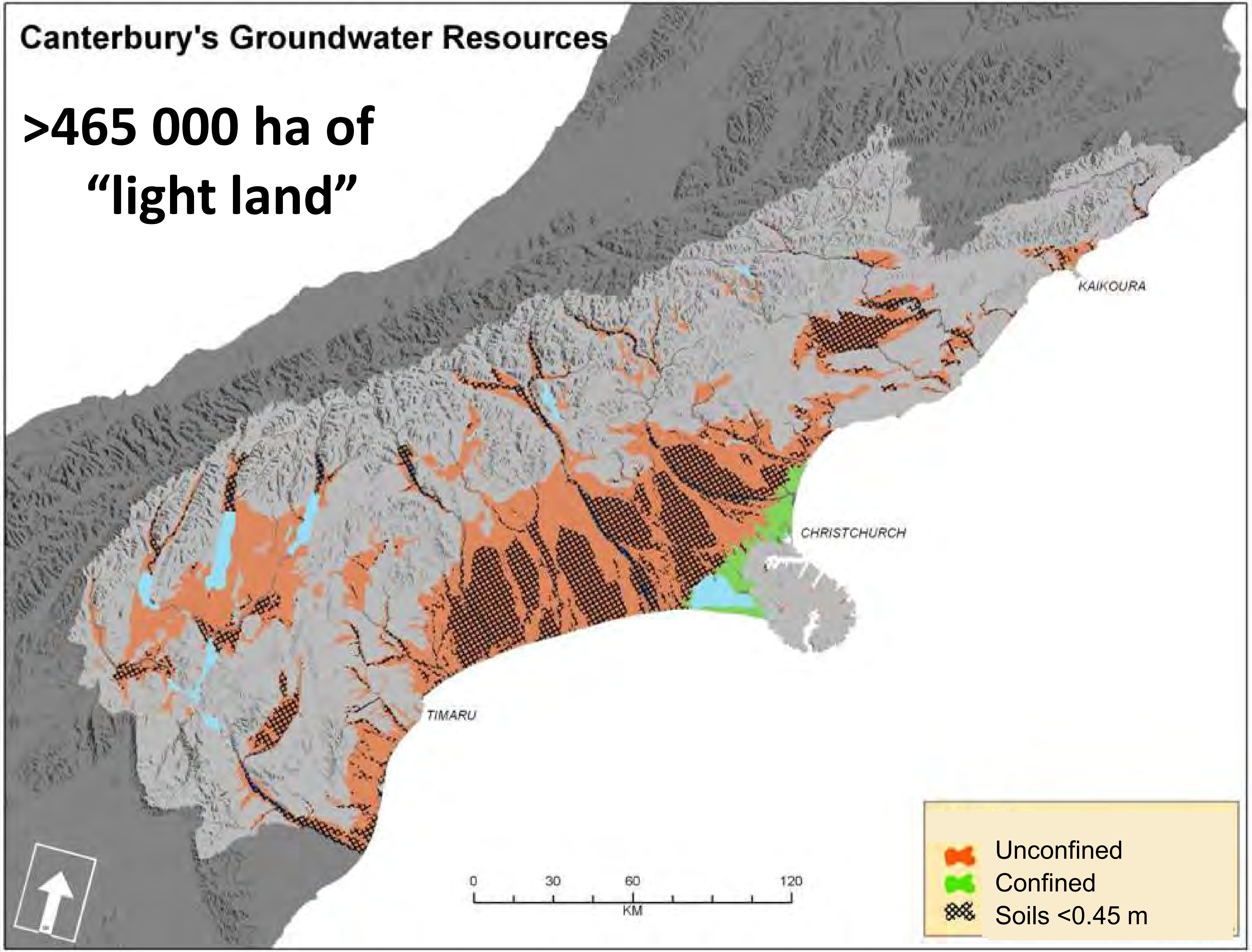
Unimproved scrub land on light soils



Martin *et al*. 2006 NZGA

The population...deer & cattle

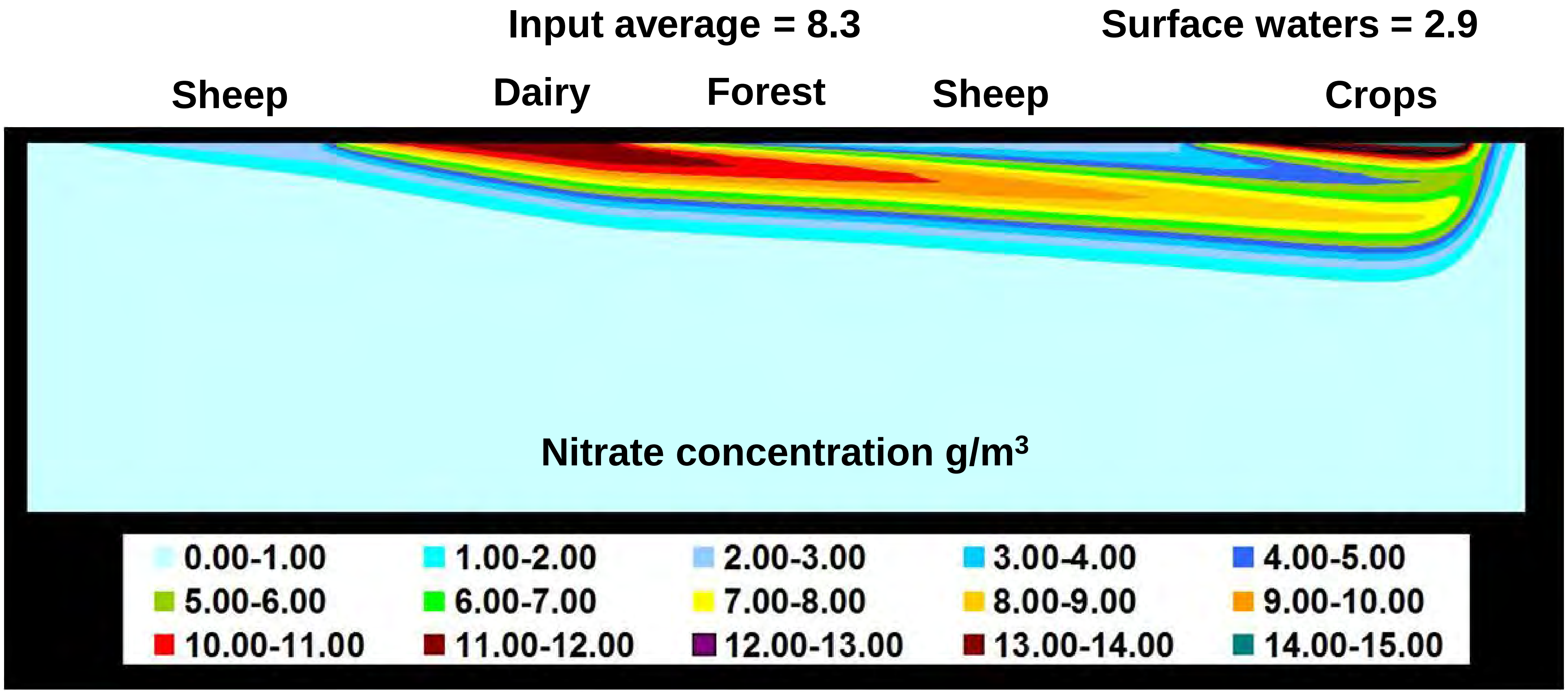




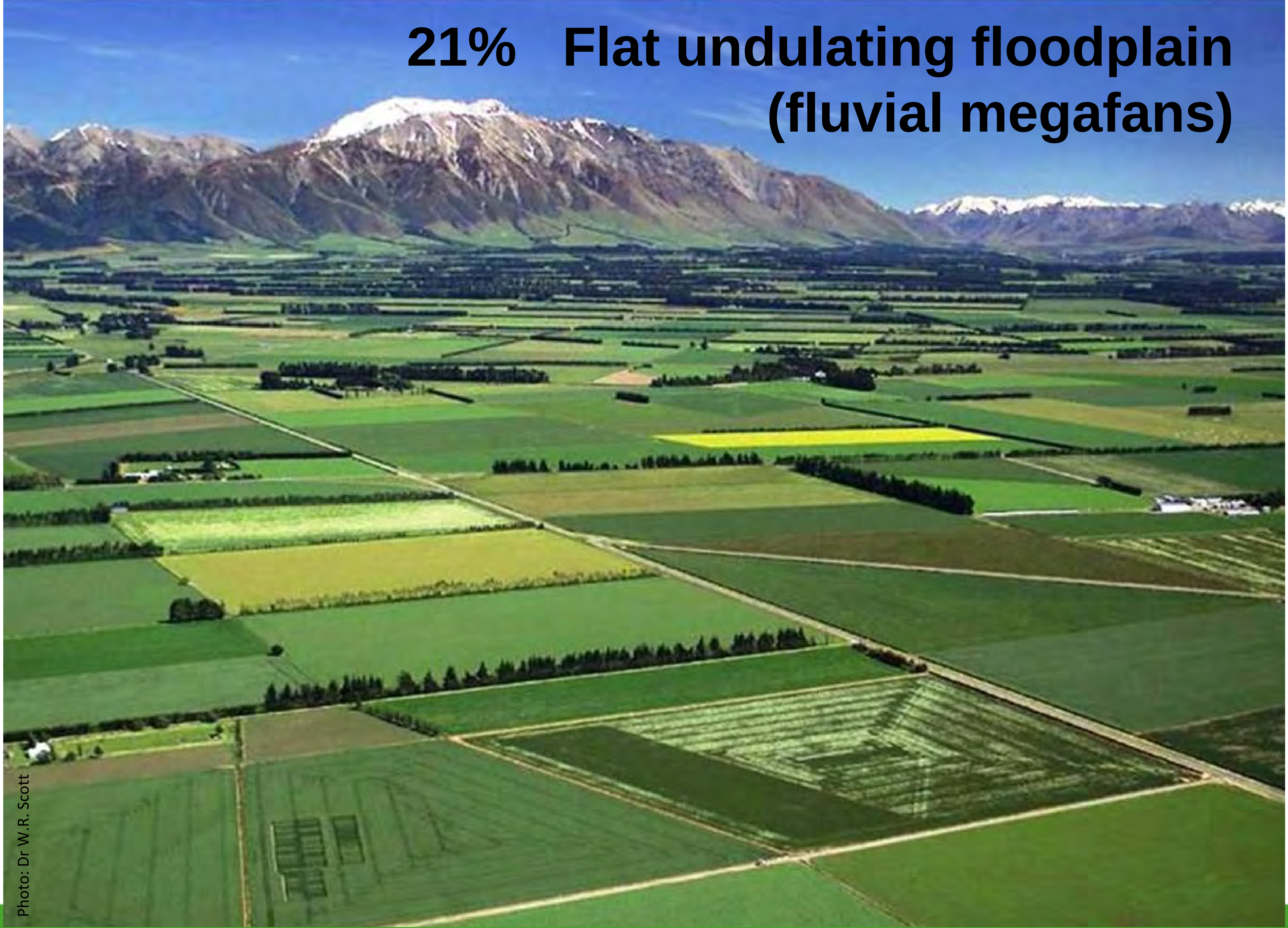
Source: Ken Taylor ECan

New

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

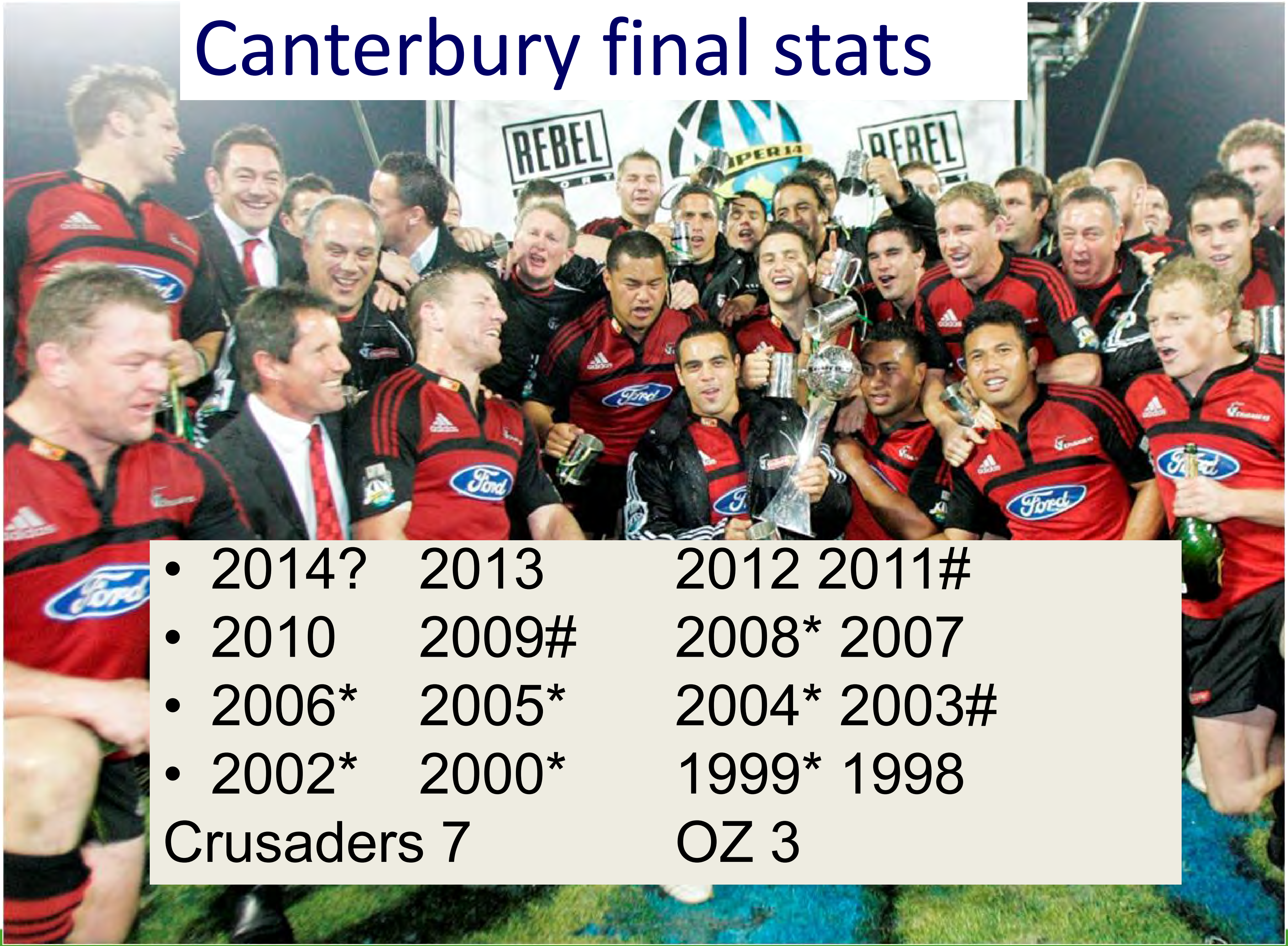
10,000 ha clover seed for export

Photo: Dr W.R. Scott

Herbage grass 1.5 - 2.5 t seed/ha

Wine production in Nth Canterbury

Canterbury final stats



- 2014?   2013   2012 2011#
- 2010   2009#   2008* 2007
- 2006*   2005*   2004* 2003#
- 2002*   2000*   1999* 1998

Crusaders 7   OZ 3

Policy & management questions

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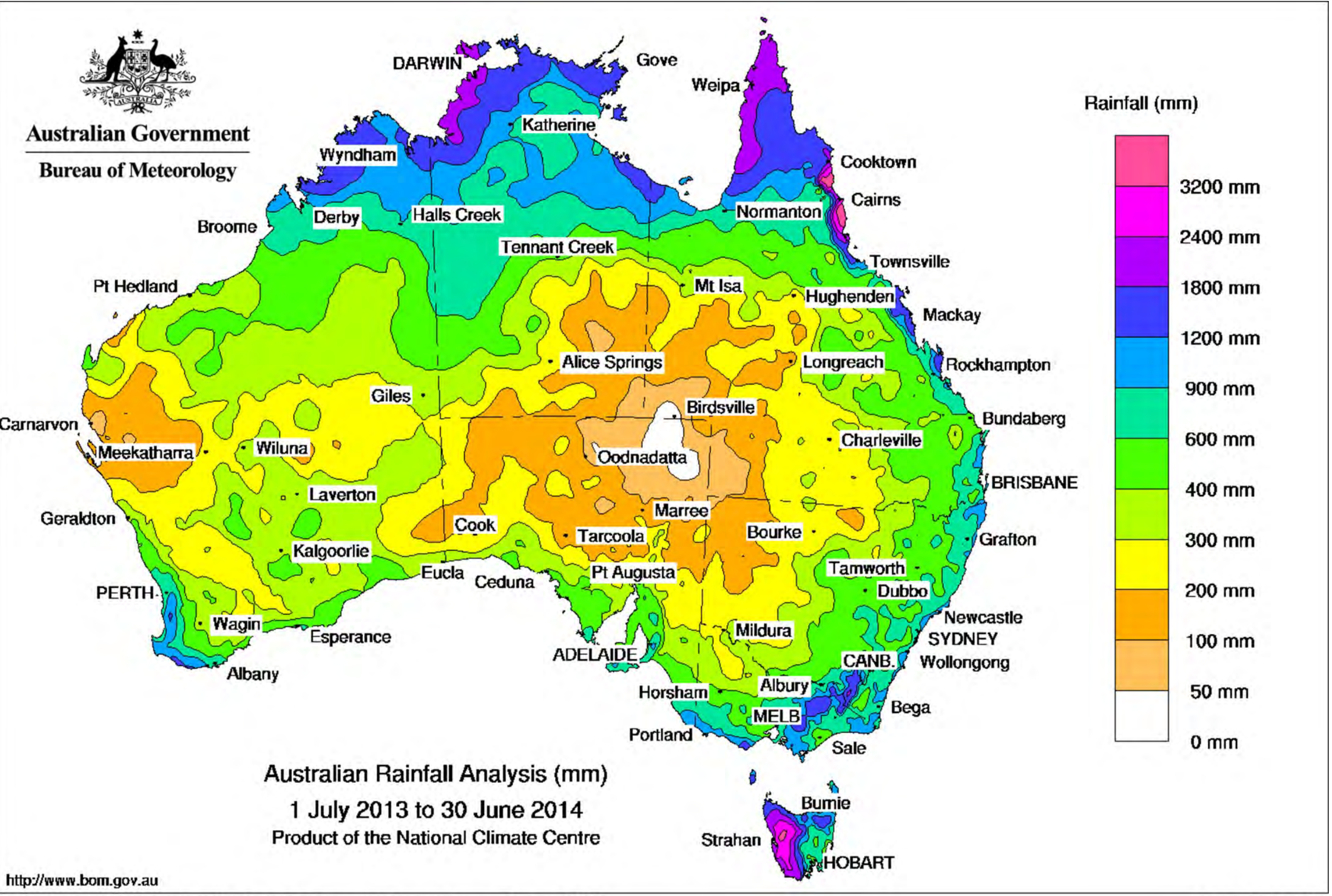
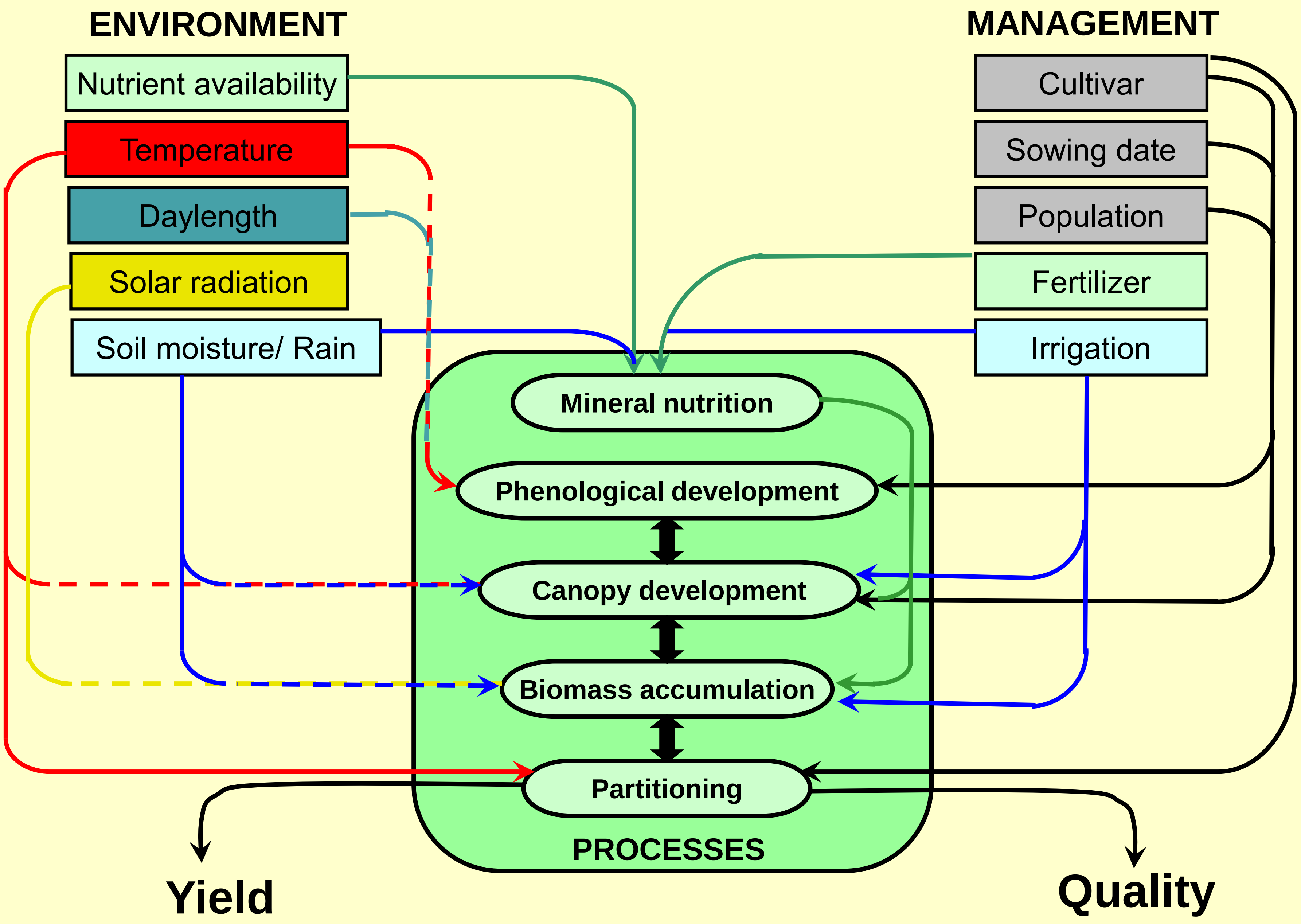
- What types of land uses, and

- 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
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
Wagin
Mildura
SYDNEY
Esperance
ADELAIDE
CANB.
Wollongong
Albany
Horsham
Albury
Bega
MELB
Portland
Sale
Burnie
Strahan
HOBART
Australian Rainfall Analysis (mm)
1 July 2013 to 30 June 2014
Product of the National Climate Centre
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

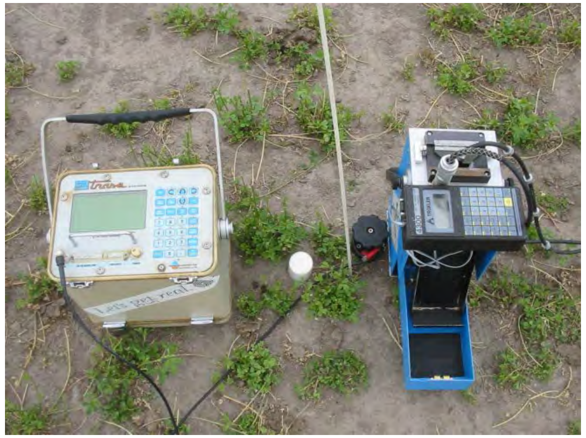
Measurements

Light environment

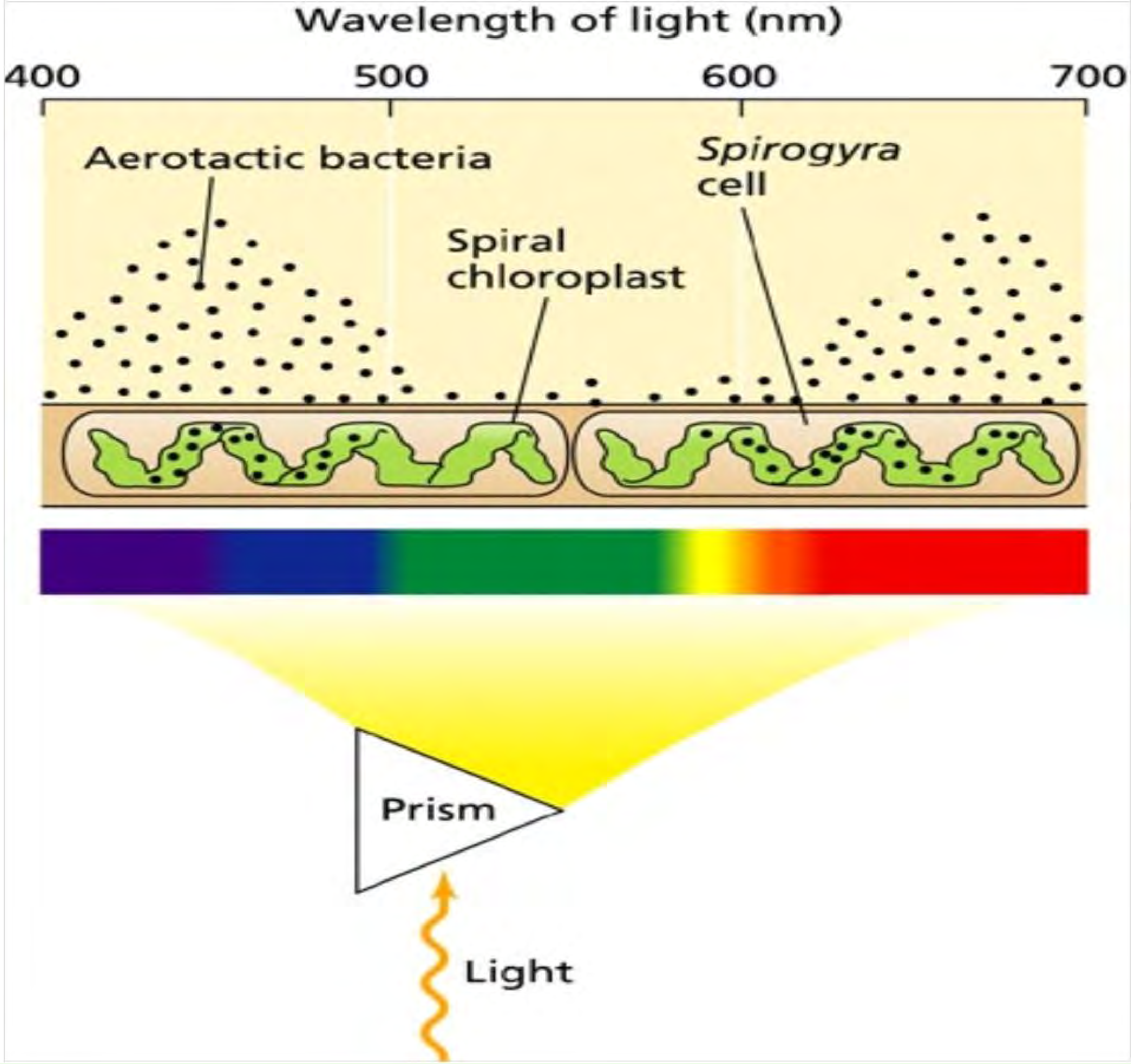
<u>Chemical Analysis:</u>
-N (shoots and roots)
-Starch in roots
-Soluble sugars in roots

<u>Temperature</u>
- 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.

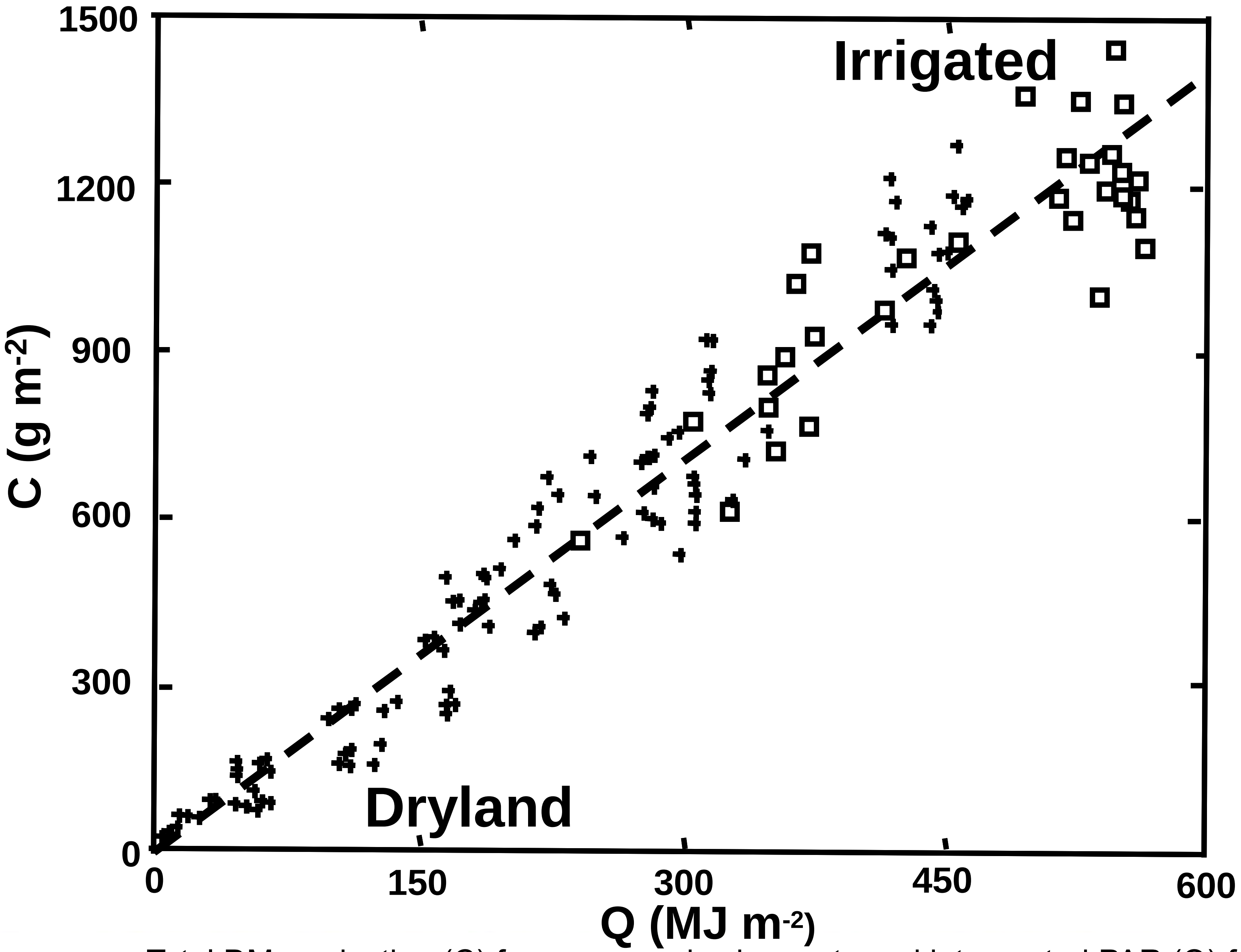
E = radiation use efficiency

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

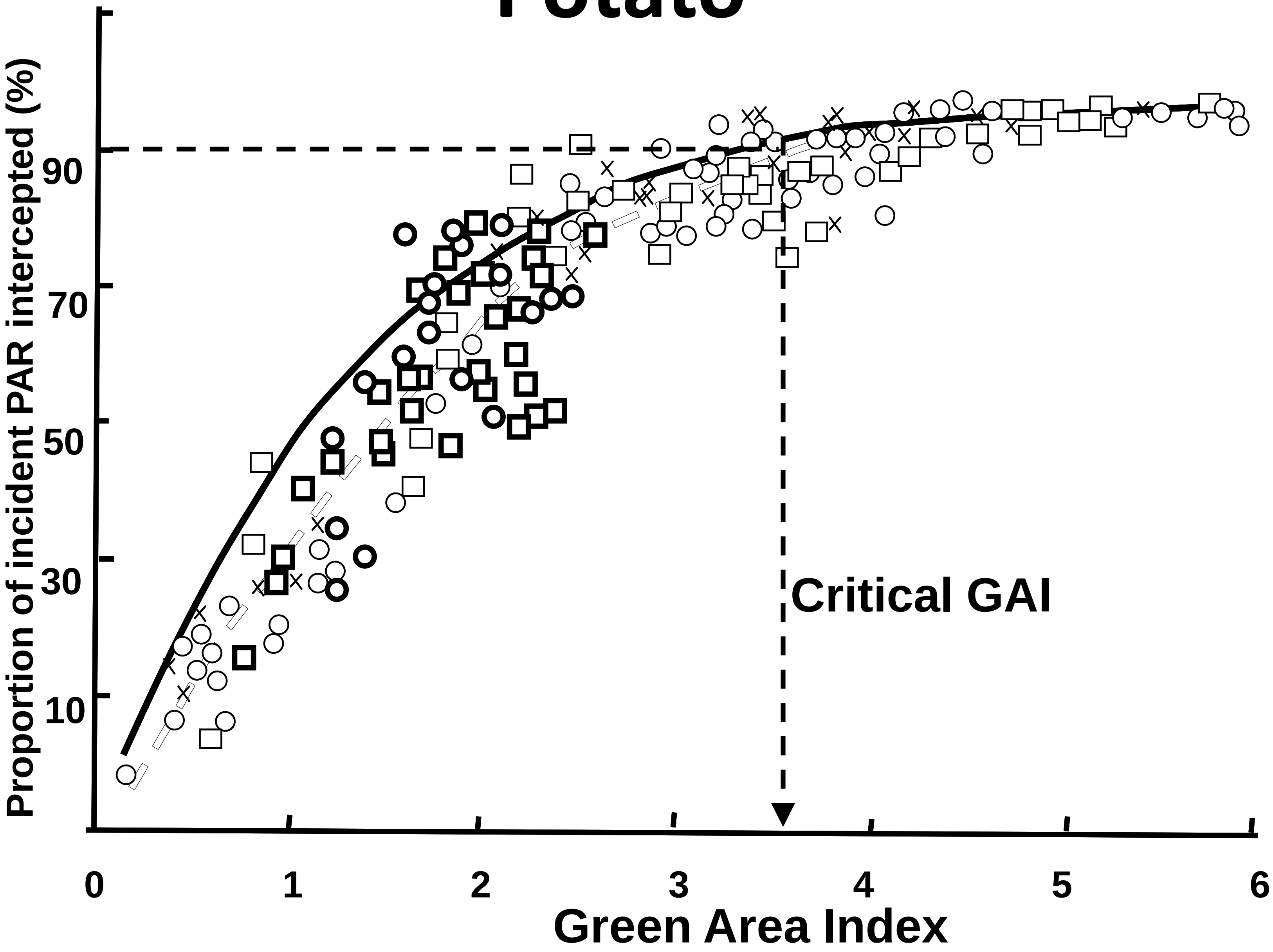
Light

- 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

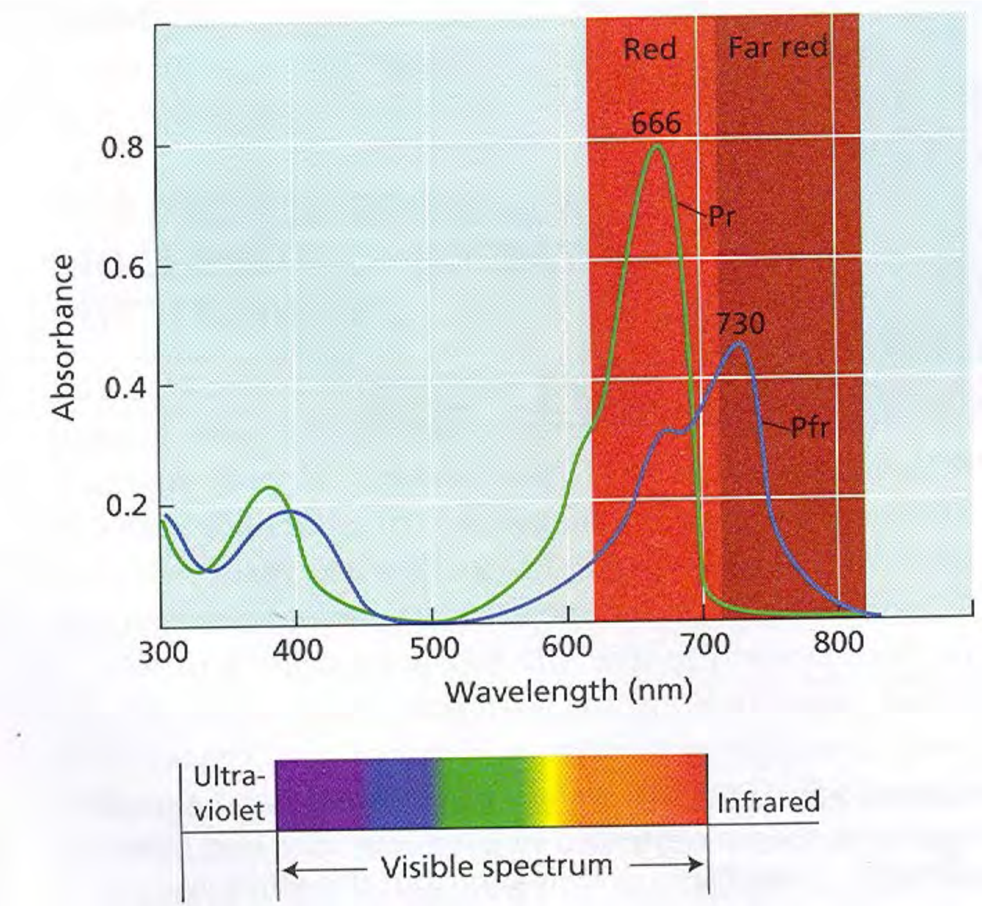
Potato



(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

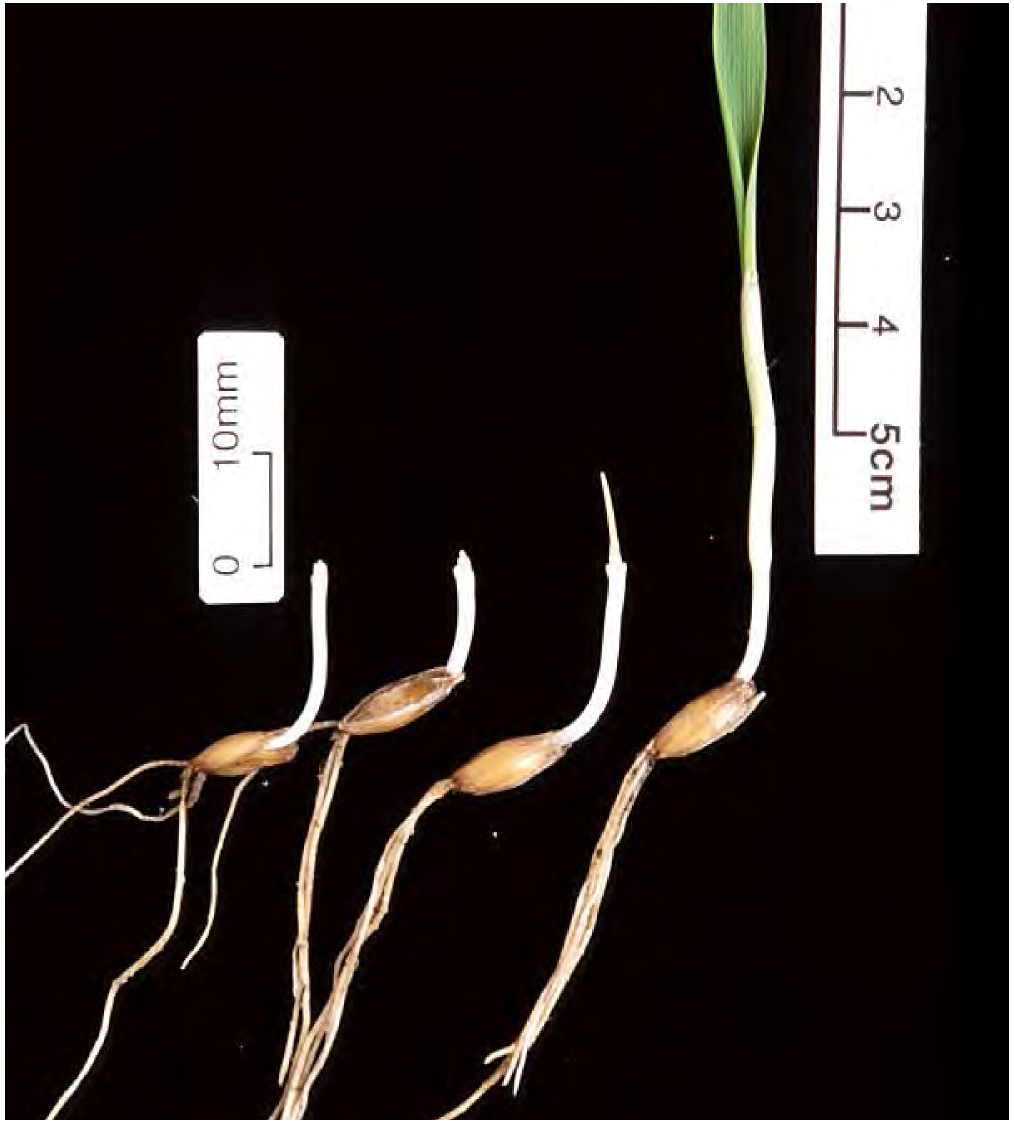
Temperature

- Tt = Thermal time (°Cd)

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

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

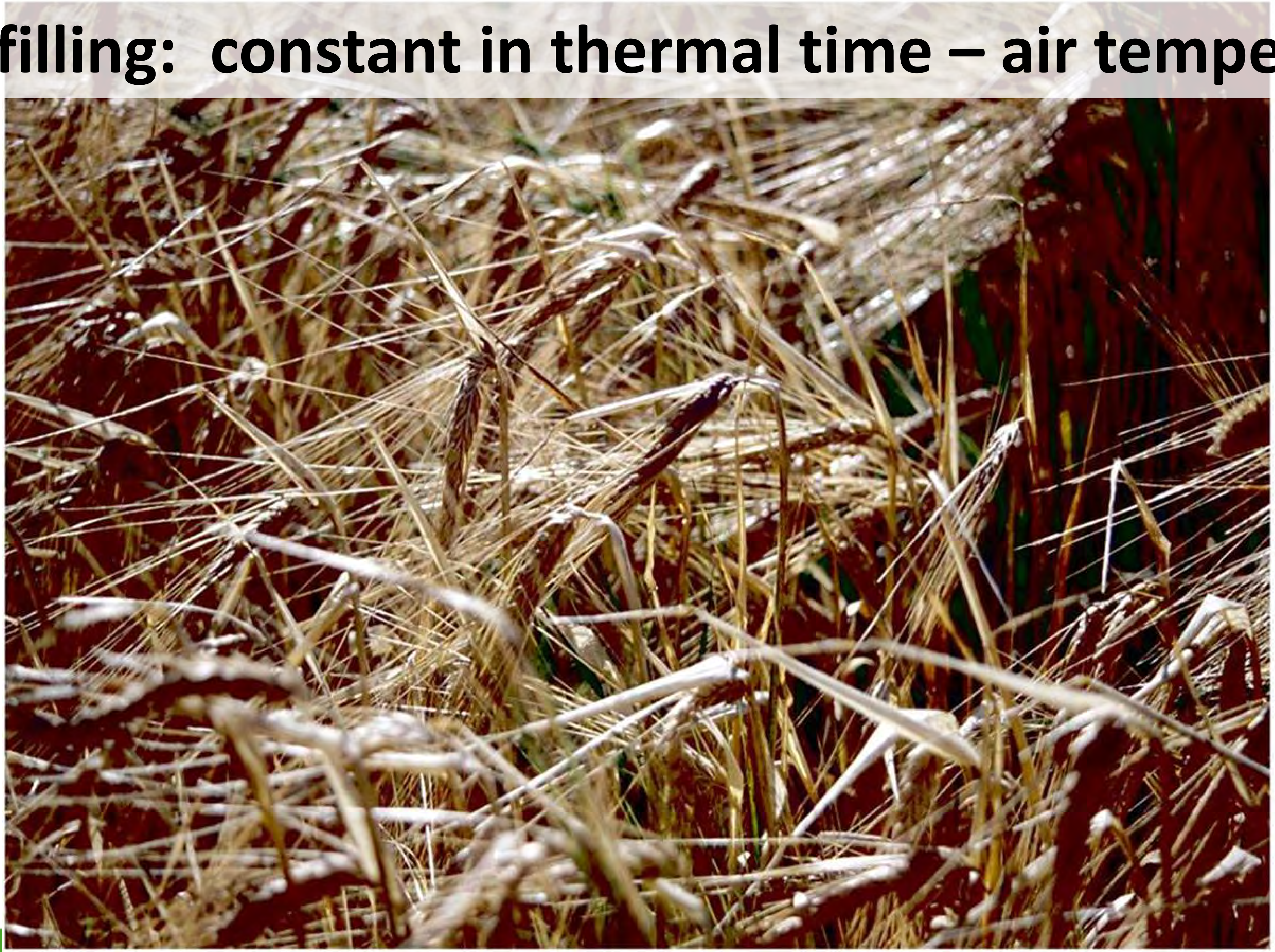
Sowing to emergence



Thermal time
- **soil temperature**

~ 125-150 °Cd

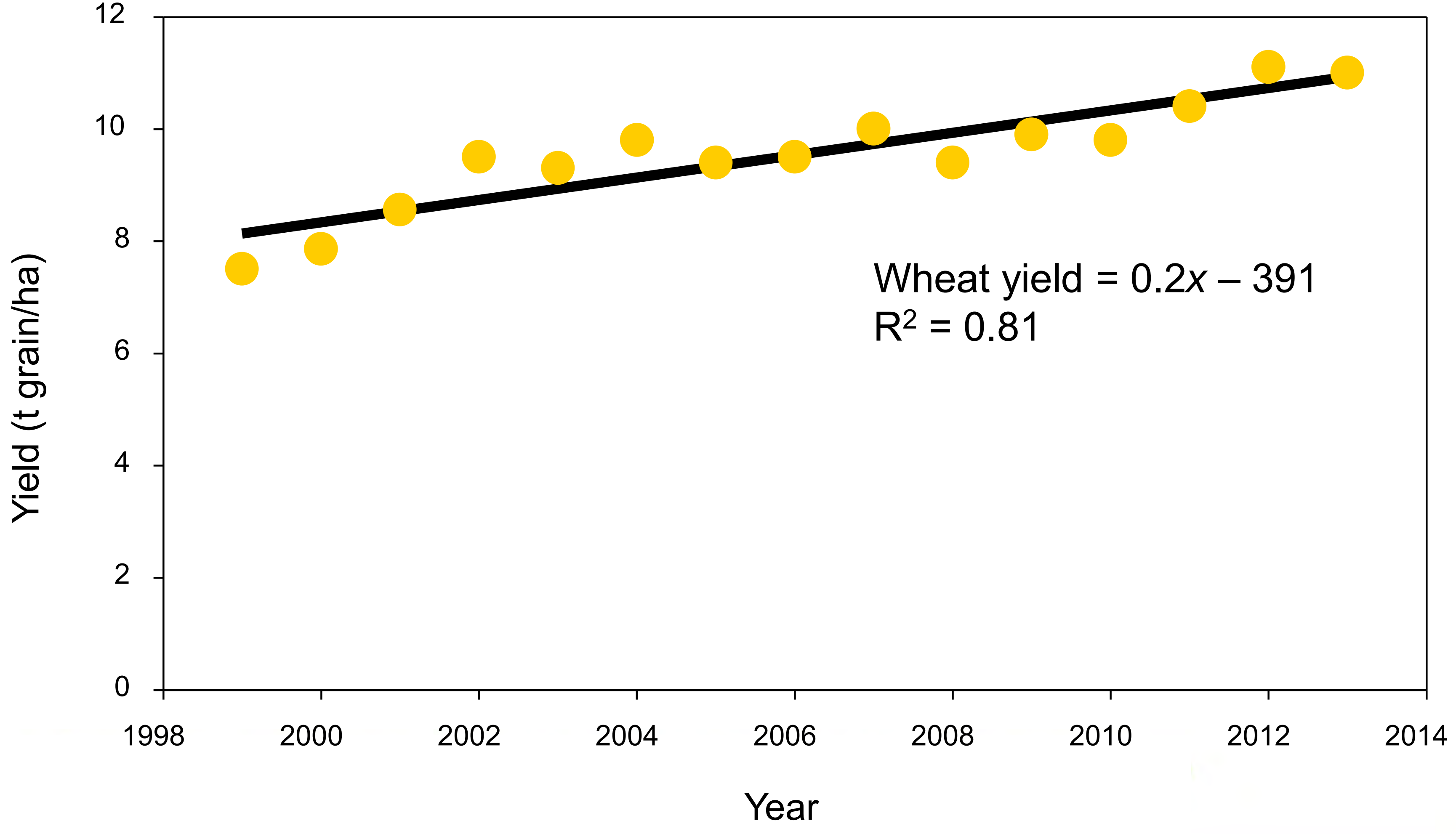
Grain-filling: constant in thermal time – air temperature



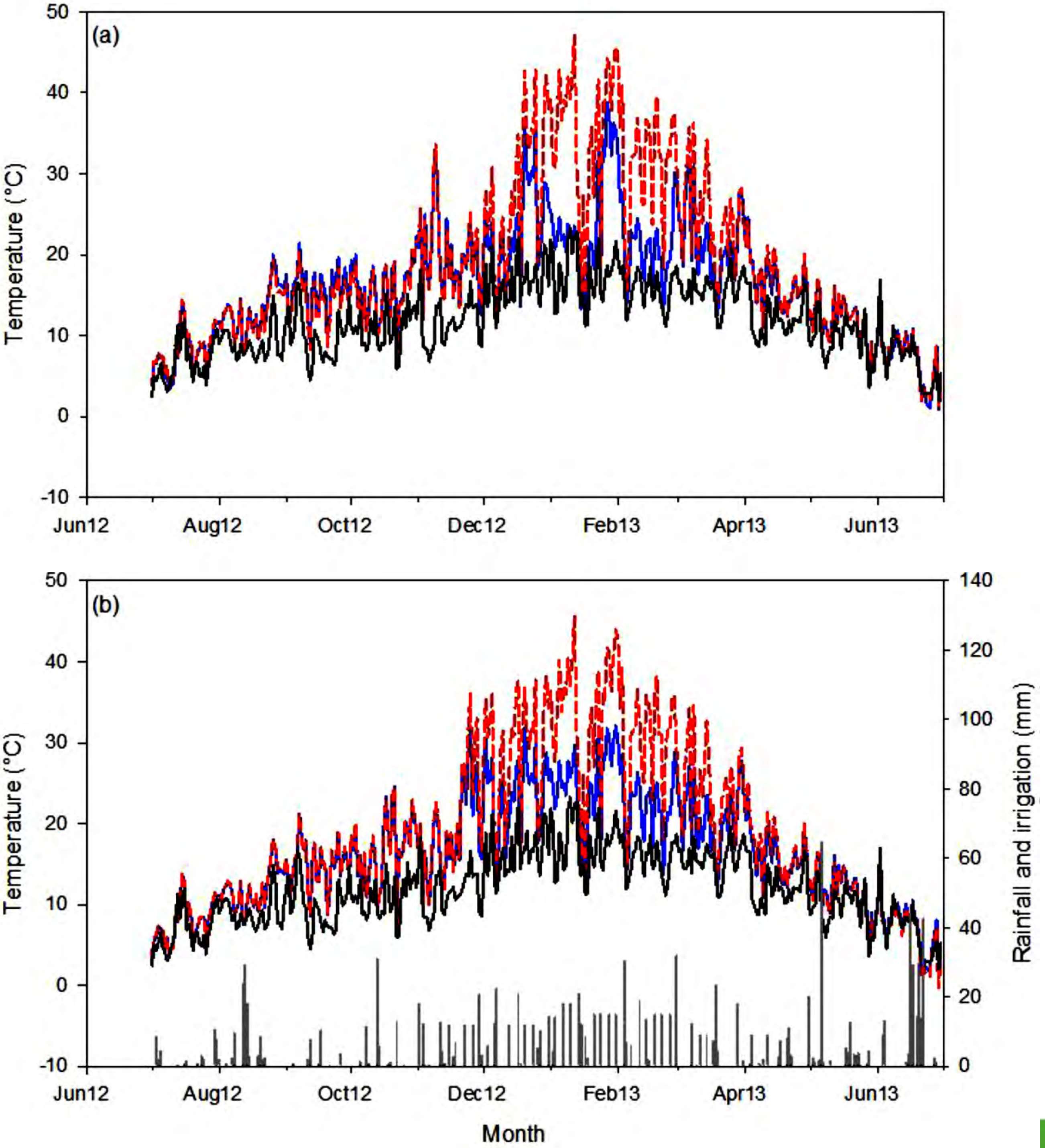
Wheat 15 t/ha; 40,000 ha
Barley 13 t/ha; 40,000 ha

Photo: Dr W.R. Scott

Wheat grain yields in Canterbury



Source: Cereal performance trials
FAR, Canterbury



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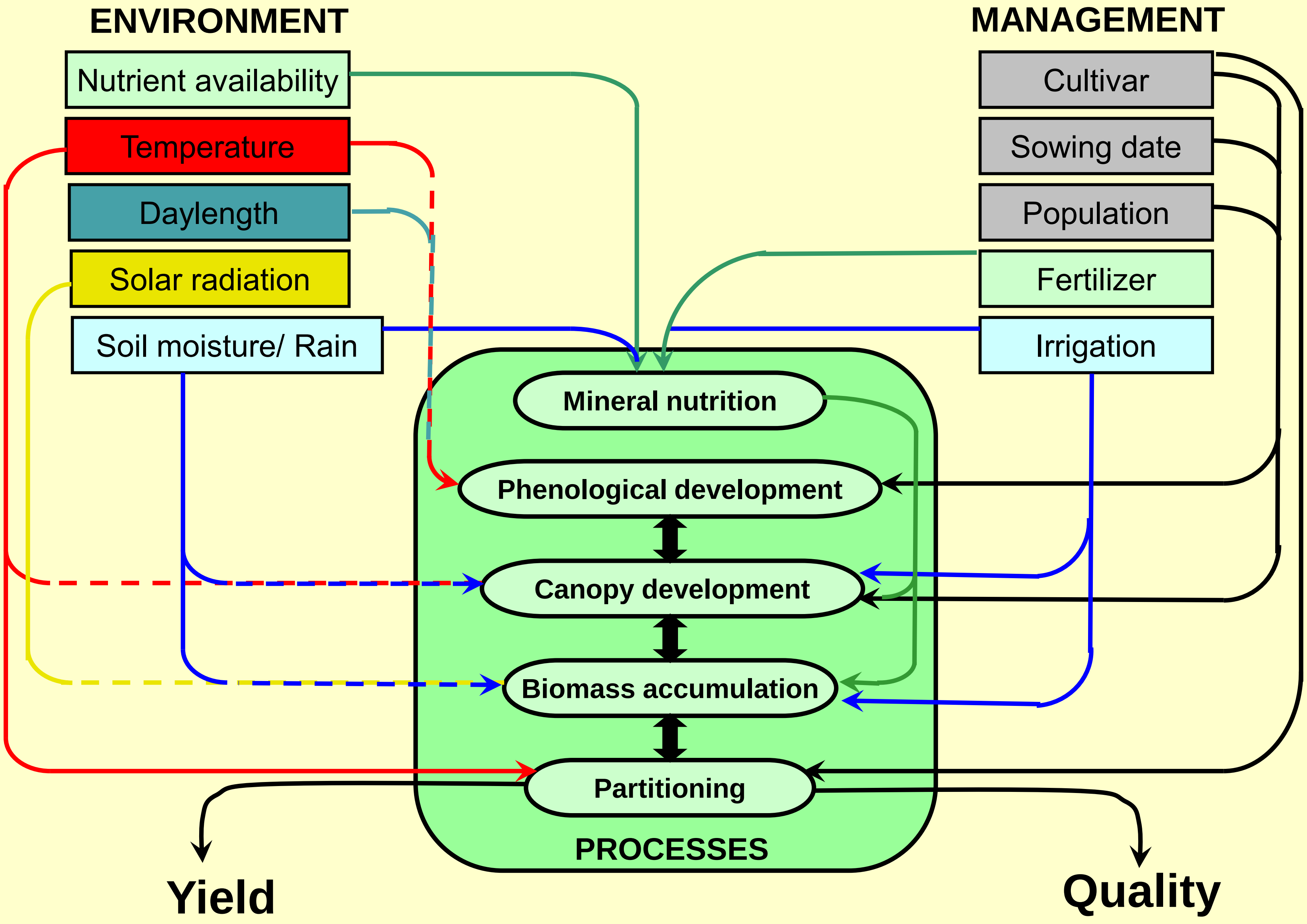
Mean daily canopy temperatures (°C) of (a) lucerne and (b) perennial ryegrass fully irrigated (■) and unirrigated (■)pastures against air temperature (■) and rainfall and irrigation (mm, ■) from1/07/2012 to 30/06/2013

Murray-Cawte, 2013



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

Olsen P<6

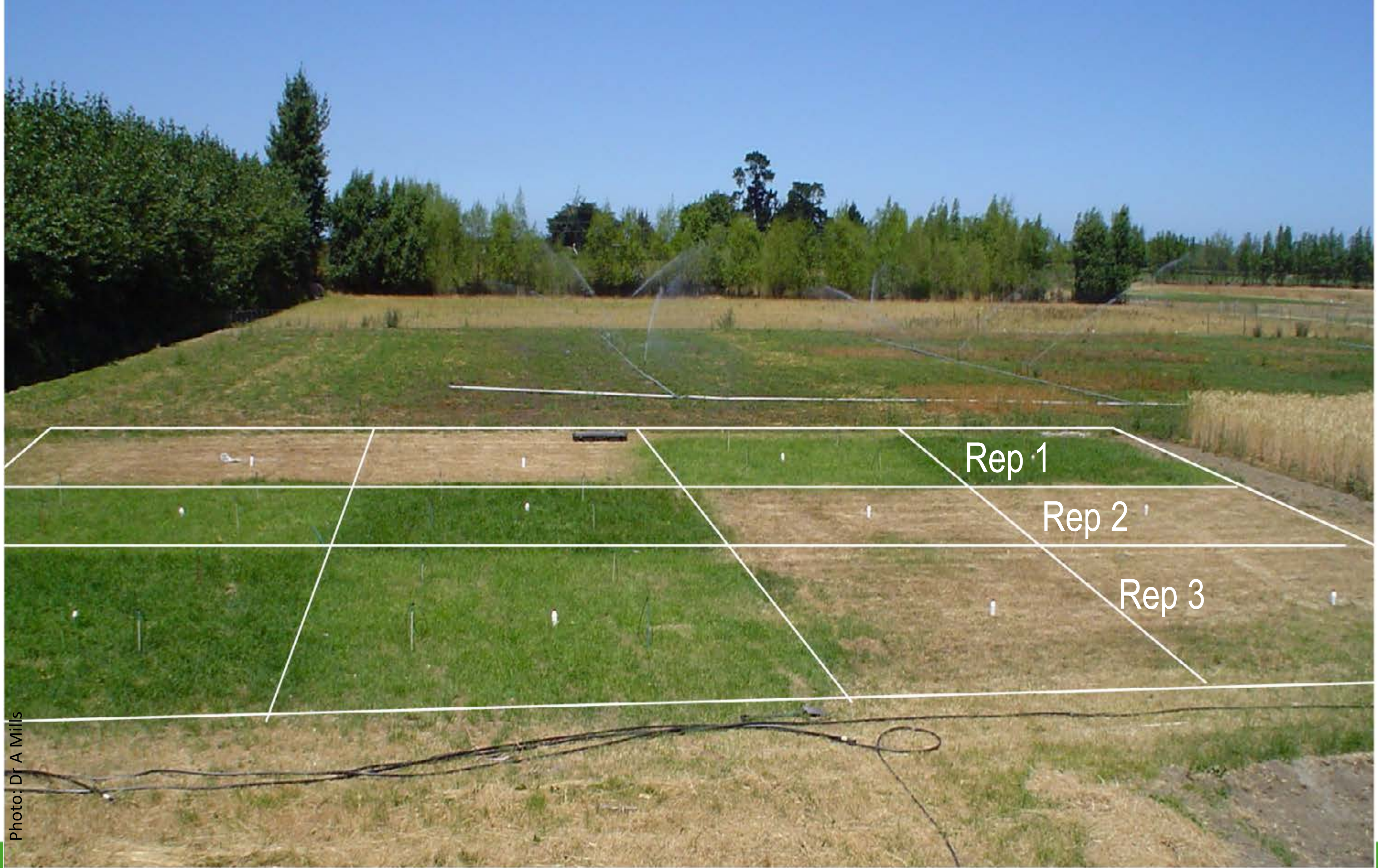
Photo: Dr A.L. Fletcher

Olsen P>20

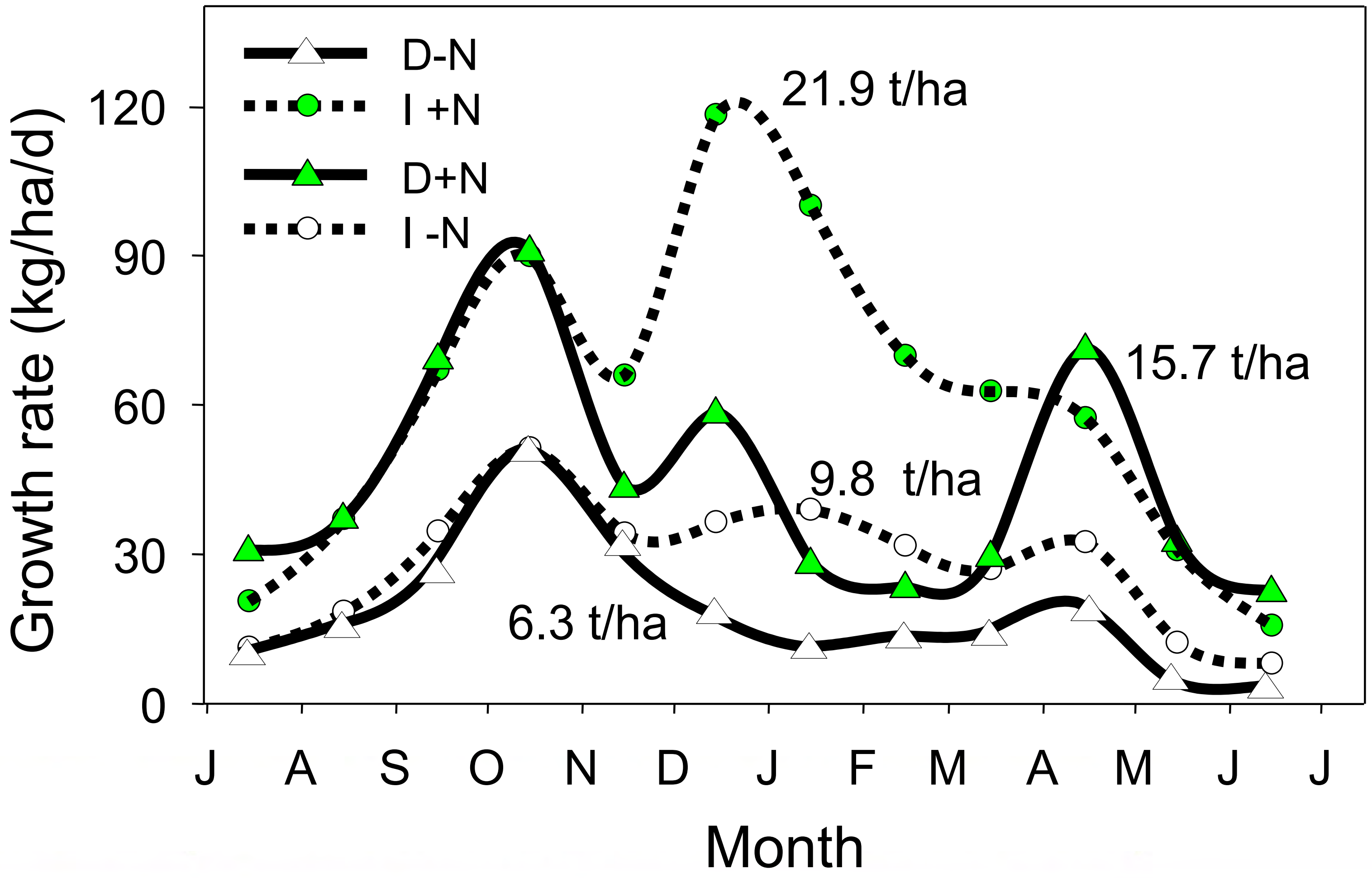
Drilling seed with fertiliser

Direct drilling = seed + fertiliser

Experiment site



Growth rates (2 year means)



Mills *et al*. 2006

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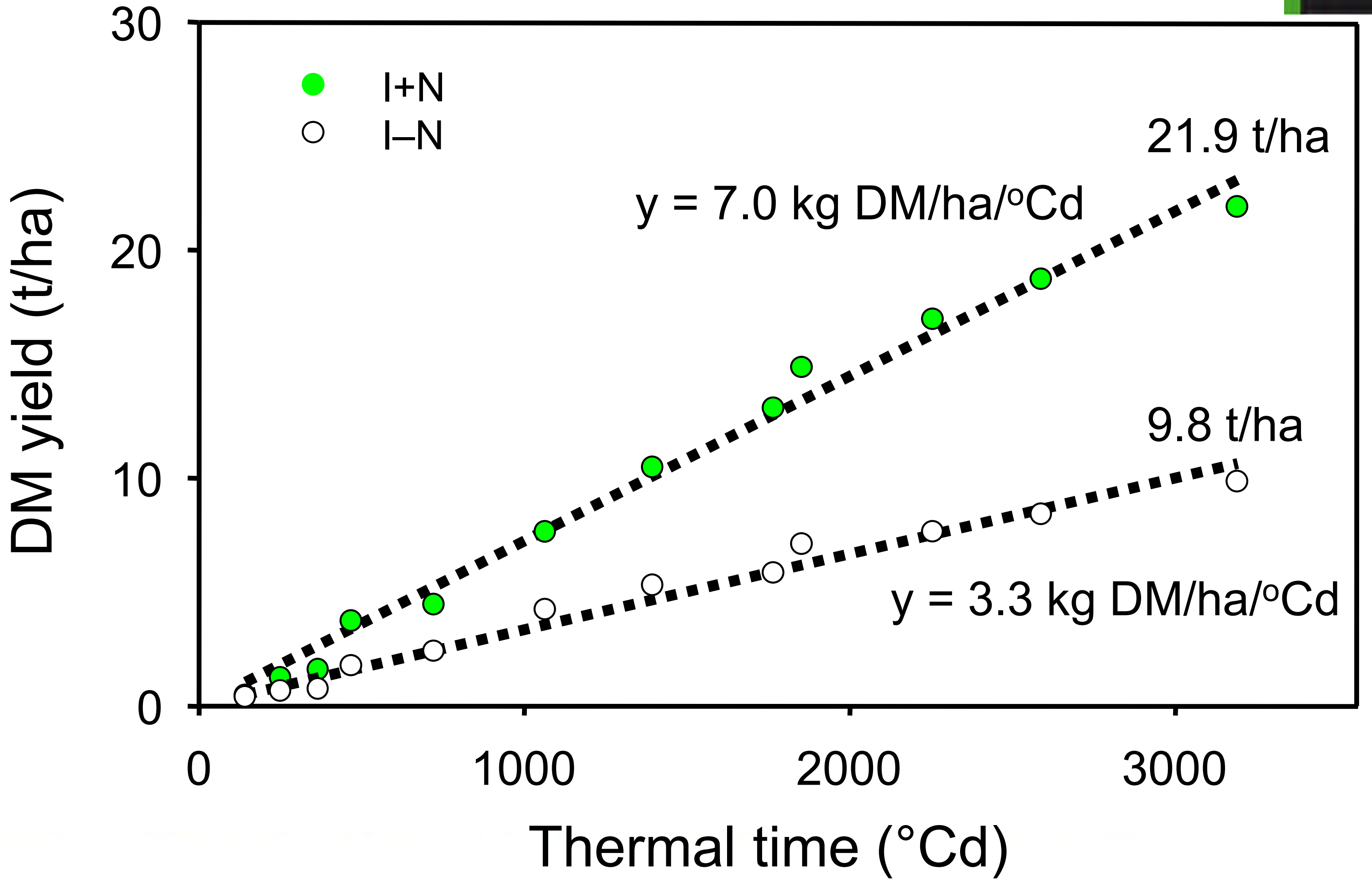
Winter
⇒ temperature response

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



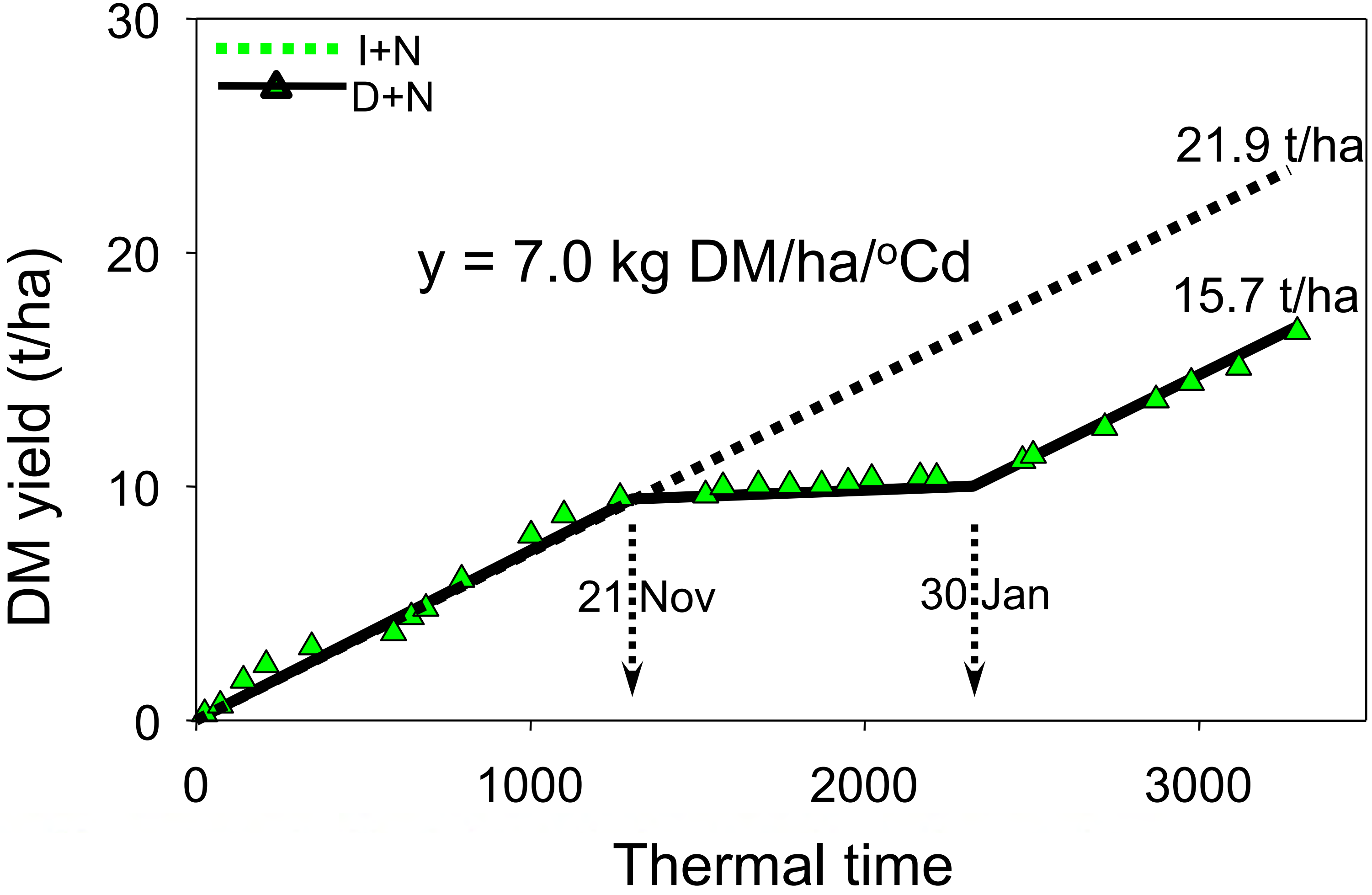
(Source: Mills *et al*. 2006)

Summer

⇒ moisture response

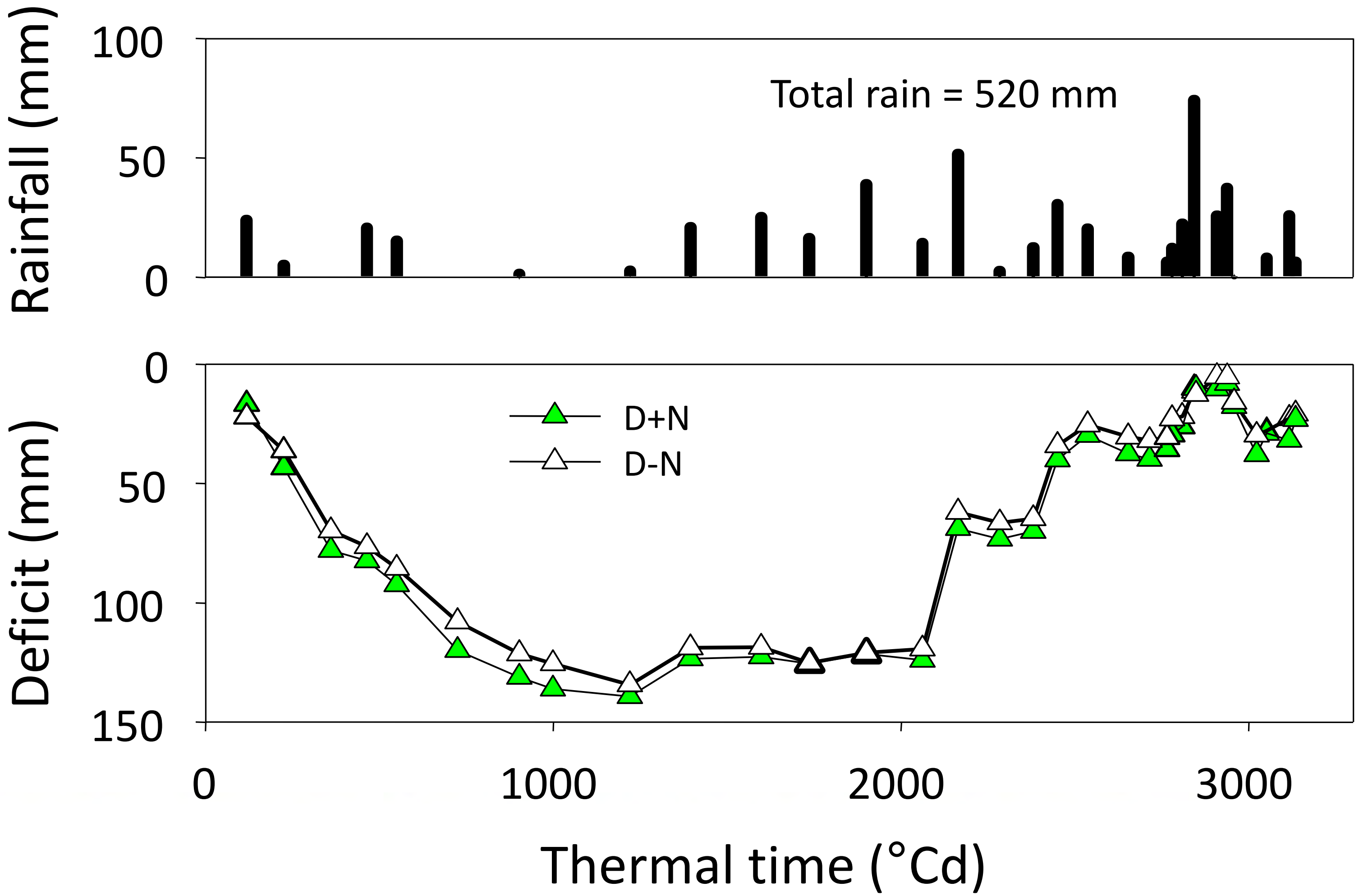
Mills 2007

Water stress effect on yield

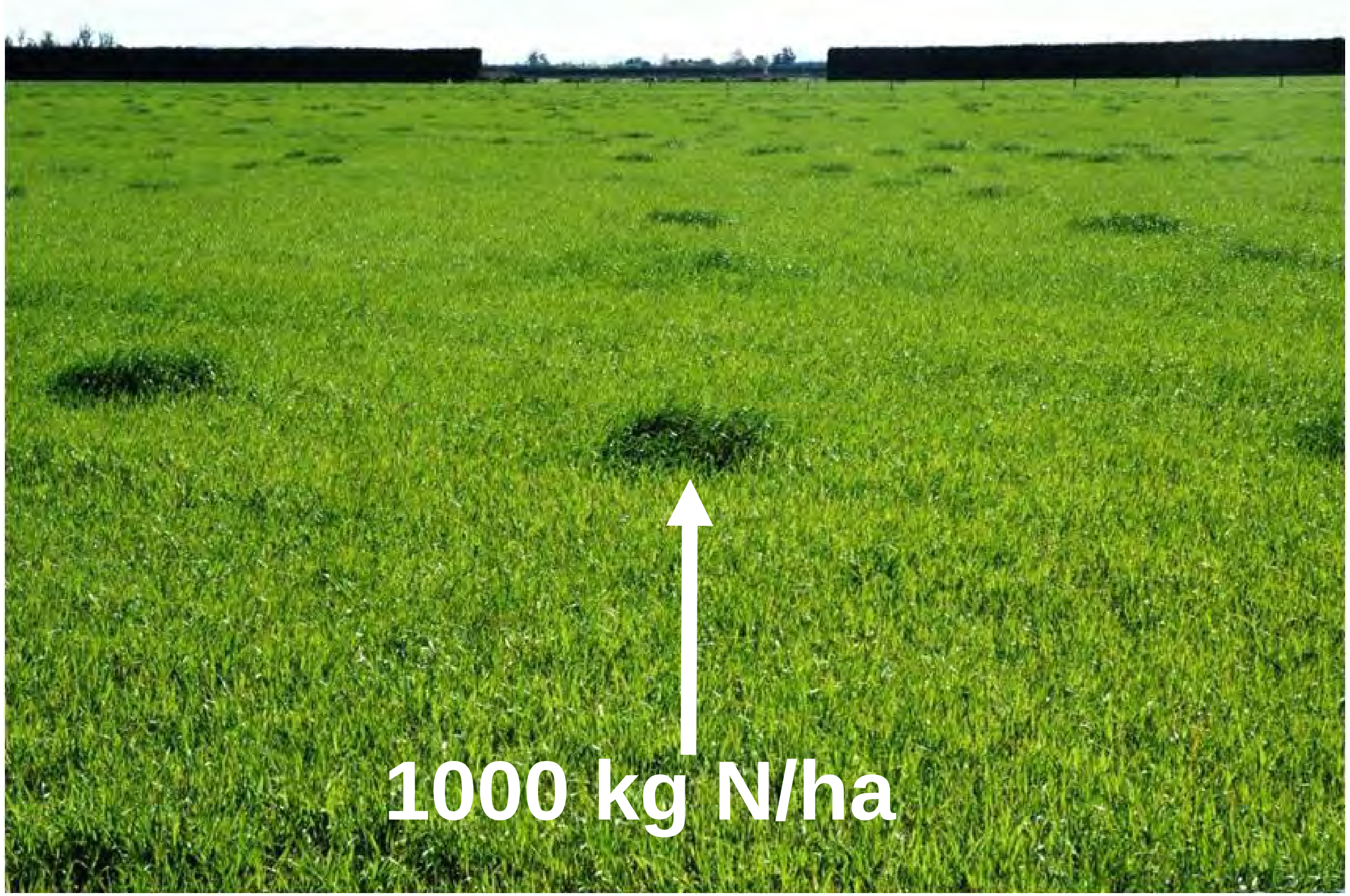


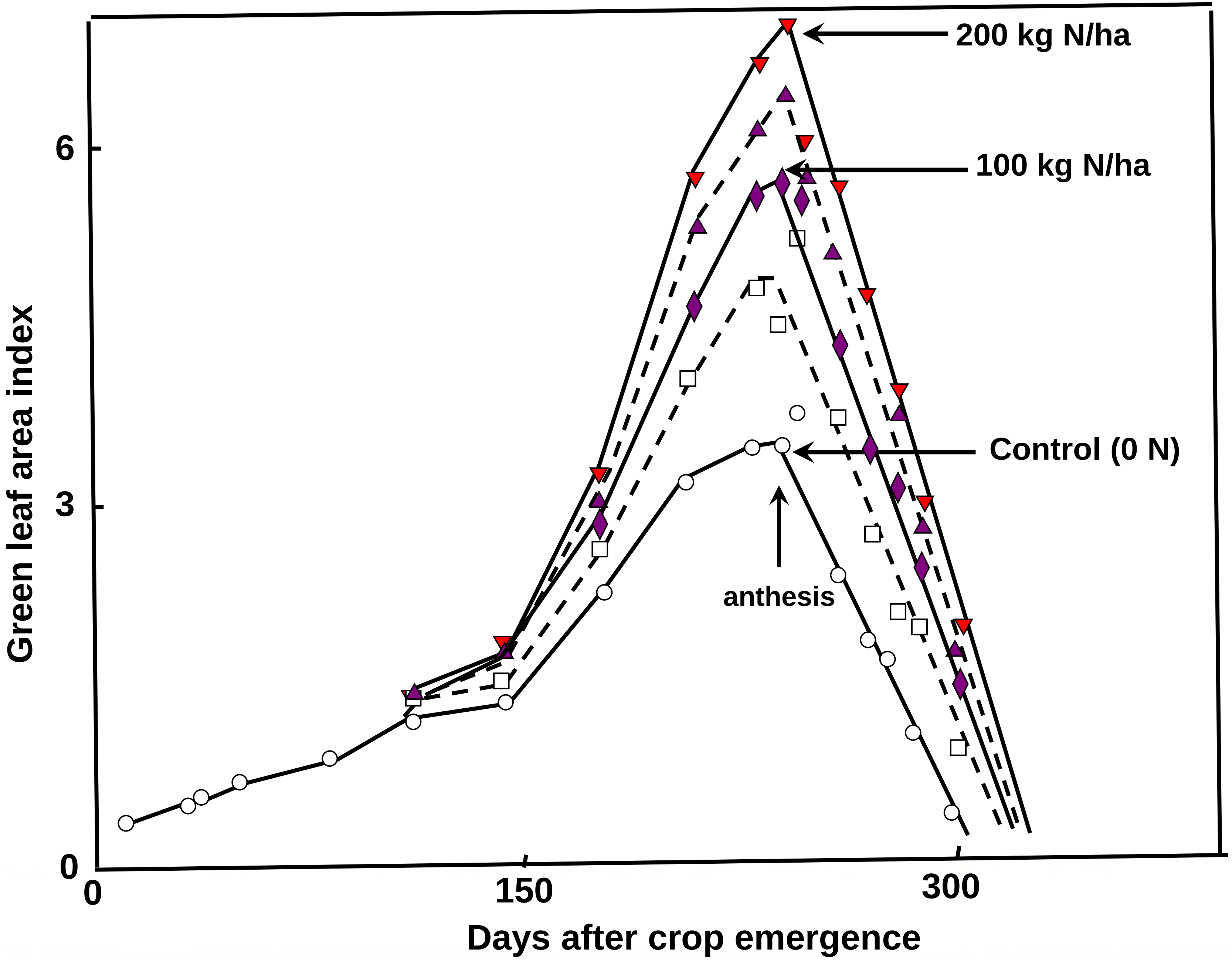
(Source: Mills *et al*. 2006)

Soil moisture deficit 2003/04



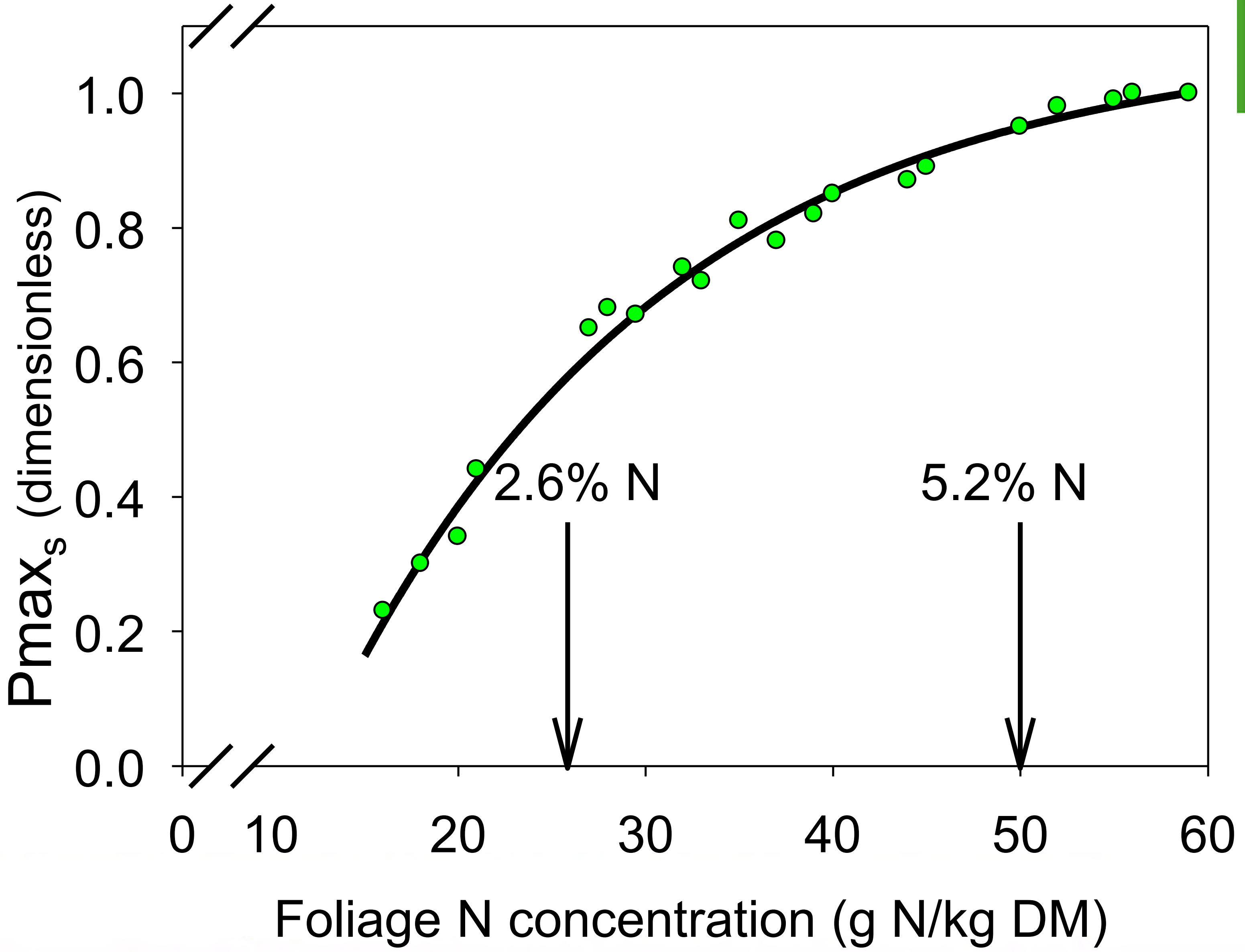
Nitrogen deficient pasture – inefficient user of water





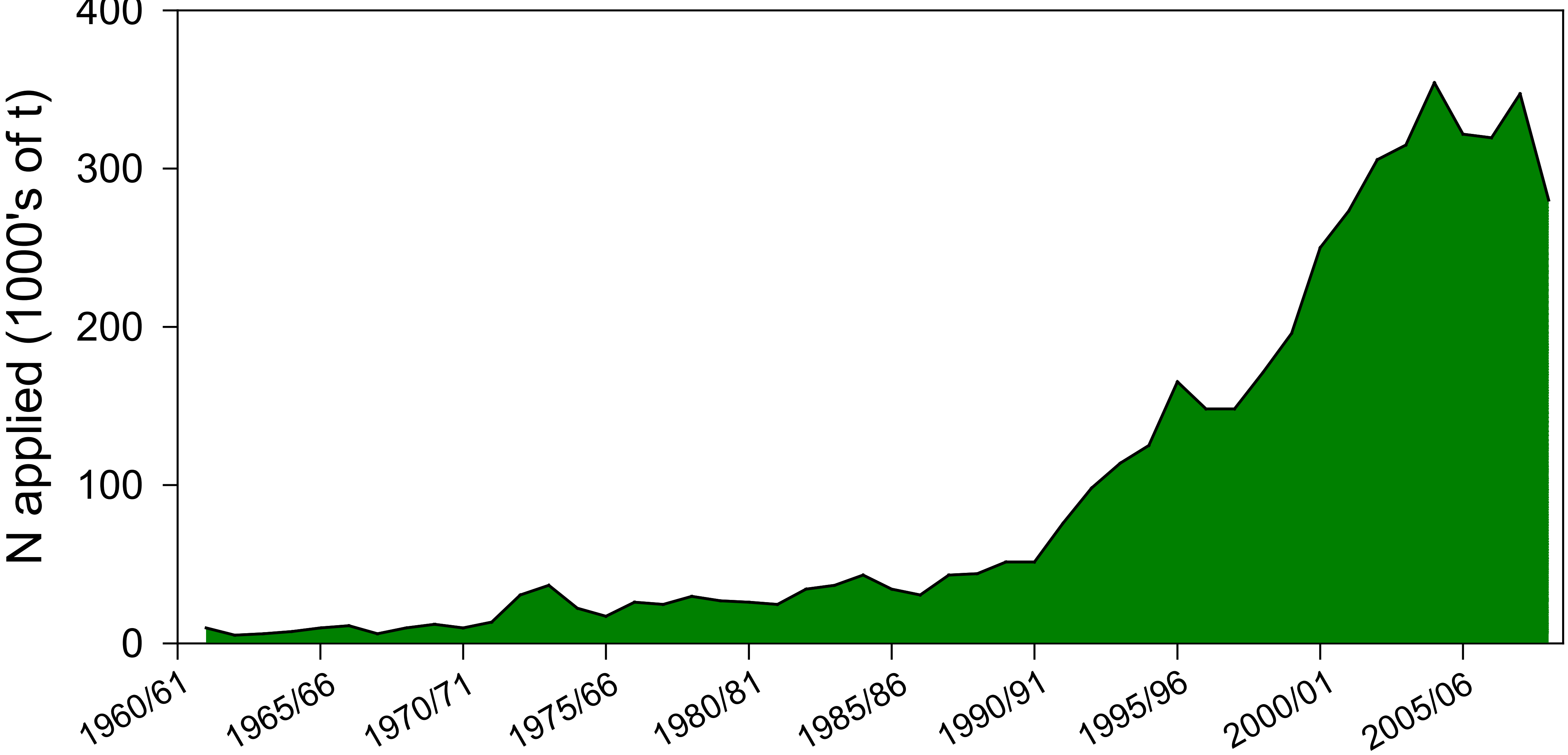
(Source: Green 1987)

Plant vs animal requirements



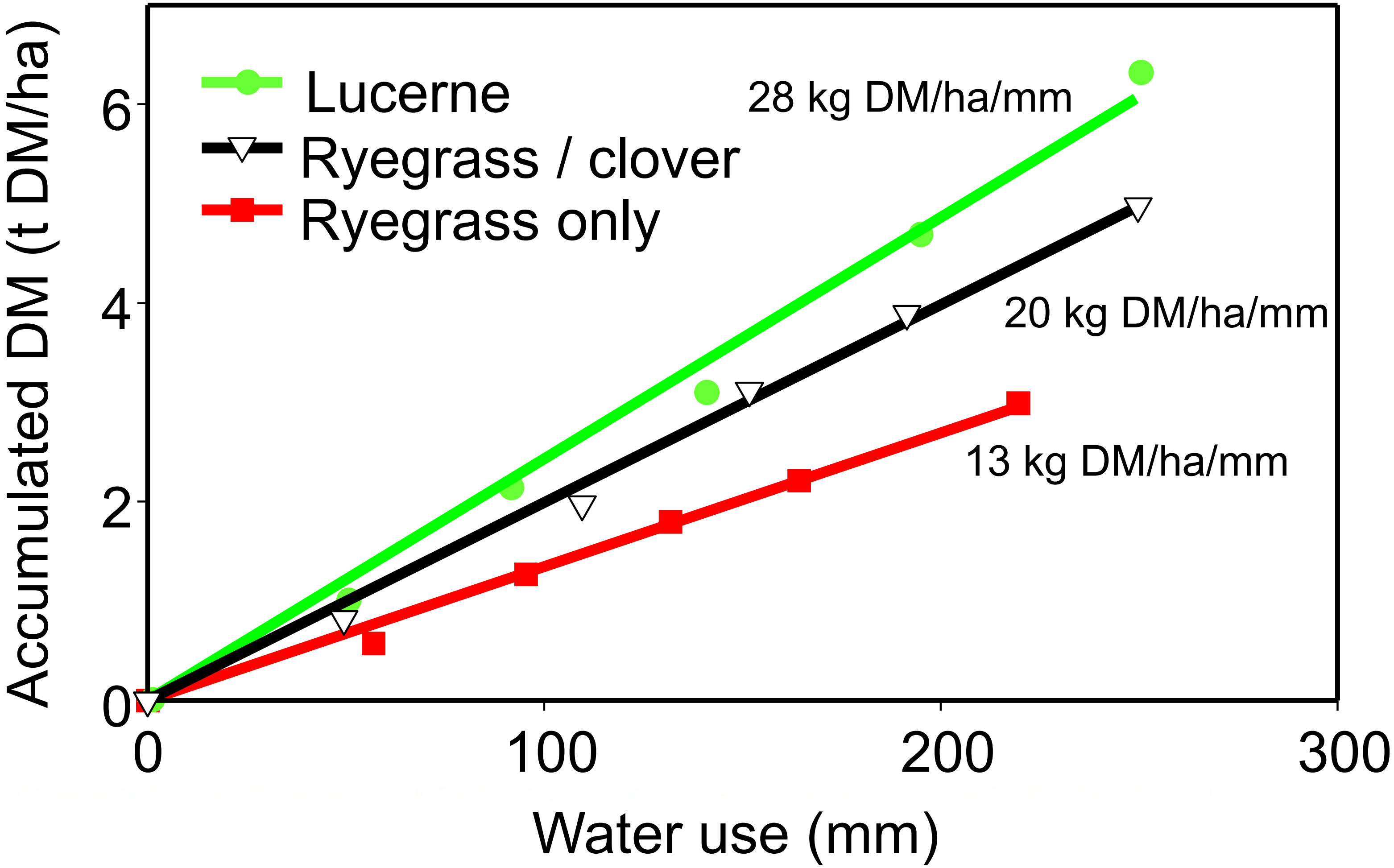
(Source: Peri *et al.* 2002)

Nitrogen fertiliser use



How can we increase WUE on-farm?

Spring WUE: legume = (nitrogen)



(Source: Moot *et al.* 2008)

‘Rosabrook’ subterranean clover

Photo: Dr A.D. Black

Biological N fixation

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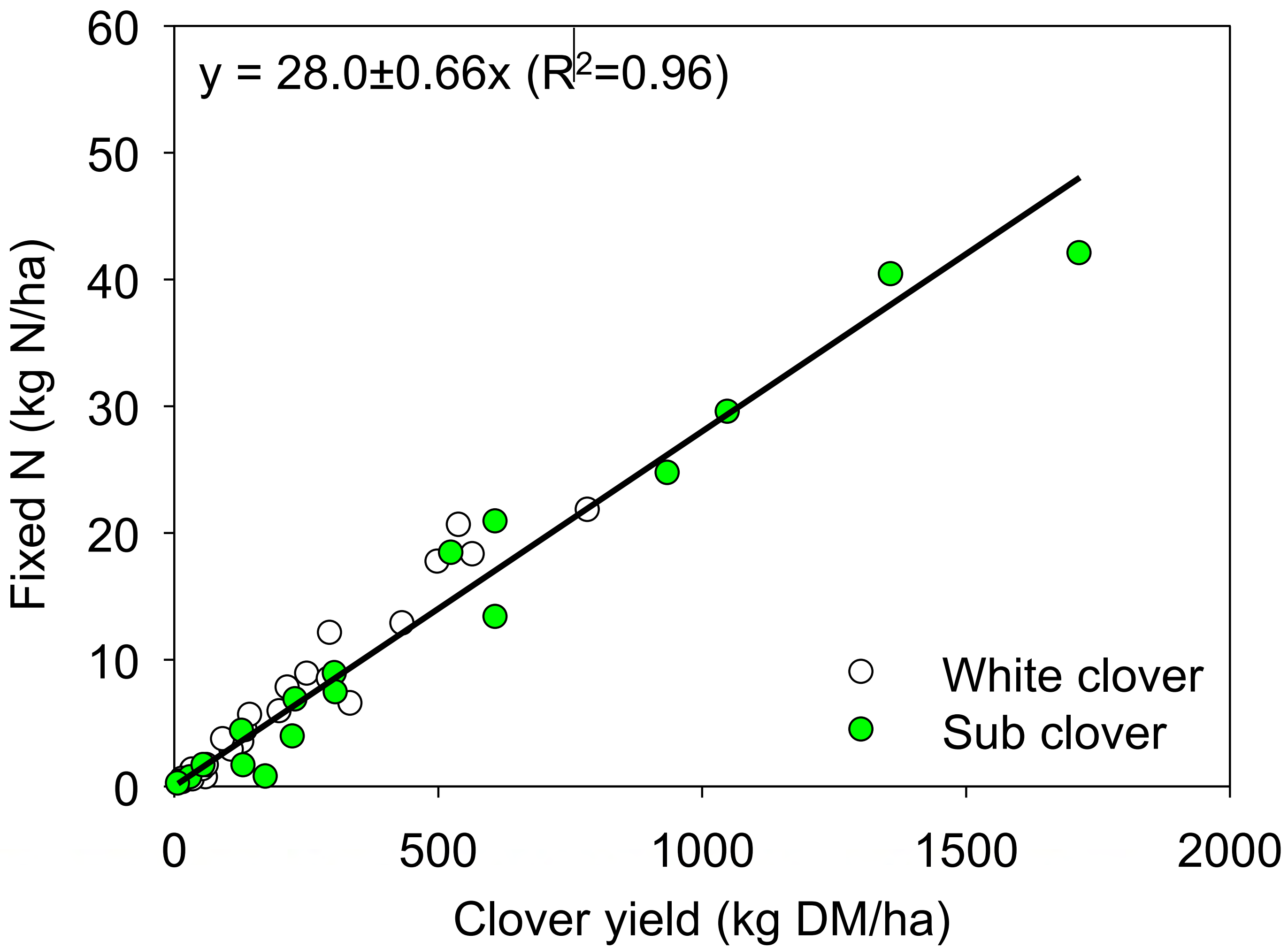
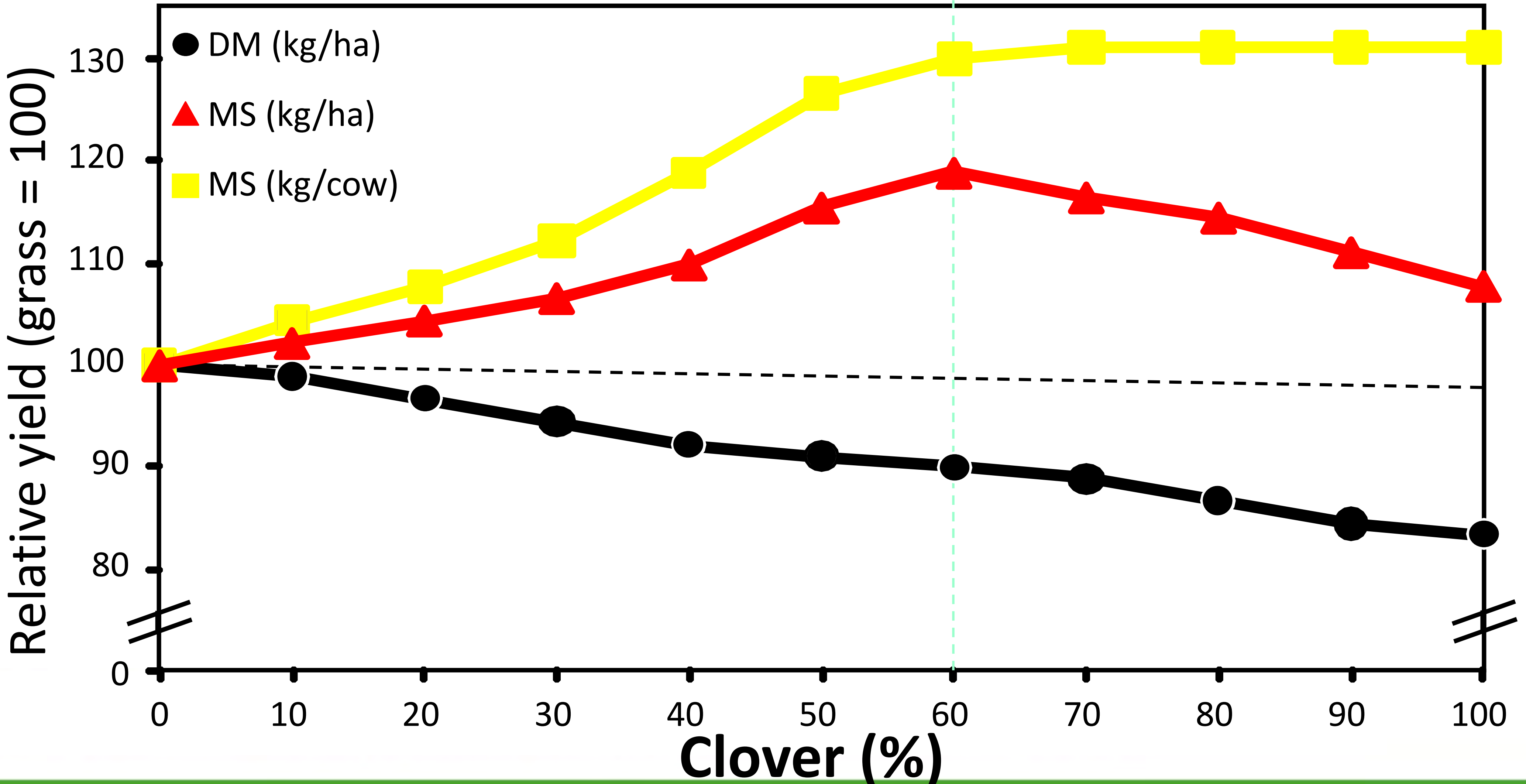



Photo: Dr DJ Moot

Sheep prefer 70% legume, 30% grass

Clover content & milksolids production



Cosgrove, 2005 - SIDE

Sheep prefer 70% legume, 30% grass


Russell lupin grazing trial at Sawdon Station
High aluminium soils
Photo: Dr AD Balck

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

References

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

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