Dryland Legumes: An overview of research in New Zealand

Derrick Moot

Professor in Plant Science

LINCOLN UNIVERSITY

Te Whare Wānaka O Aoraki

LU Dryland Pasture Research

1) **Farmer survey (1998 – 1 Masters)**

2) **Directed Experiments:**
   - 19 PhD
   - 9 Masters
   - 18 Honours students
   - 25 interns (9 countries)

3) **Science and Modeling – (2000 – present):**
   - 40 international journal
   - 80 conference

Lucerne issues

A) Pests and diseases – 1980's

- Largely overcome by new cultivars

B) Which deep-rooted species?

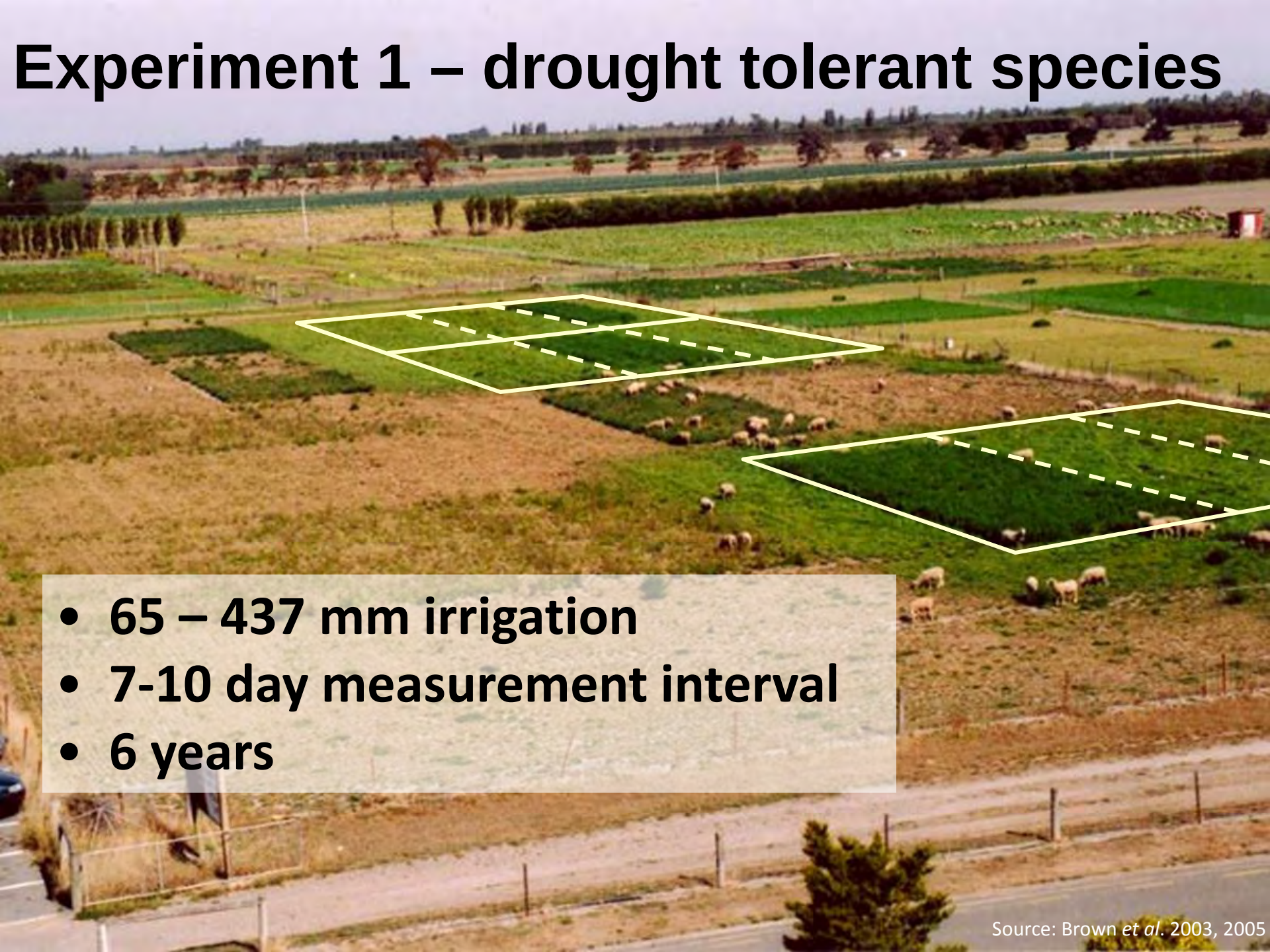
e.g. chicory, lucerne, red clover

Lucerne issues

C) Lambing time

- Average 23% higher but 3-weeks later
- Ewes and lambs on lucerne pre-weaning?
- 10% flowering – basal bud formation

Experiment 1 – drought tolerant species



- 65 – 437 mm irrigation
- 7-10 day measurement interval
- 6 years

Source: Brown *et al*. 2003, 2005

Measurements

Light environment

Chemical Analysis:

-N (shoots and roots)

-Starch in roots

-Soluble sugars in roots

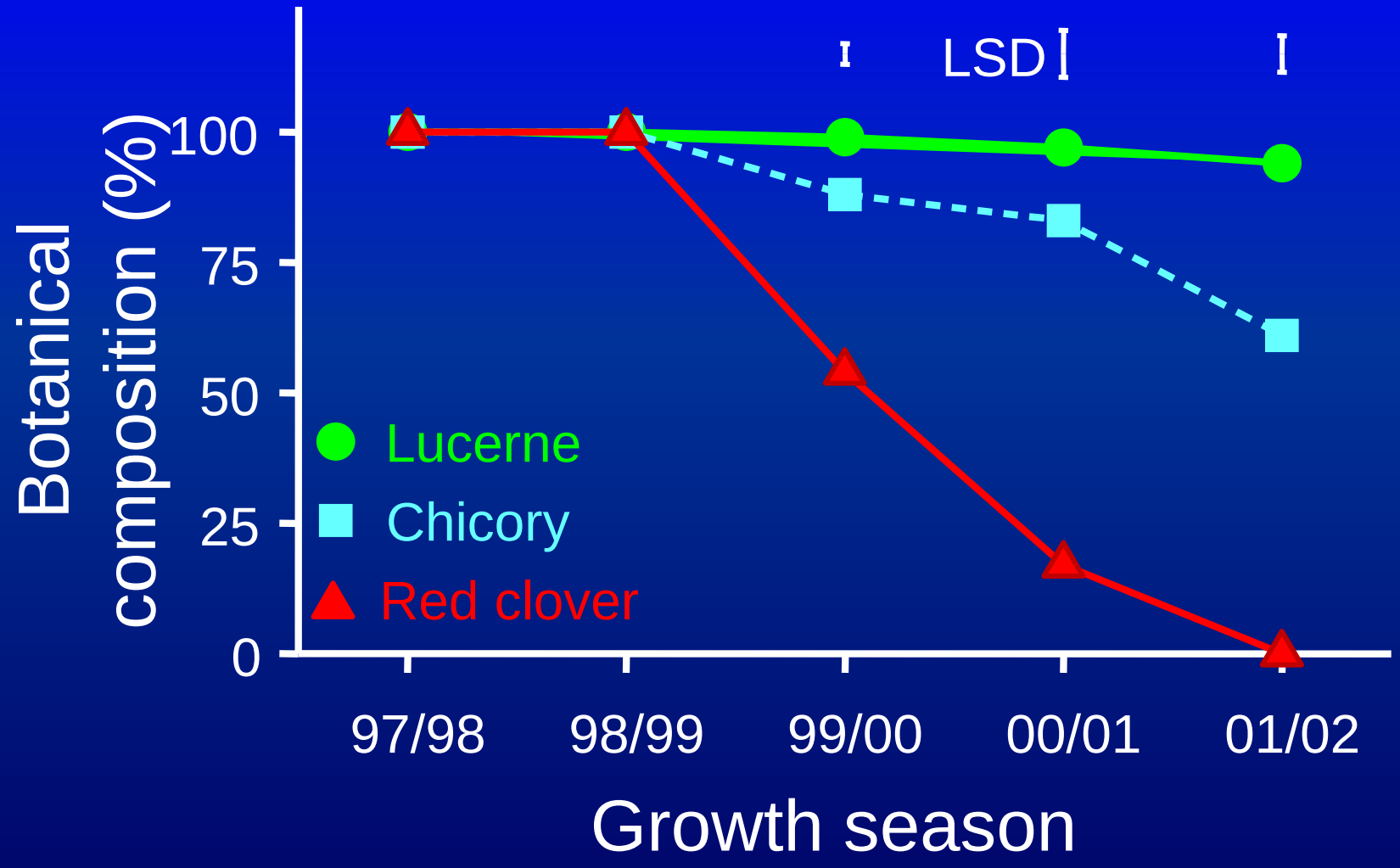
Others:

- SLW
- SPAD
- Chl_{a+b}

Soil moisture

Photosynthesis

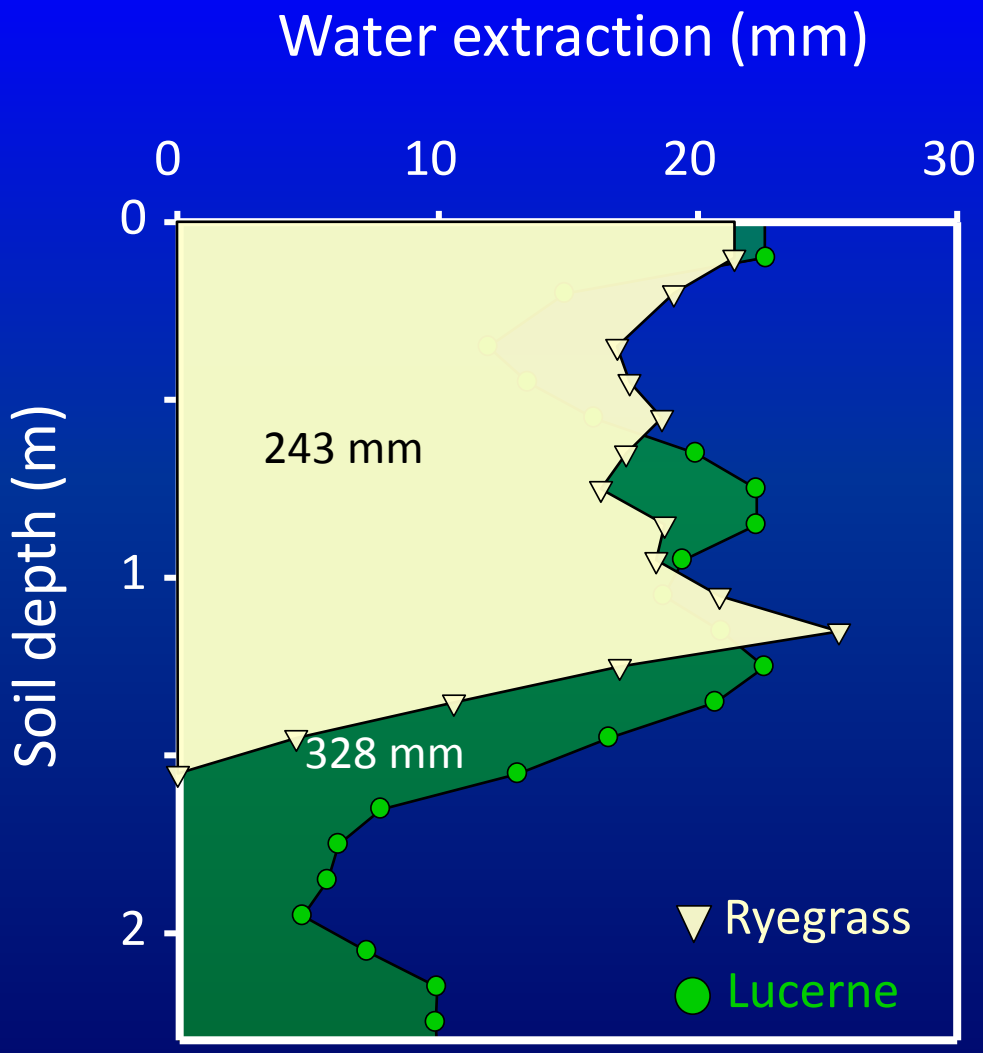
Persistence



Source: Brown & Moot 2004

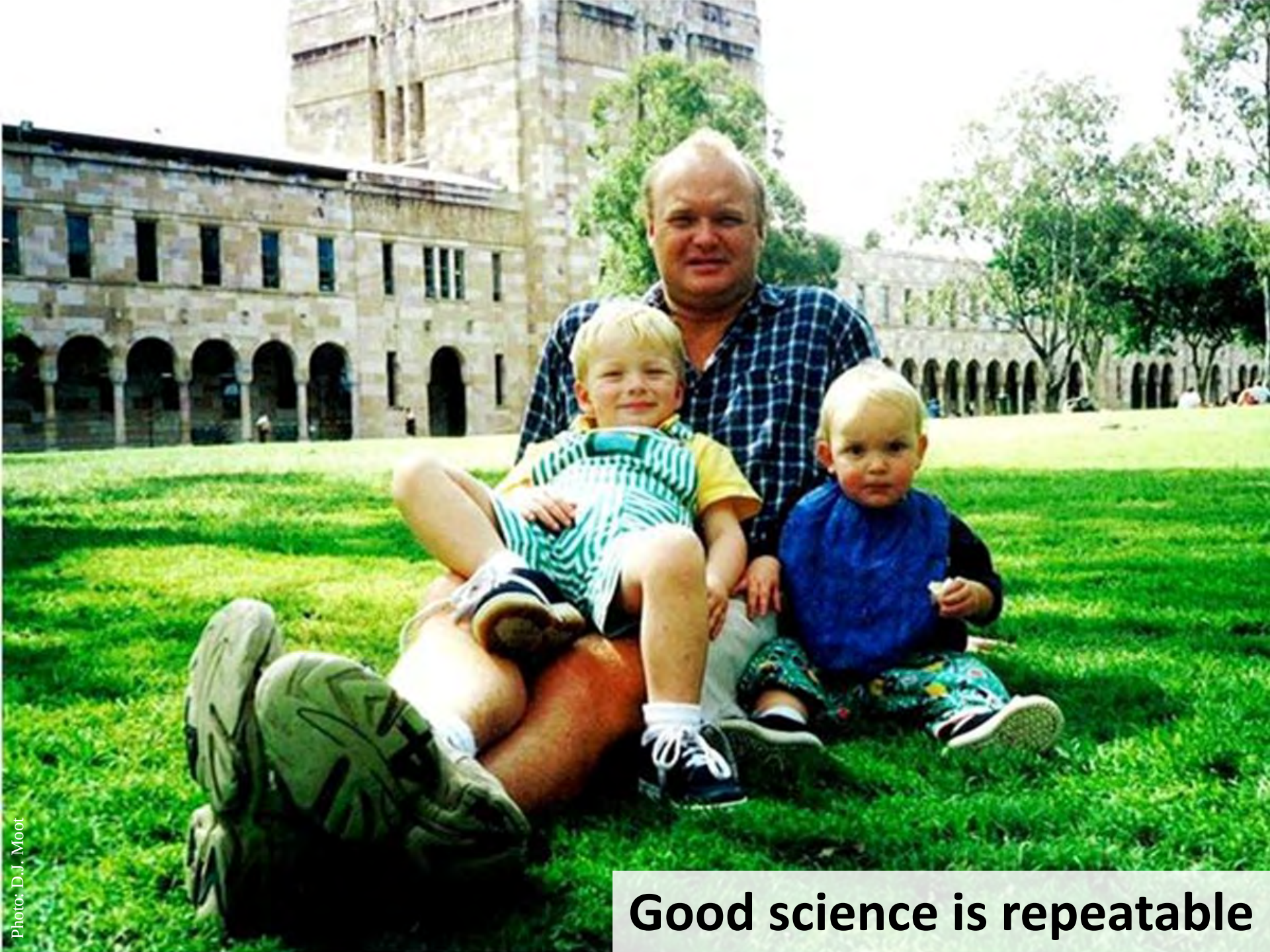
Ryegrass/clover vs. Lucerne

Soil water extraction: Species



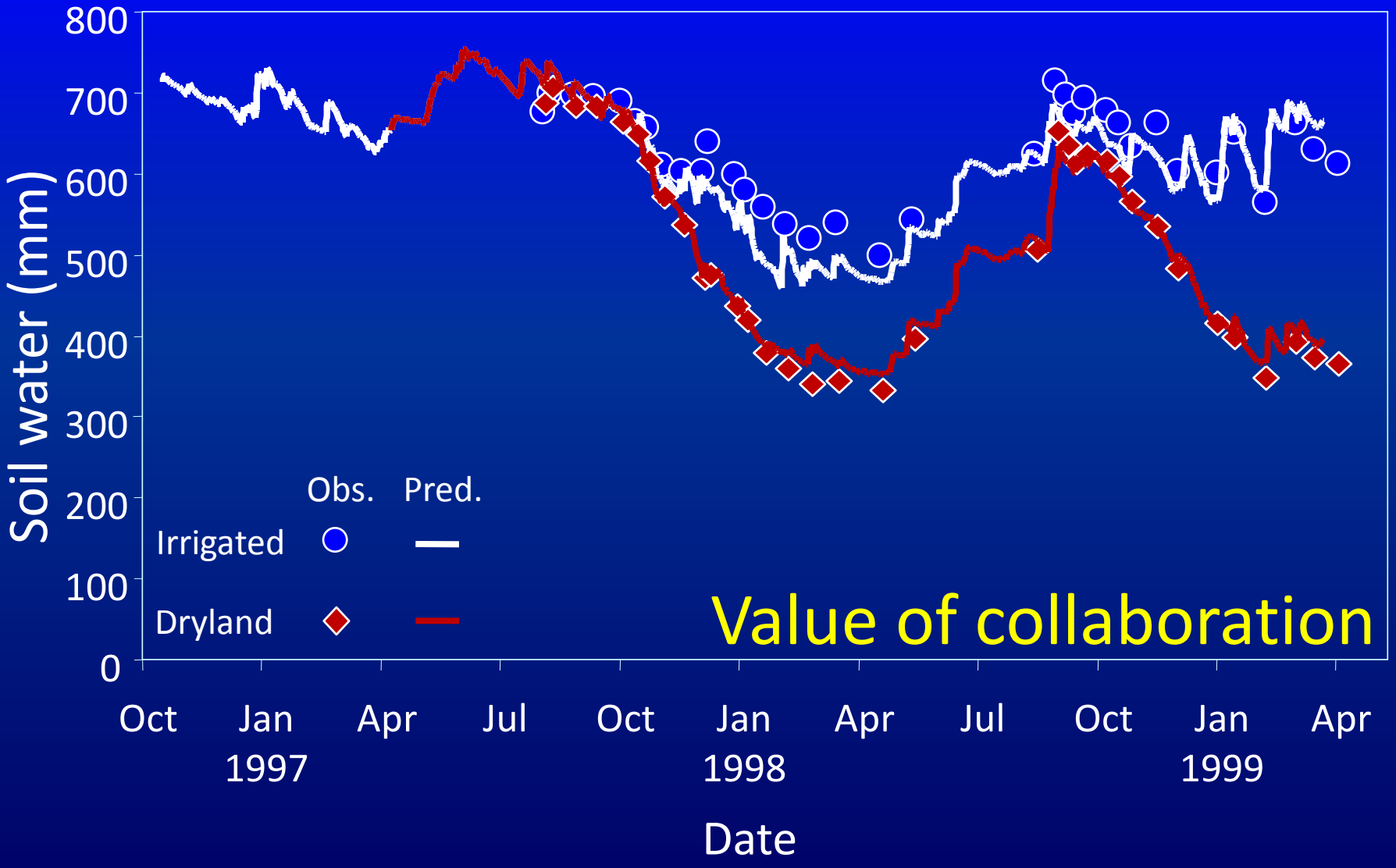
Lucerne has 85 mm more available water

Source: Moot *et al*. 2008



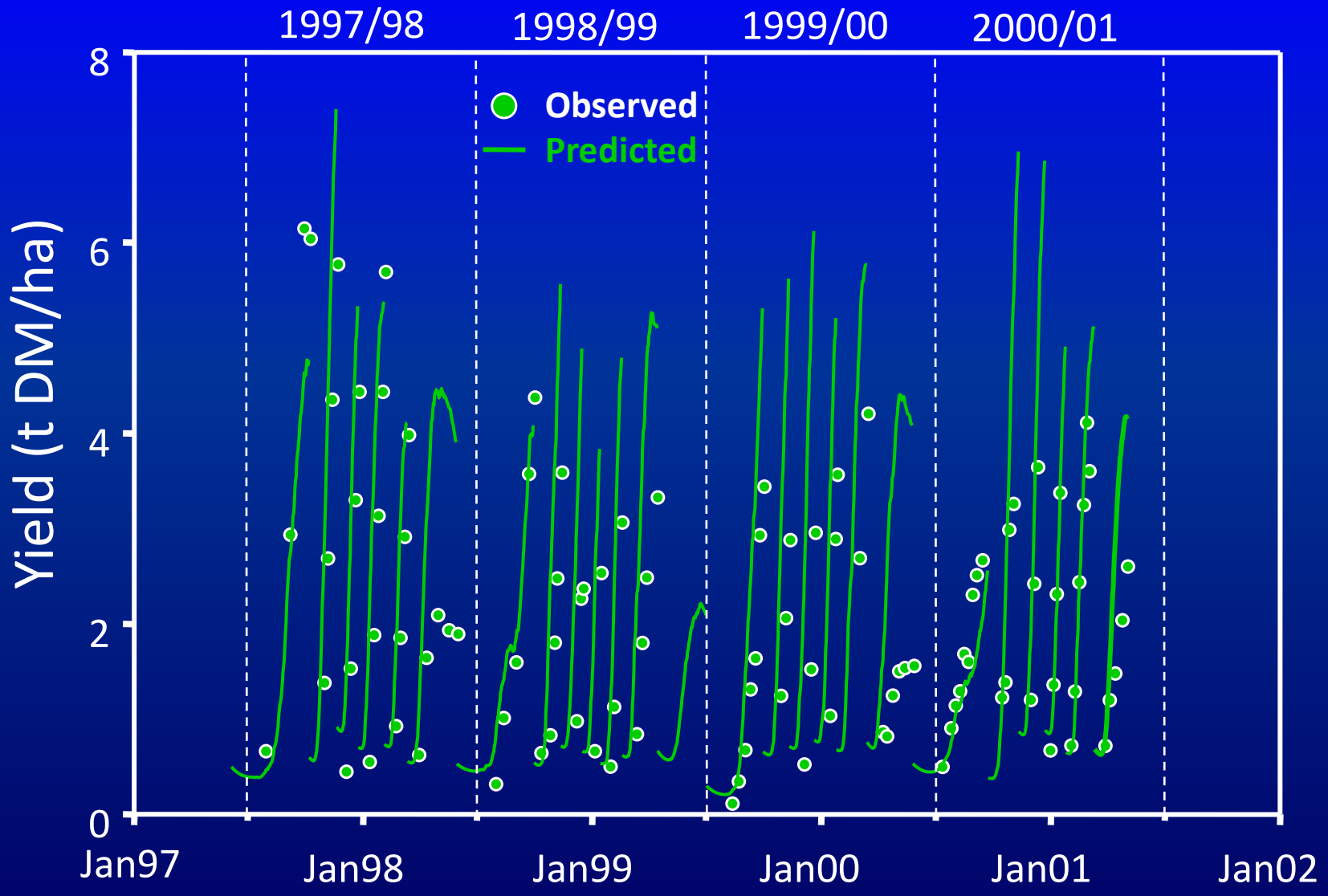
Good science is repeatable

Total soil water to 2.3 m depth



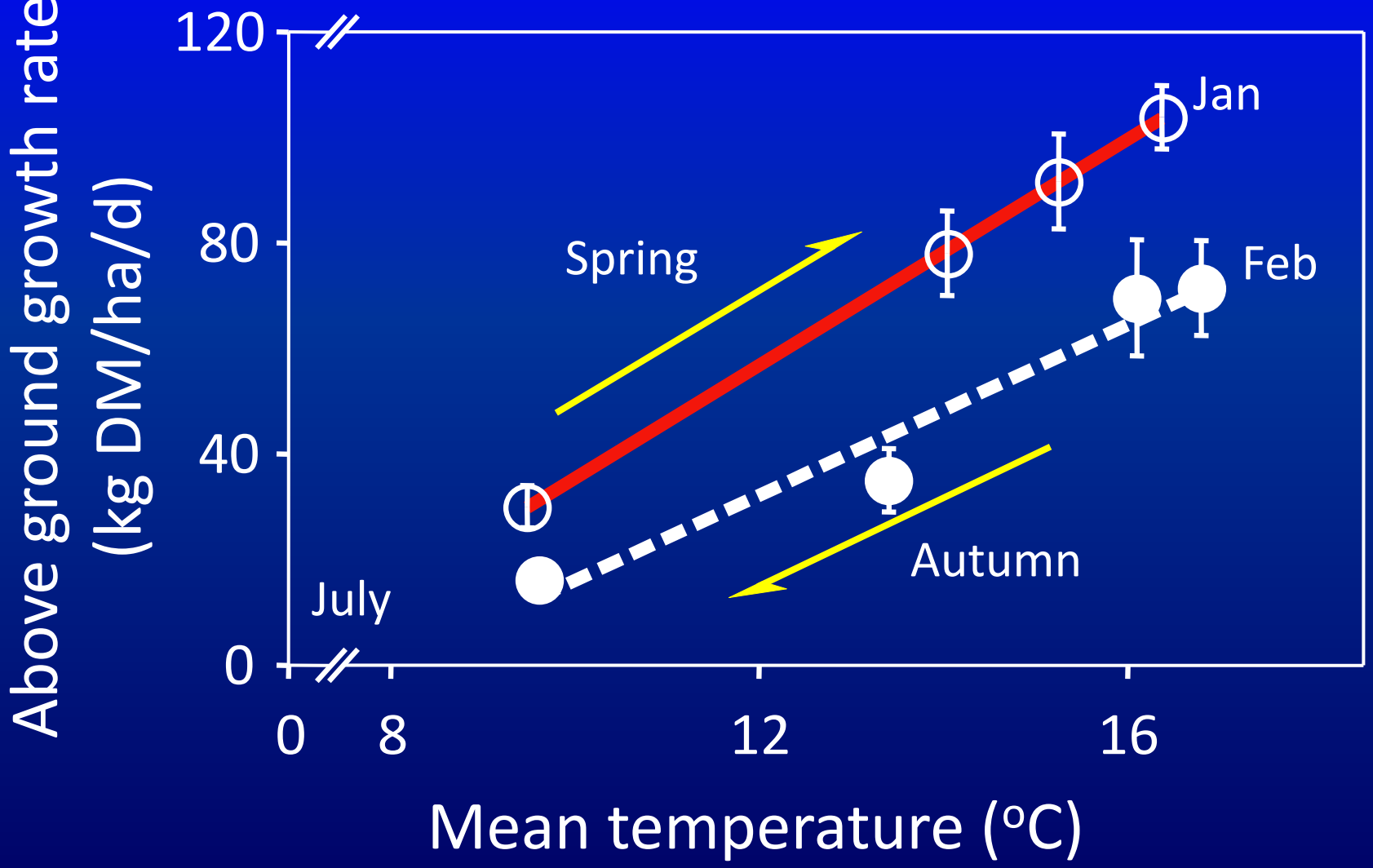
Source: Moot *et al*. unpublished

Original APSIM_Lucerne prediction



Source: Teixeira *et al*. unpublished

Vegetative growth

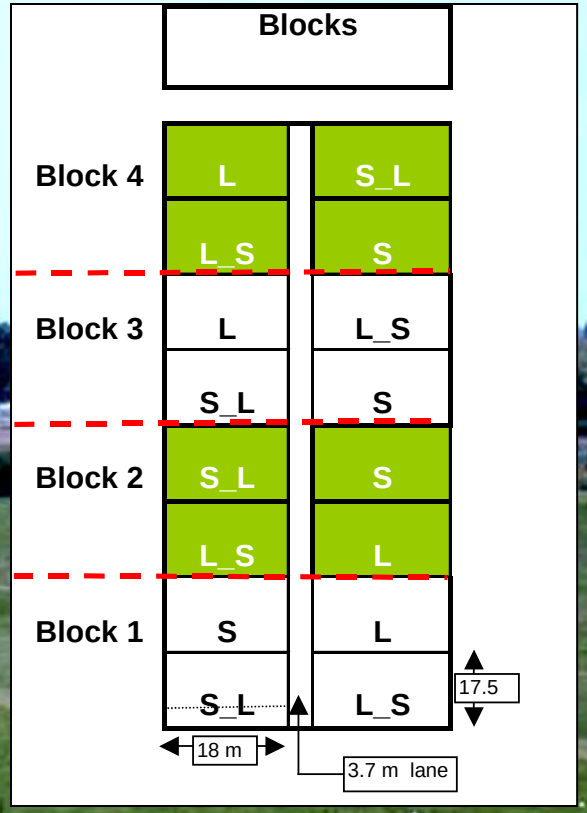


Source: Moot *et al*. 2003

What's going on down there?

Experiment 2

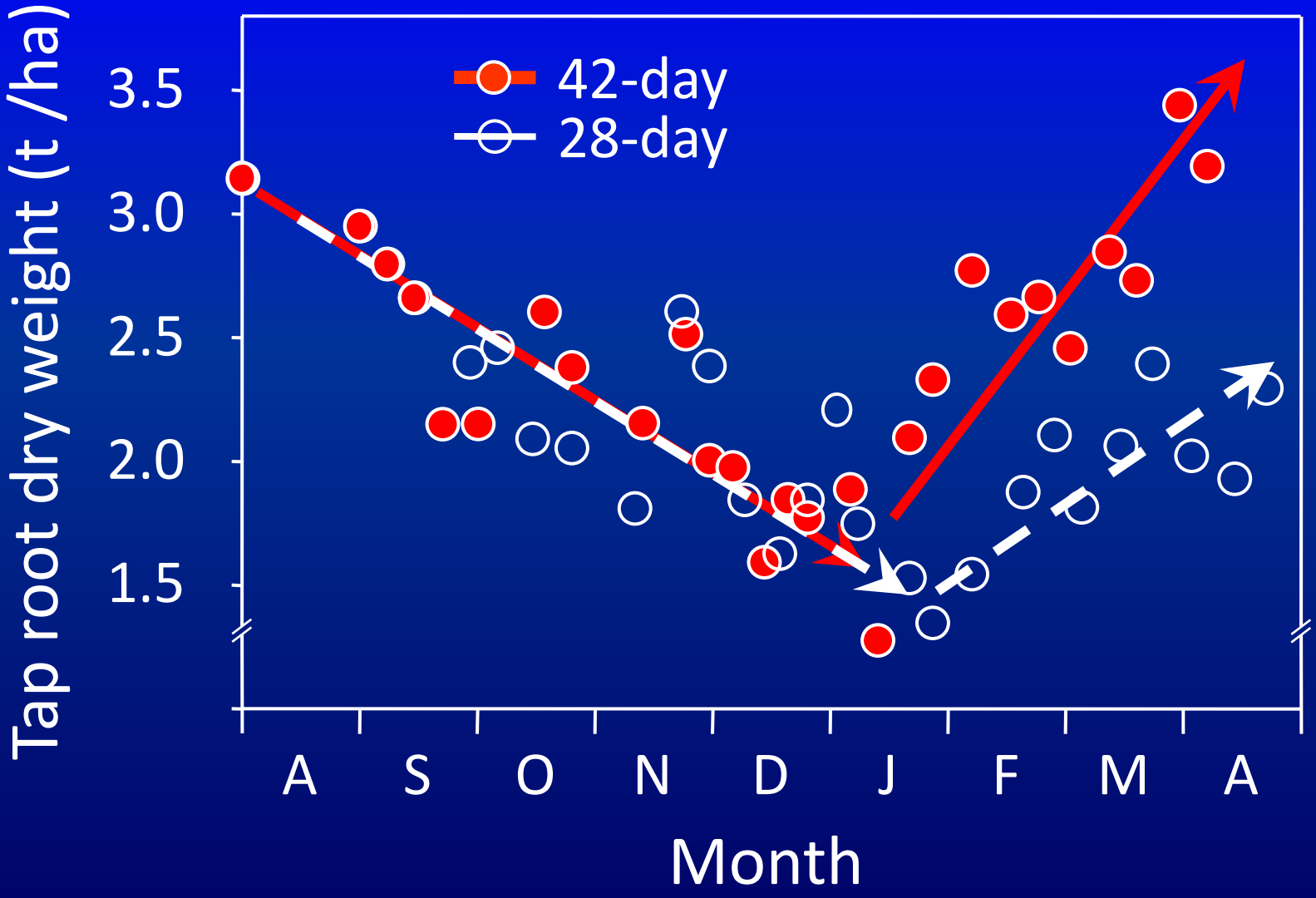
38 days resting
4 days grazing



25 days resting
3 days grazing

Photo: E.I. Teixeira
Lincoln University

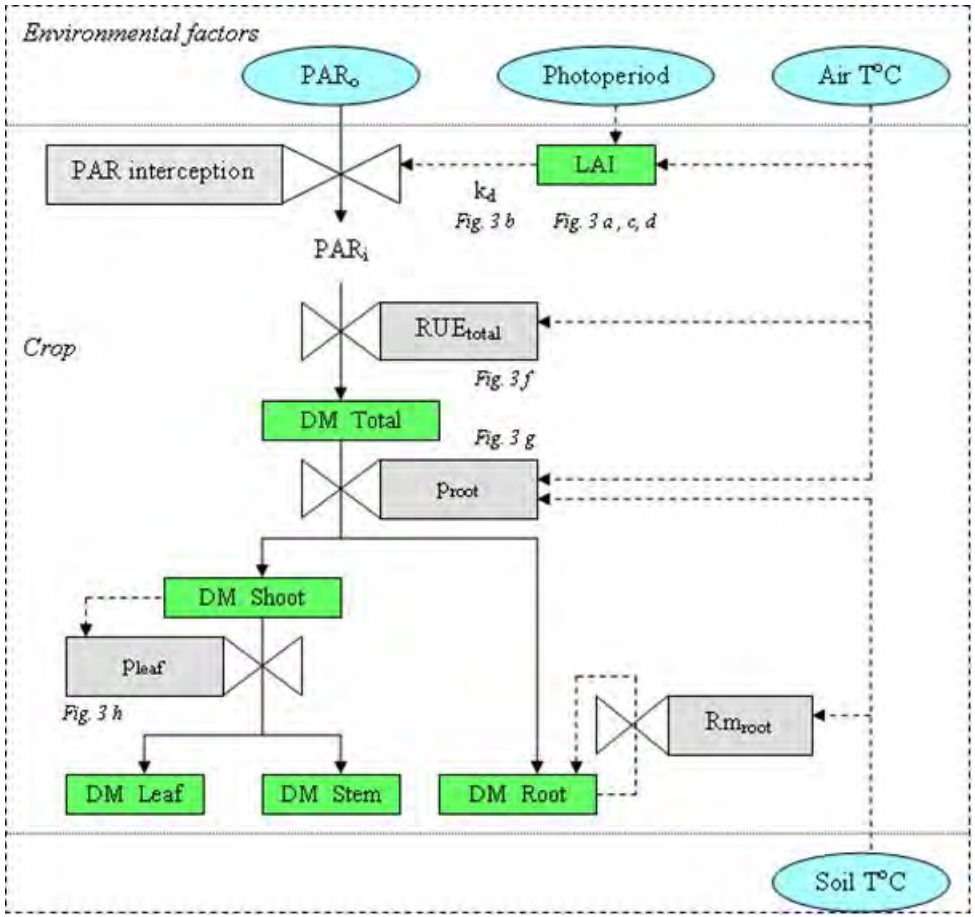
Partitioning to roots

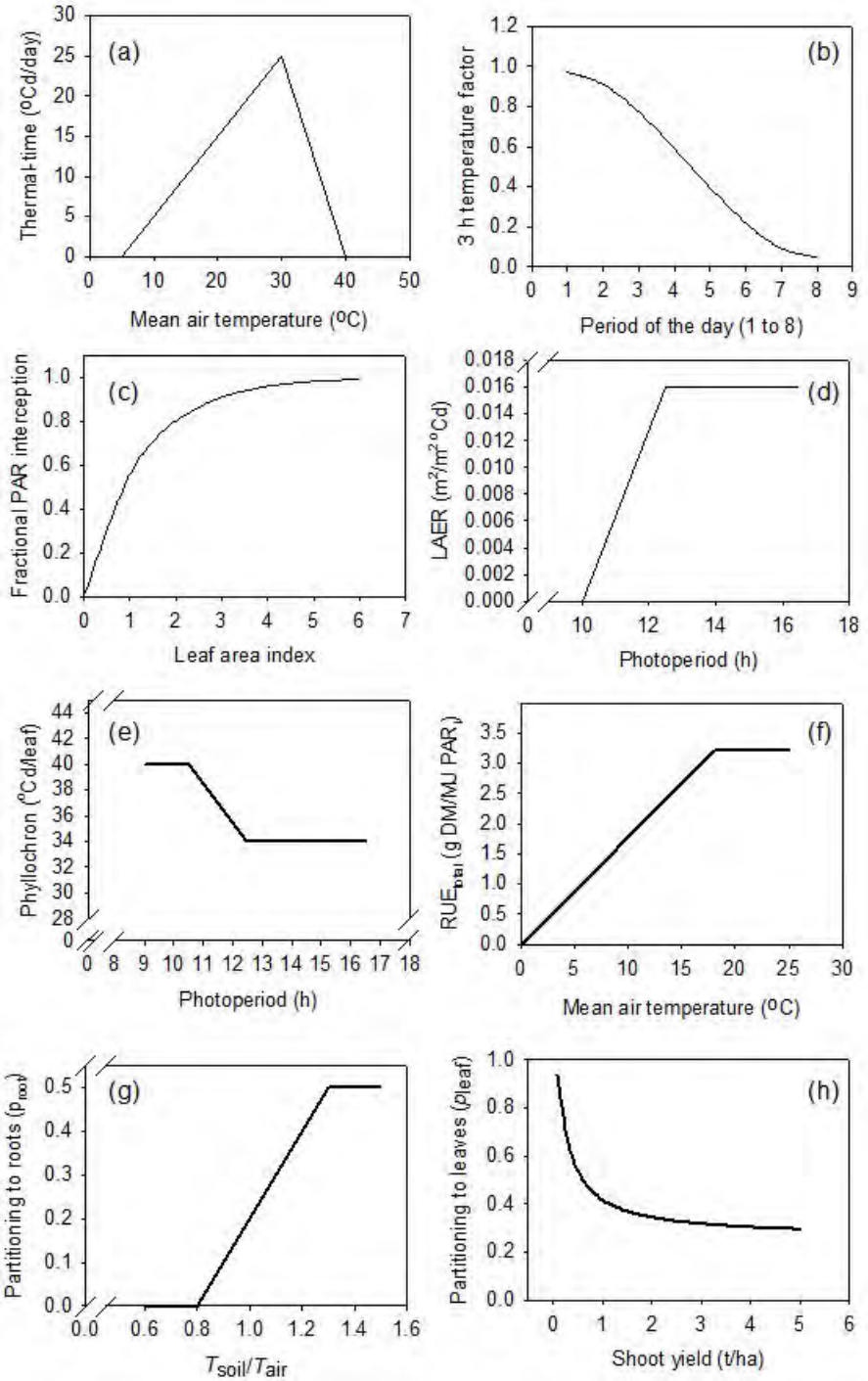


Source: Moot *et al*. 2003


Photo: E.I. Teixeira
Lincoln University
20
15
10
5
0

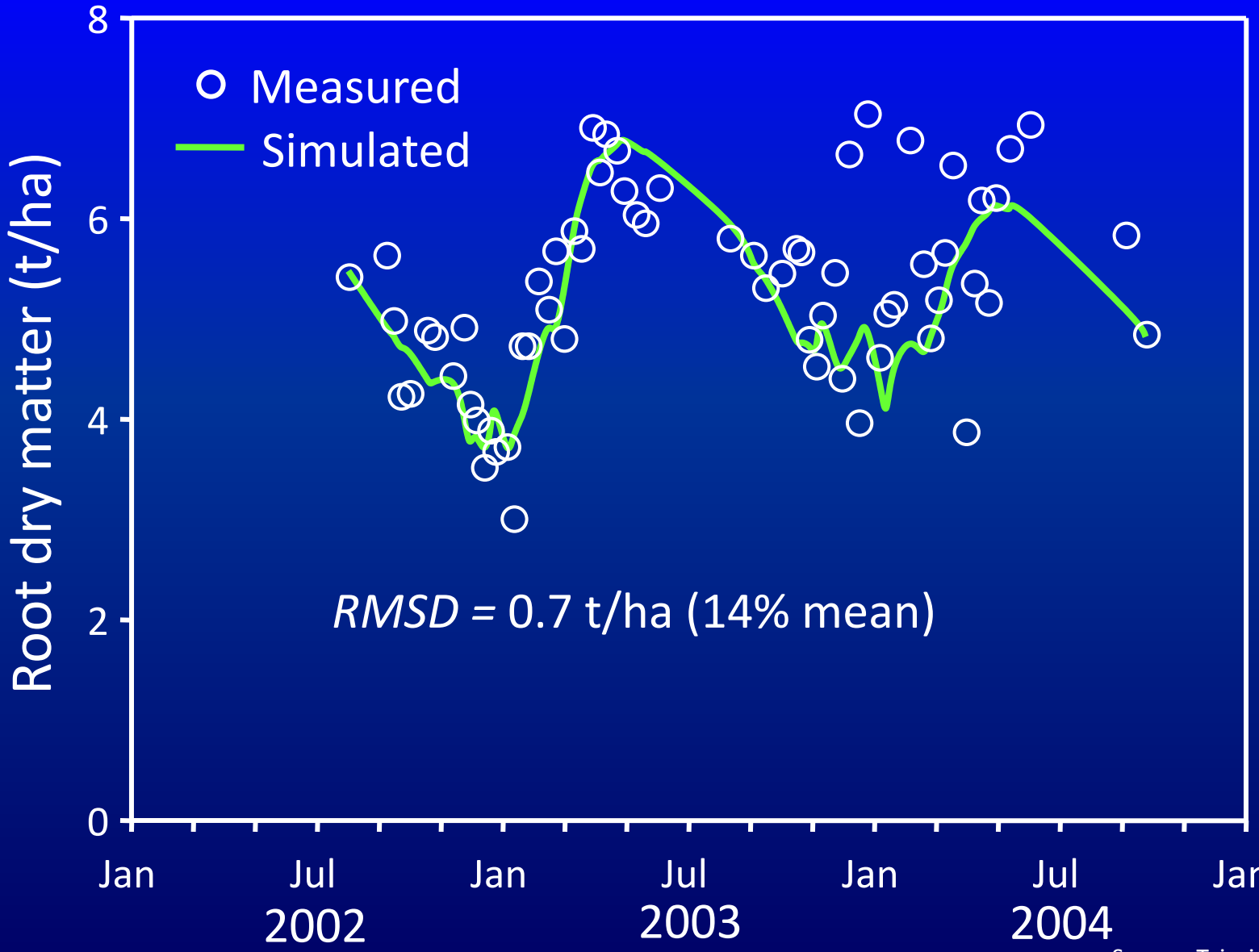
Model maker





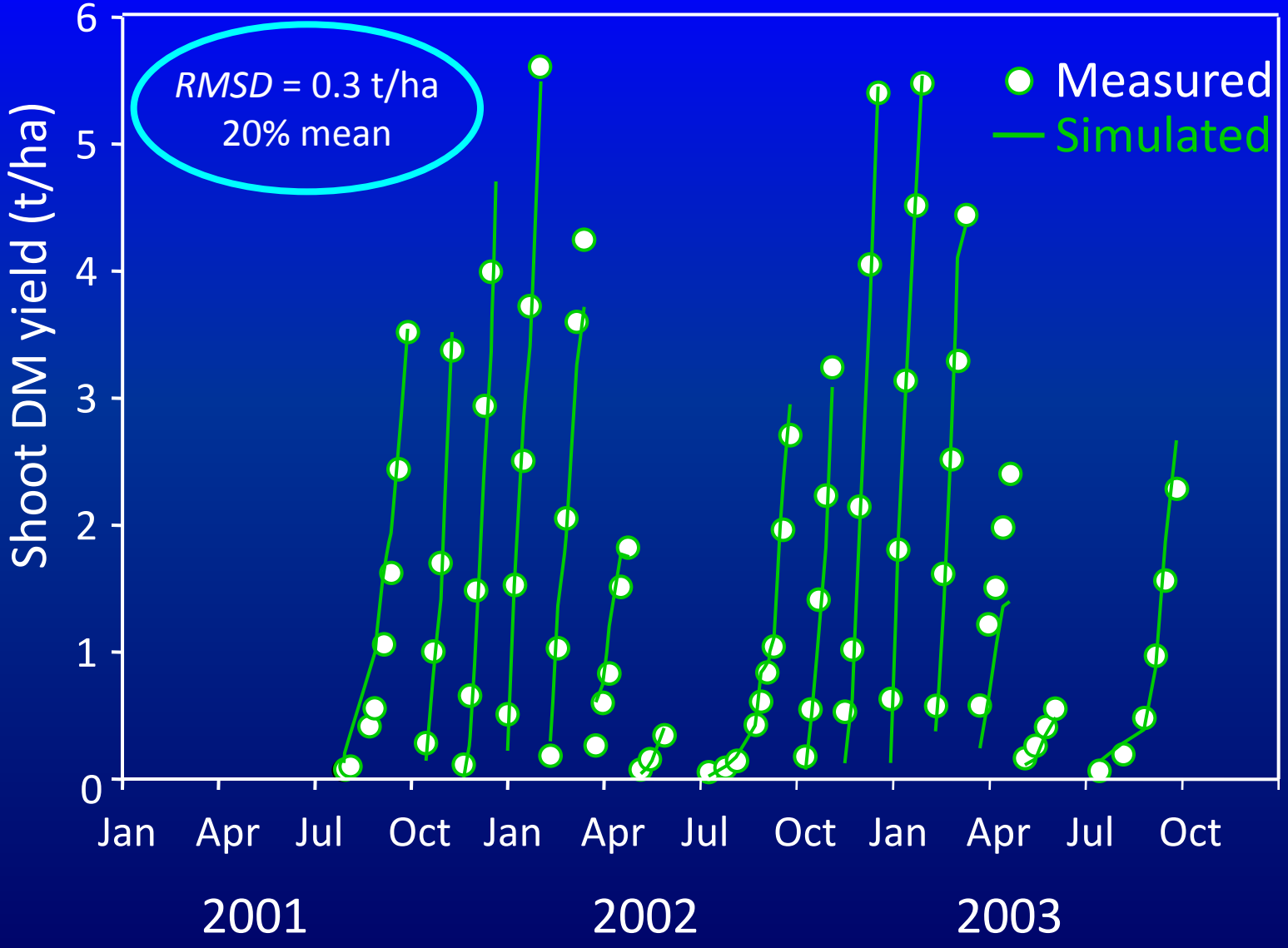
Source: Teixeira *et al*. 2009

Adjusting Rm for the best fit



Source: Teixeira *et al*. 2009

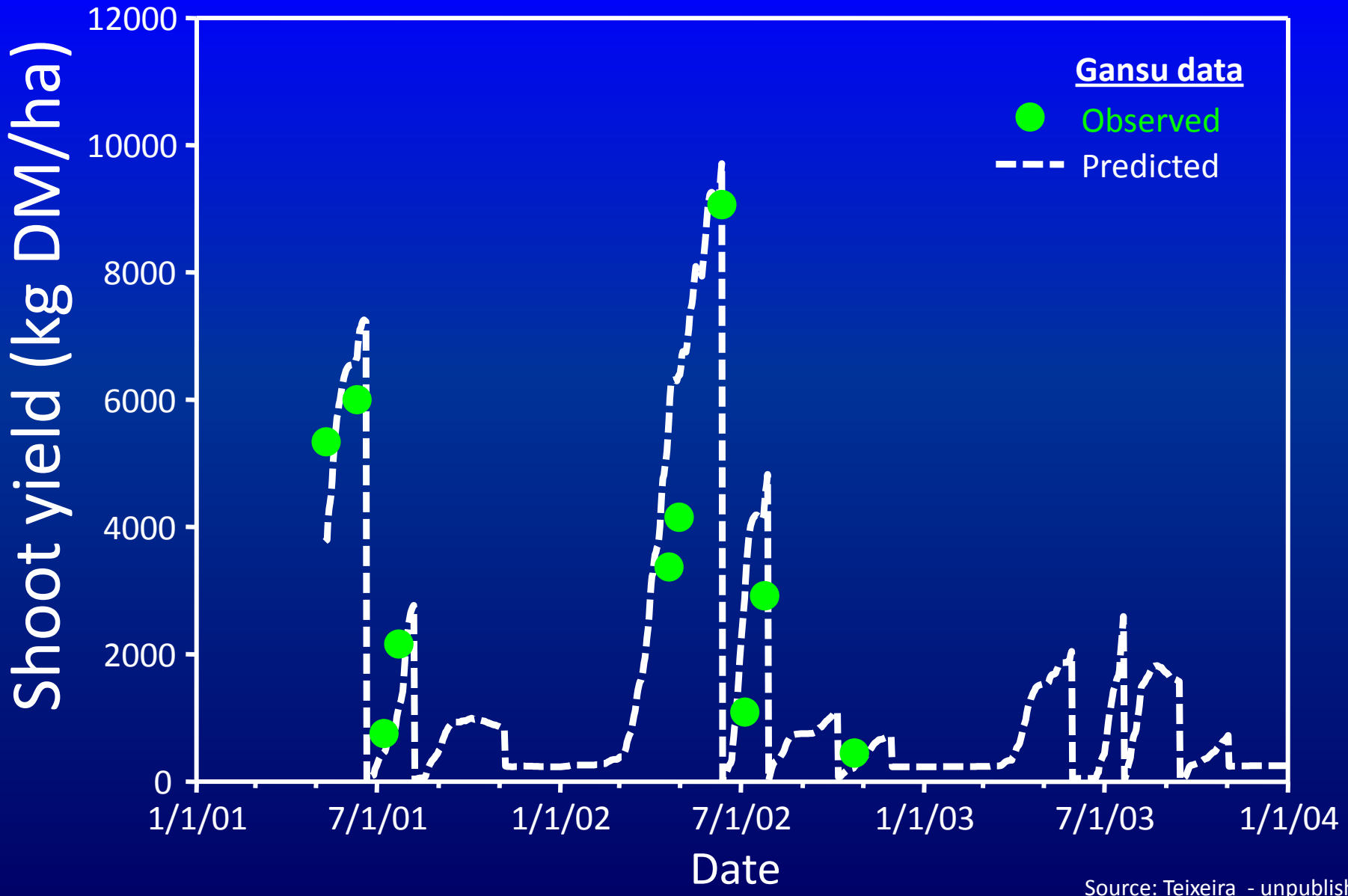
Predictions of shoot yield



Source: Teixeira *et al*. 2009

Photo: DJ Moot

APSIM Lucerne Validation



Source: Teixeira - unpublished

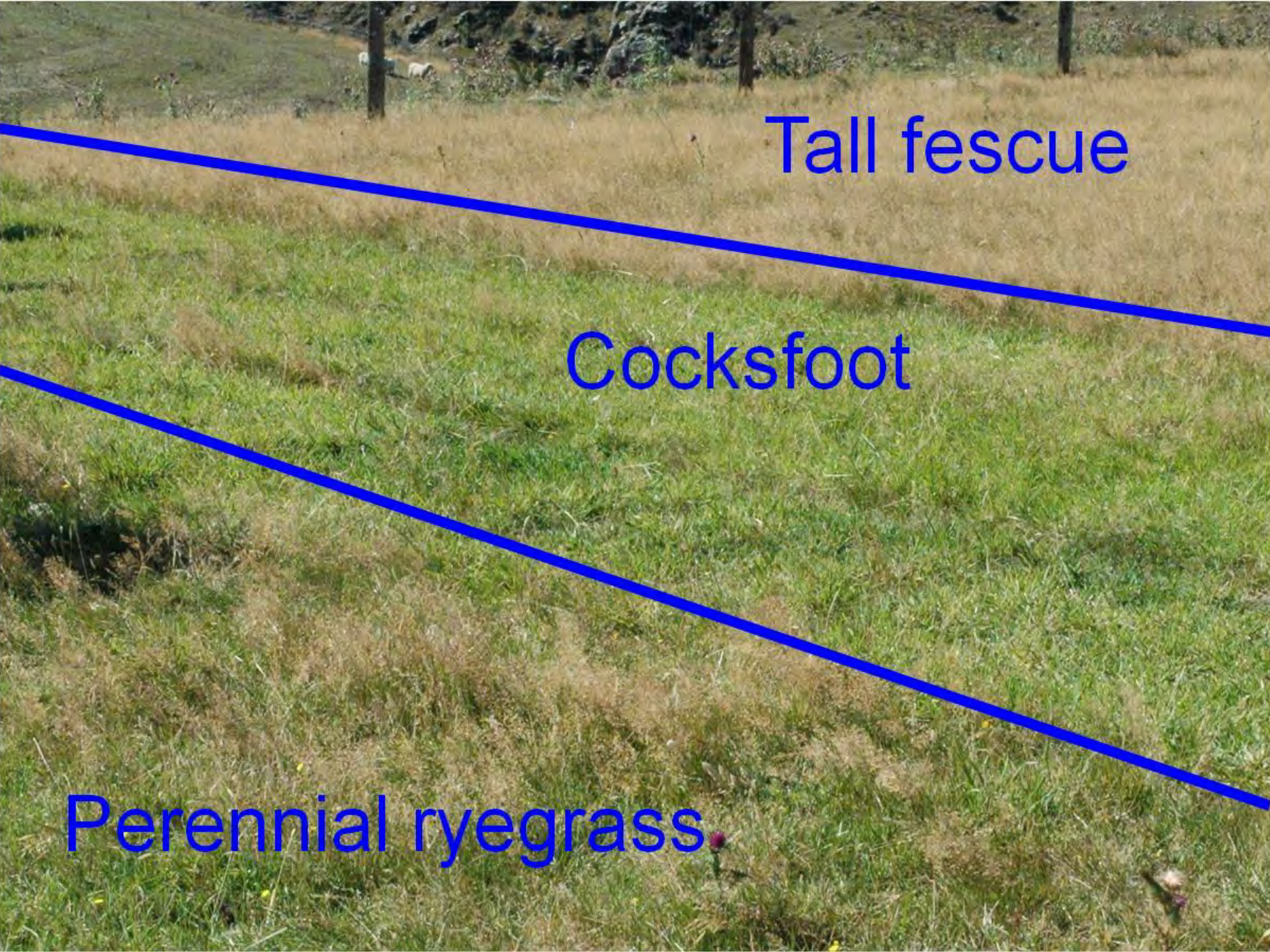
Lucerne research outcomes

1) Identified lucerne as “God’s Plant”

2) Quantified the interactions of lucerne and its biophysical environment - APSIM

3) Validated science with independent data sets

4) Trebled (?) lucerne seed sales


Tall fescue
Cocksfoot
Perennial ryegrass

Experiment 3

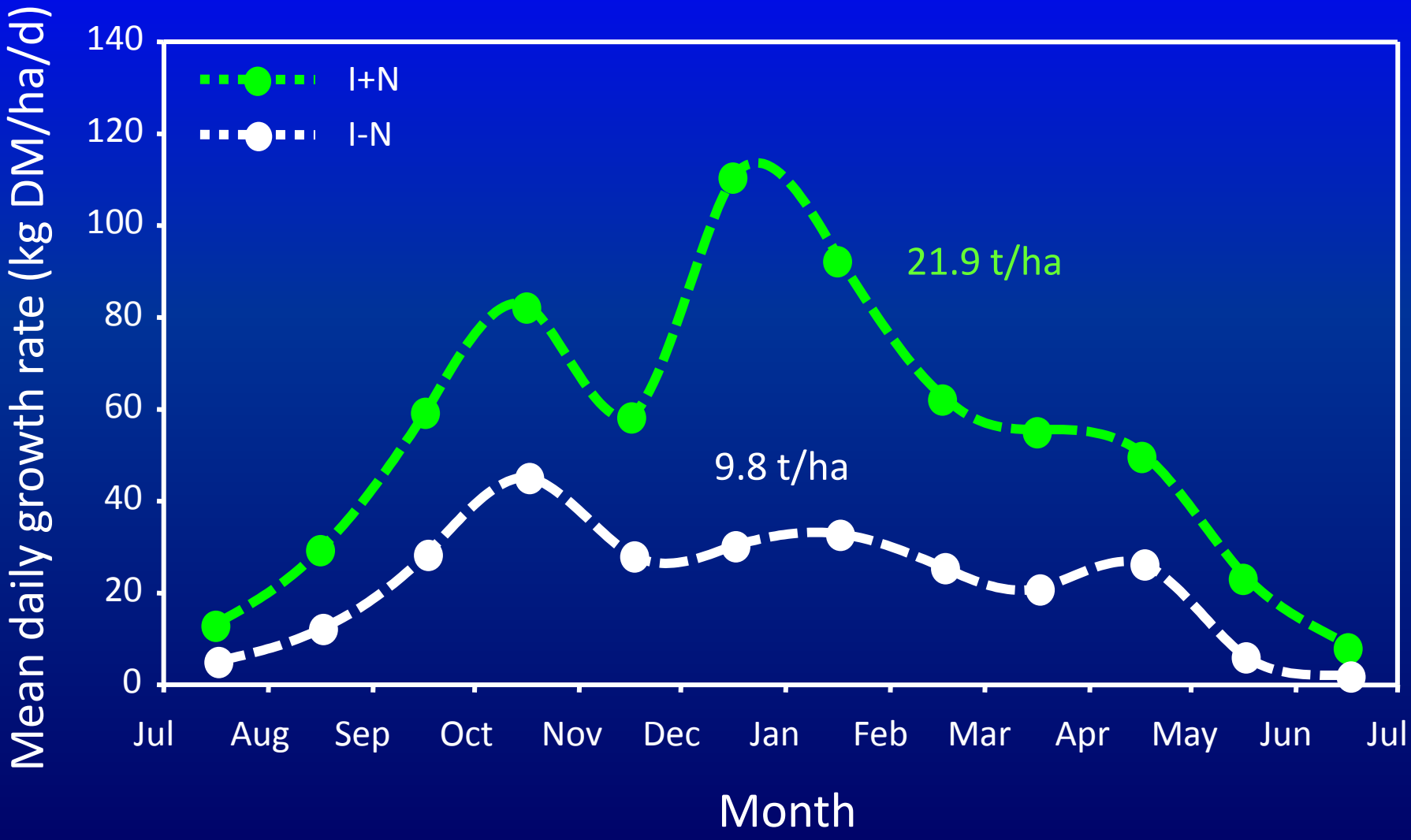
Rep 1

Rep 2

Rep 3

Photo: A Mills
Lincoln University

Pasture Growth Rates – 2 yr mean

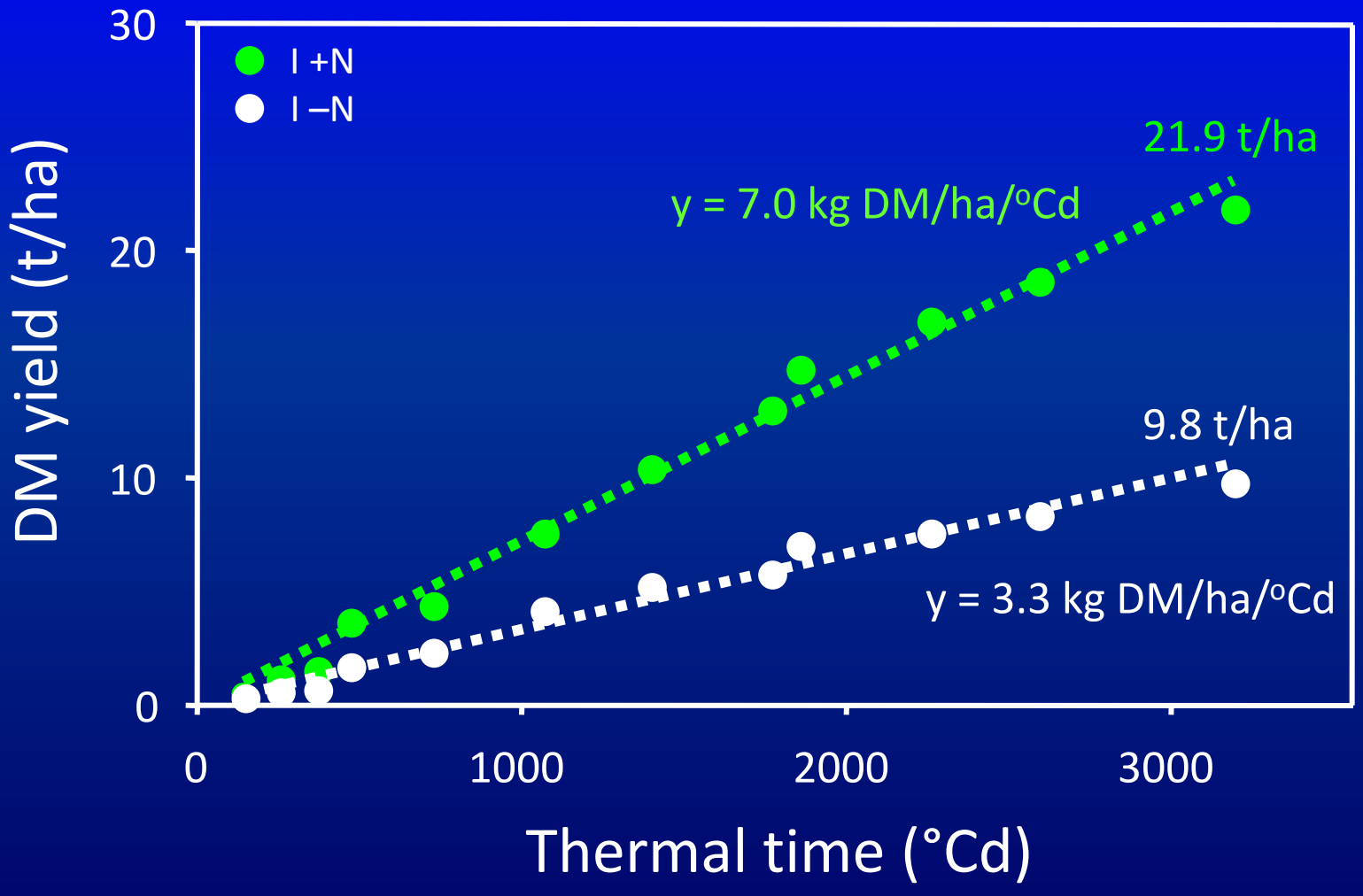


Source: Mills *et al*. 2006

Winter ⇒ temperature response

Photo: K Pollock
Lincoln University

The Nitrogen gap

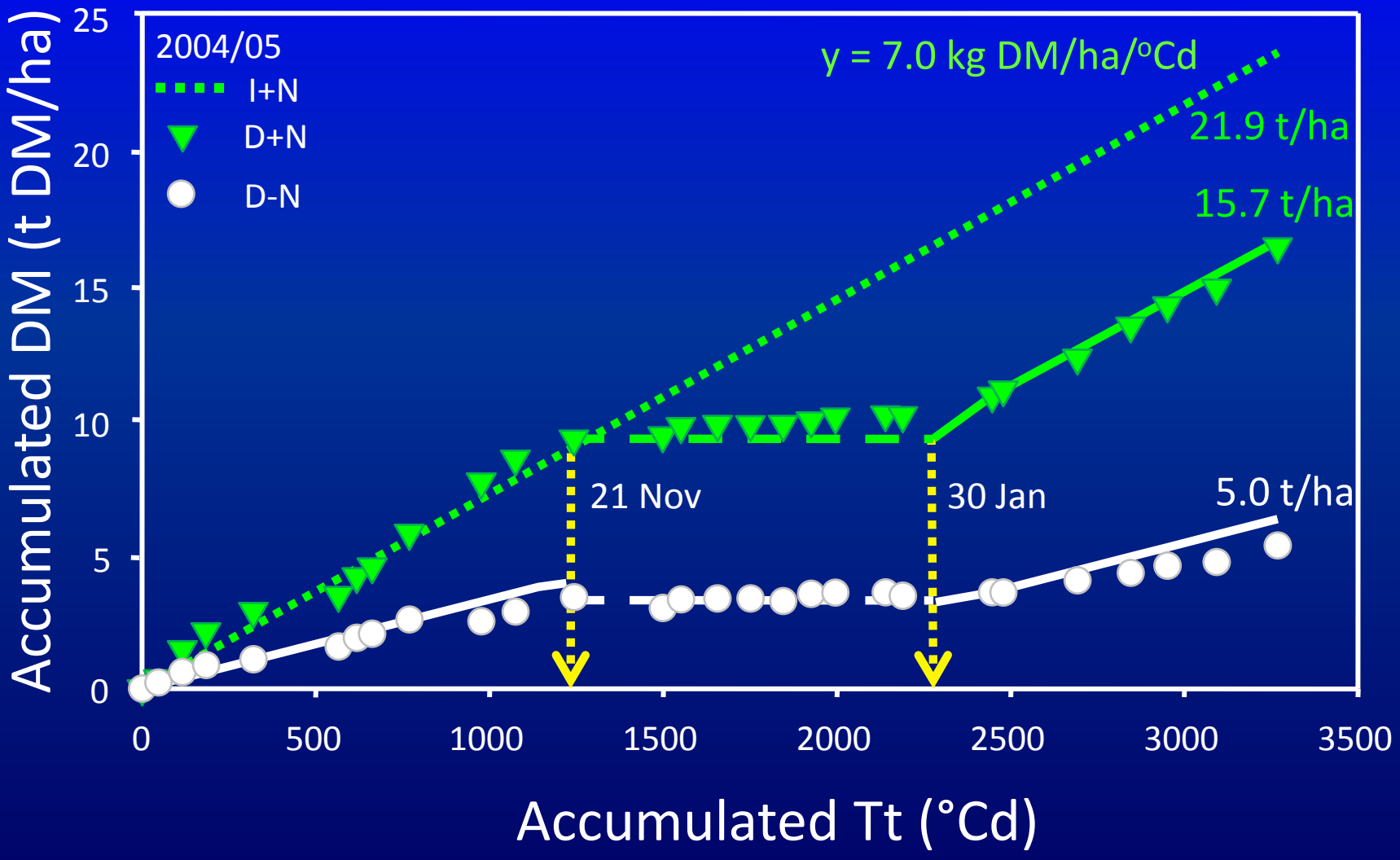


Source: Mills *et al*. 2006

Summer ⇒ moisture response

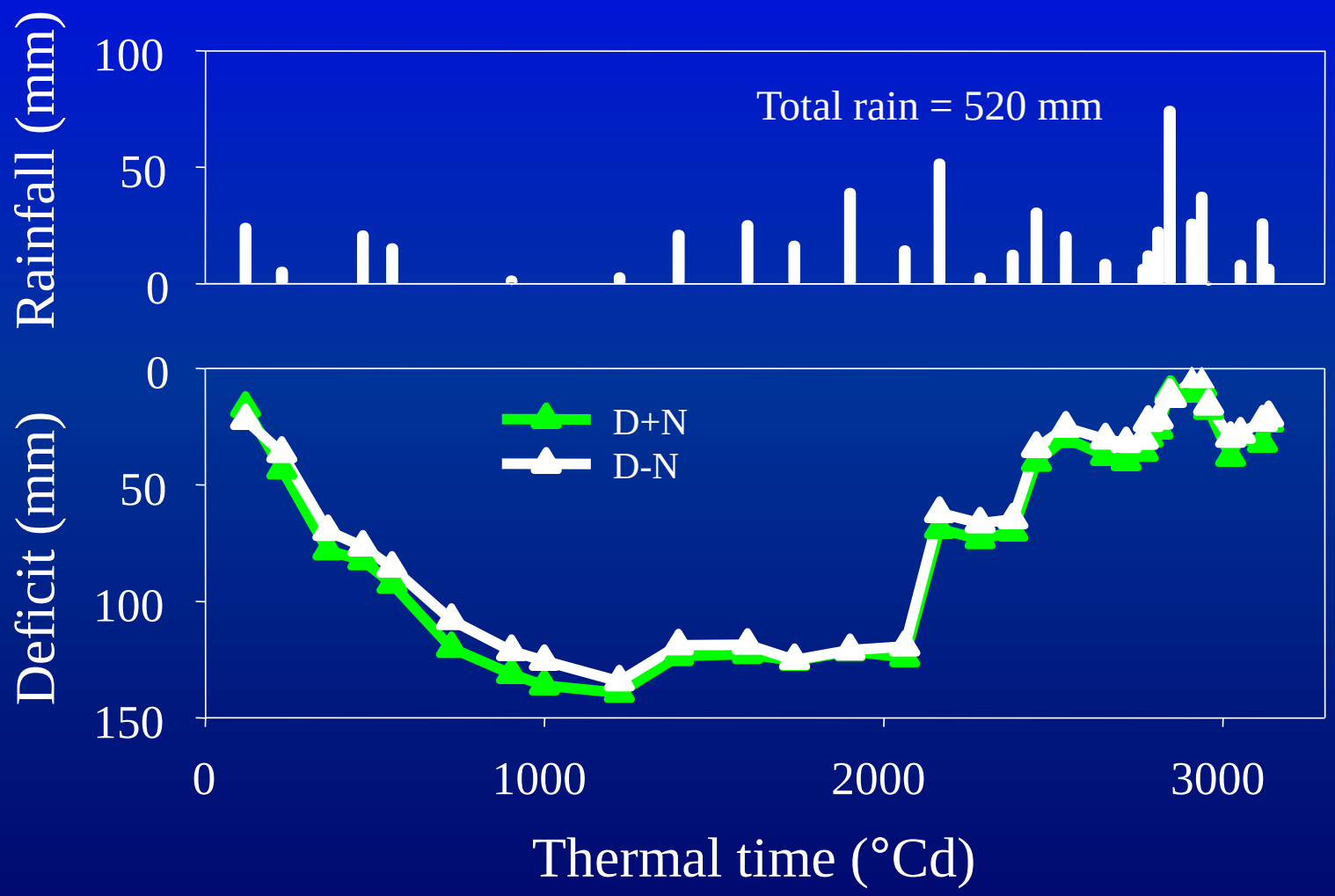
Photo: A Mills
Lincoln University

The Nitrogen gap



Source: Mills *et al*. 2006

Soil moisture deficit 2003/04



Source: Mills *et al*. 2006

Nitrogen deficient pasture

1000 kg N/ha

Water and nitrogen = ryegrass

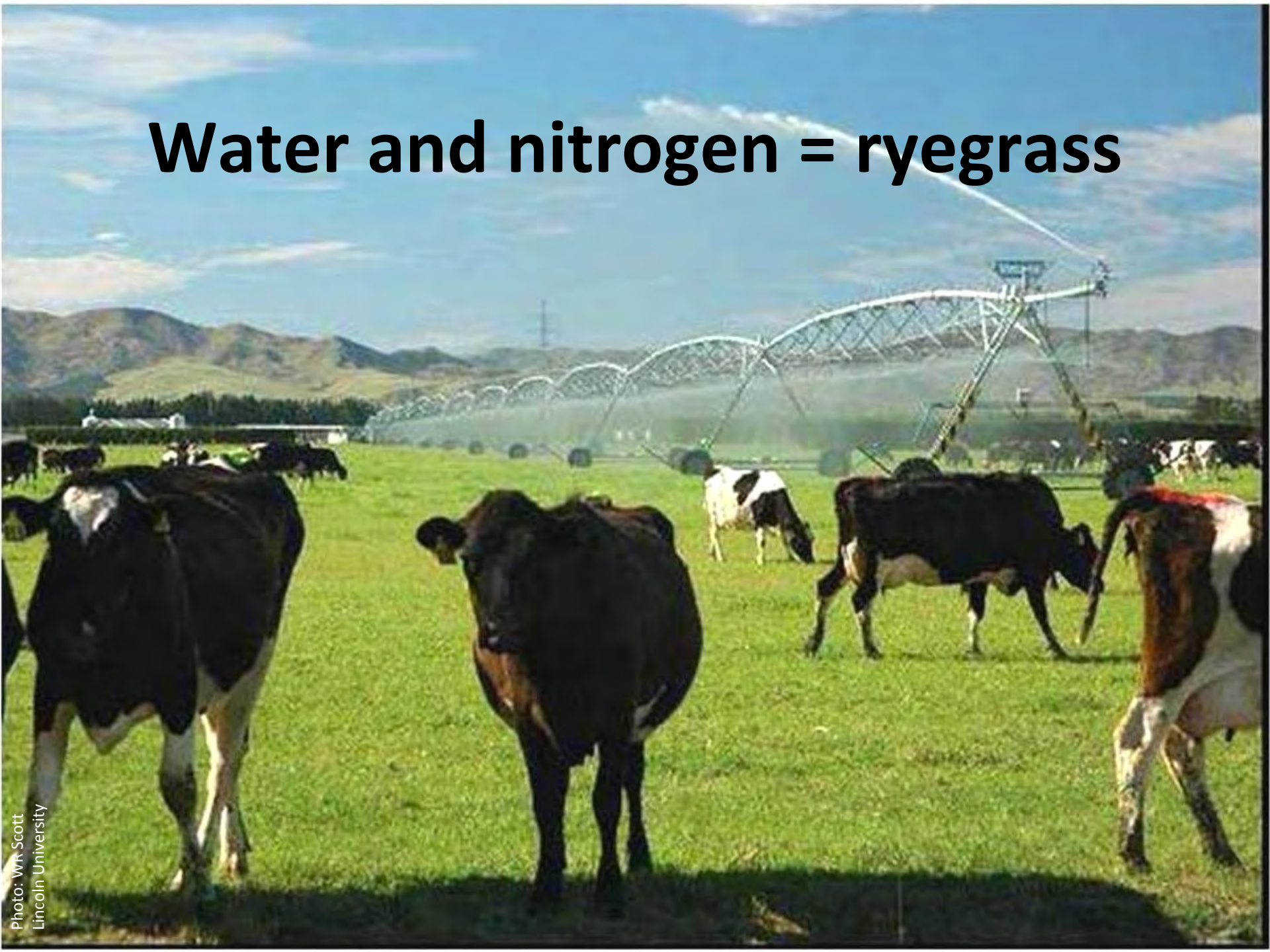
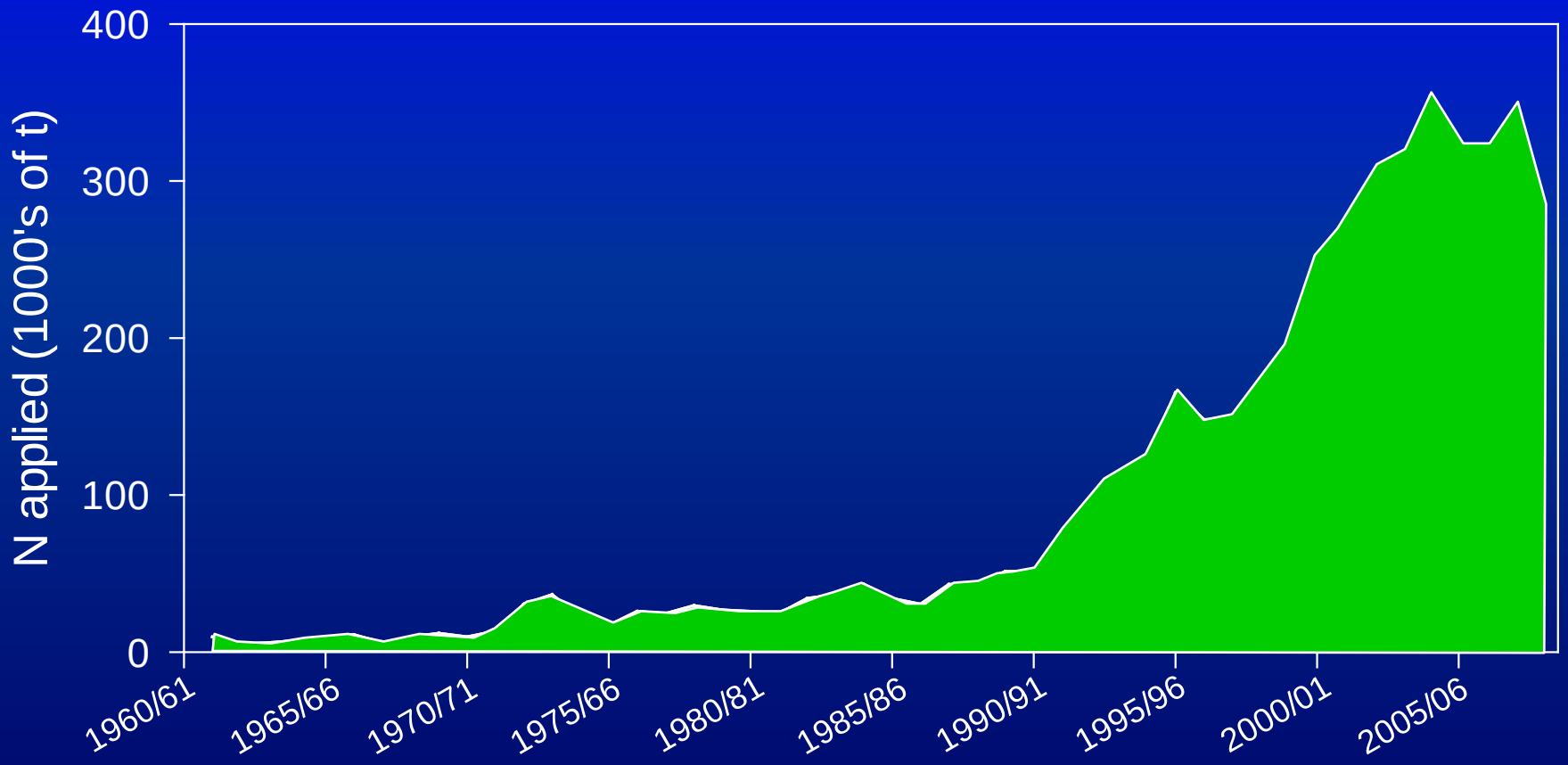


Photo: WR Scott
Lincoln University

Nitrogen fertiliser use



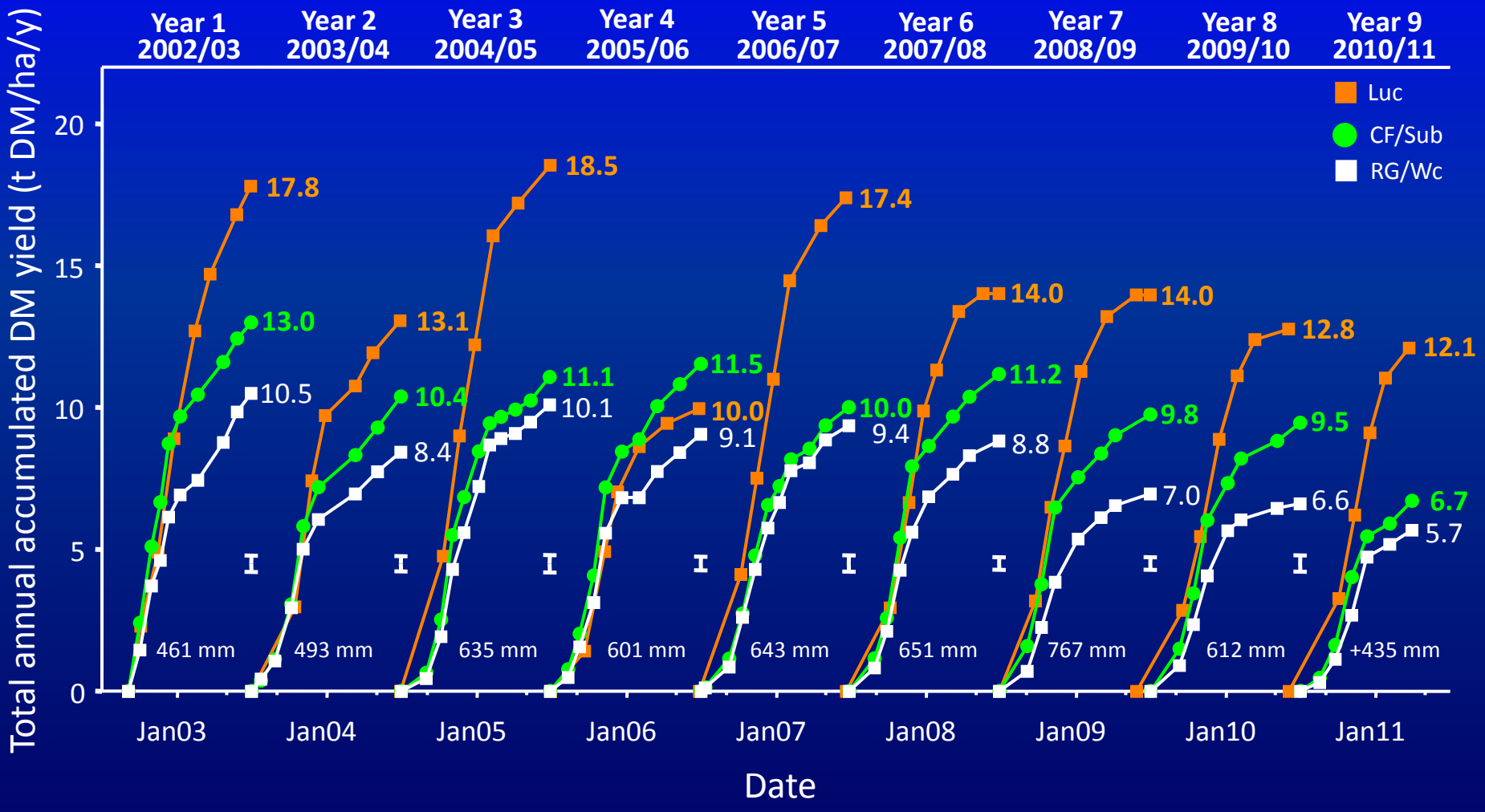
Source: New Zealand Fertiliser Manufacturers' Research Association


Nitrogen fixation
25 kg N/t DM
Source: Lucas *et al*. 2010
Photo: DP Monks
Lincoln University

Experiment 4 - ‘MaxClover’

‘MaxClover’ Total DM Yields

(to 30 March 2011)



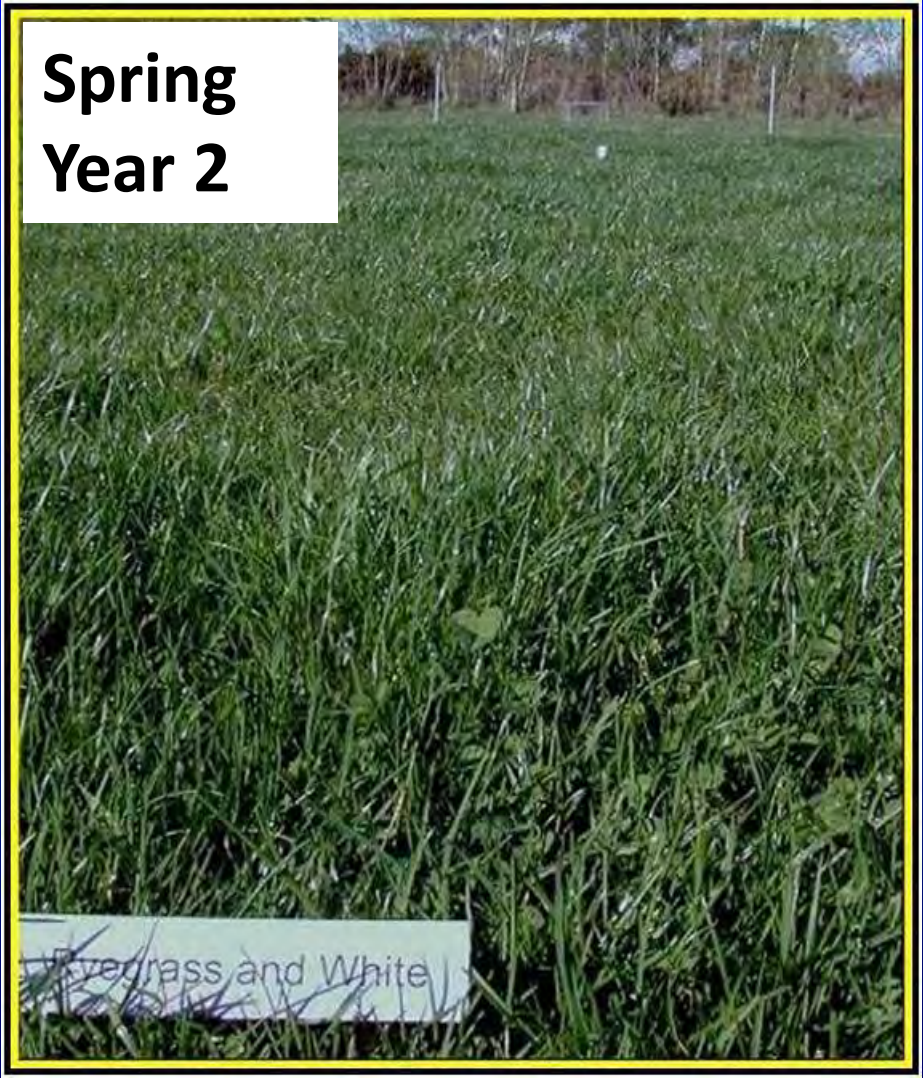
Source: Mills *et al*. 2010, Moot 2012

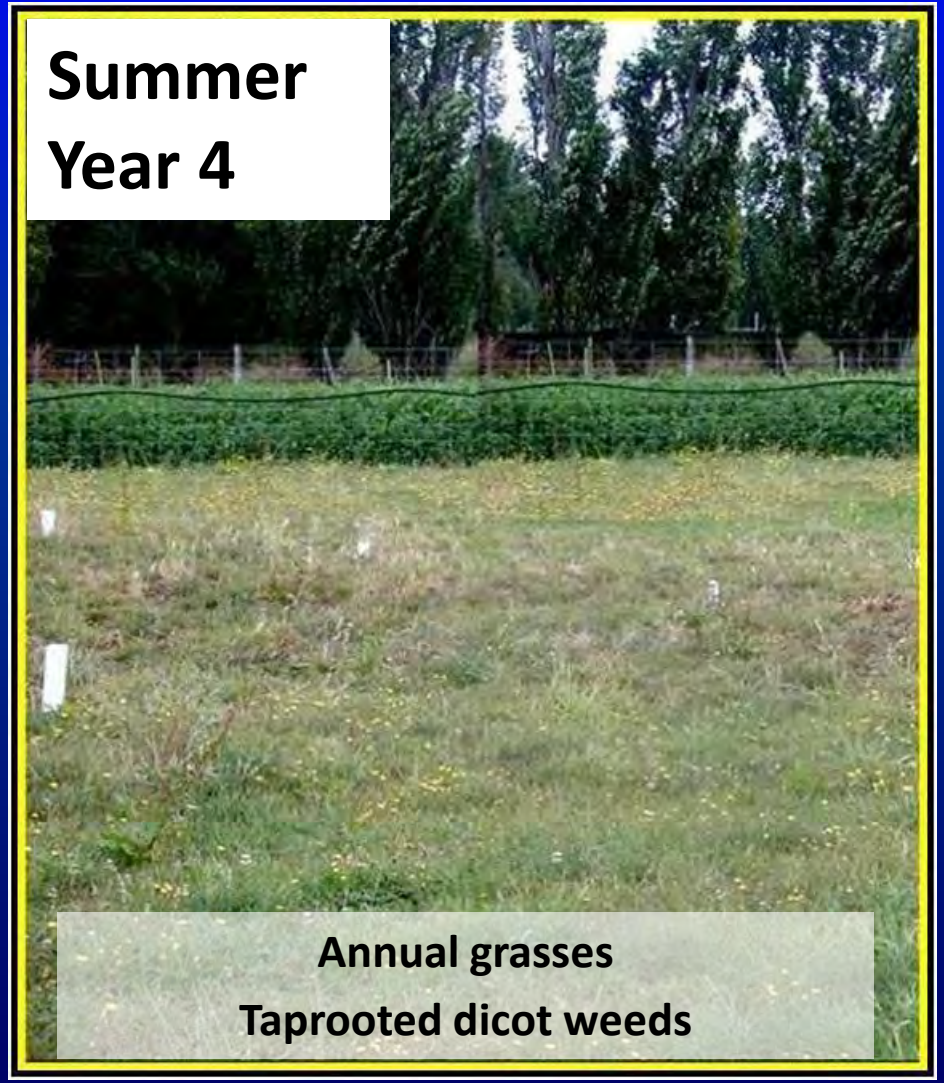
RG/Wc pastures

Unsown species

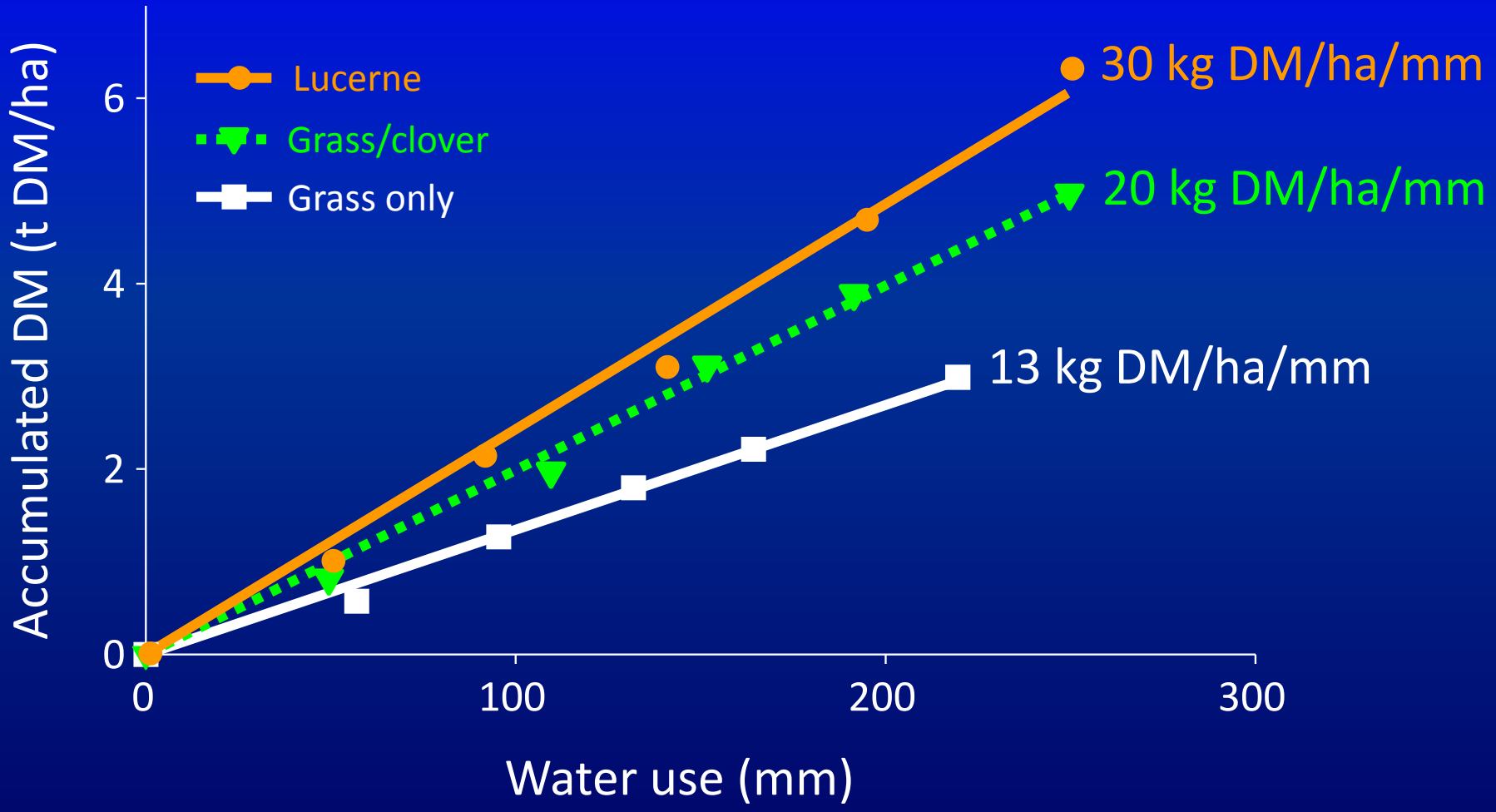
<5% in Year 1

>45% in Year 6





Spring WUE: legume = (nitrogen)



Source: Moot *et al*. 2008

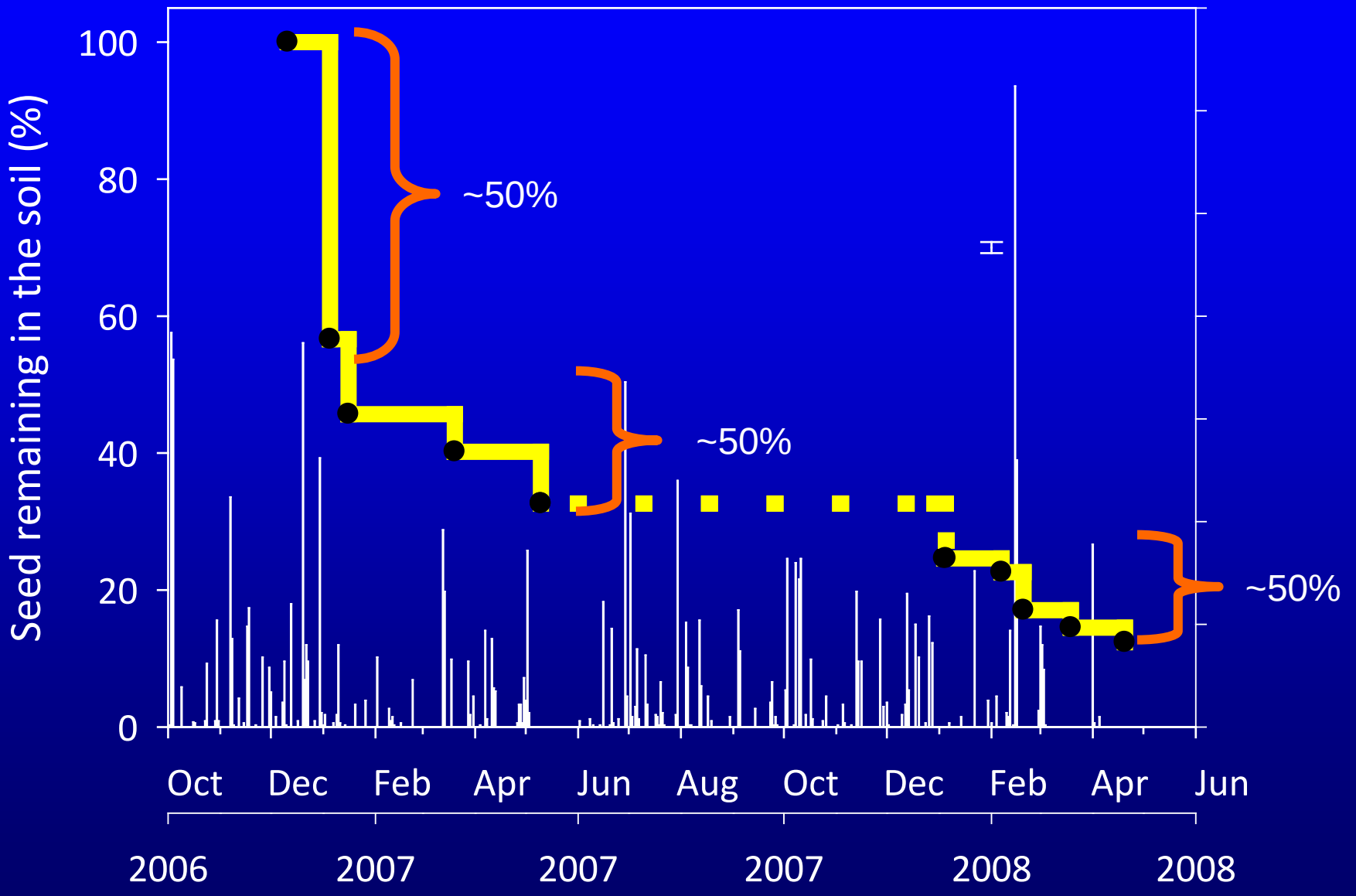
Sub clover – grazing mgmt

Sheep prefer 70% legume, 30% grass

Overdrilling Ates *et al*. 2010

Balansa clover – seed bank

Managing the balansa seed bank!



Source: Monks *et al.* 2008

Key dryland extension messages

- Lucerne – if you can, grow it!
- Physiologically, N not H_2O limits growth
- Cocksfoot survives but is nitrogen deficient
- Sub and balansa can be managed with CF

Over grazed – high erosion risk - Peru

Grazing is not grazing mgmt

Photo: DJ Moot

Over grazed – high erosion risk - Marlborough

Problems have common solutions

Extension

SERVANT LEADER

Sustainable Farming Fund

Ministry of Agriculture and Forestry
Te Manatū Ahuwhenua, Ngāherehere

Where to plant

Photo: D Avery
Marlborough

When to graze

Photo: D Avery
Marlborough

How to graze

Photo: D Avery
Marlborough

What else to feed

Photo: D Avery
Marlborough

Photo: D Avery
Marlborough

Autumn = flowering plants

Photo: M Smith
Lincoln University

Rotation 4 Pre-graze

Plot 6 (28/2/08) **2.0 t DM/ha produced in 51 d**

Which animals?

Photo: D Avery
Marlborough

Deer = no risk of bloat

How to manage water

Photo: V Fasi
Lincoln University

Talk to the farmers

In the field

Again


And again

And again

146 Field days since 2007

10 MonitorFarm

Old fashioned pasture species proving their worth

by Howard Keene

Old fashioned pasture species grown under modern management are proving better than ryegrass and white clover for pasture farmers without irrigation.

Lincoln University plant scientists Derrick Moot and Dirk Lucas have been looking for the best pasture species in dryland situations for the past decade or so years.

"We started doing this with no funding because we thought it was important," Dr Moot told farmers at a North Canterbury monitor farm day last month.

He said the work was funded by Moot & Moot NZ, and the challenge was to find species that entered stable low performance and persistence.

NEW WAYS WITH LUCERNE

Stop, look, and change

Legume legend

Moot points on management

Cocksfoot on the comeback trail

Clear signal for system change

Innovation is the key

Lucerne beats drought

Benefits of climate change

Plant species choice key to success

Profit in the dry

Making the most of Water

Lucerne powers change on-farm

Lucerne is likely drought-beater

Lucerne behind four-fold increase in profit

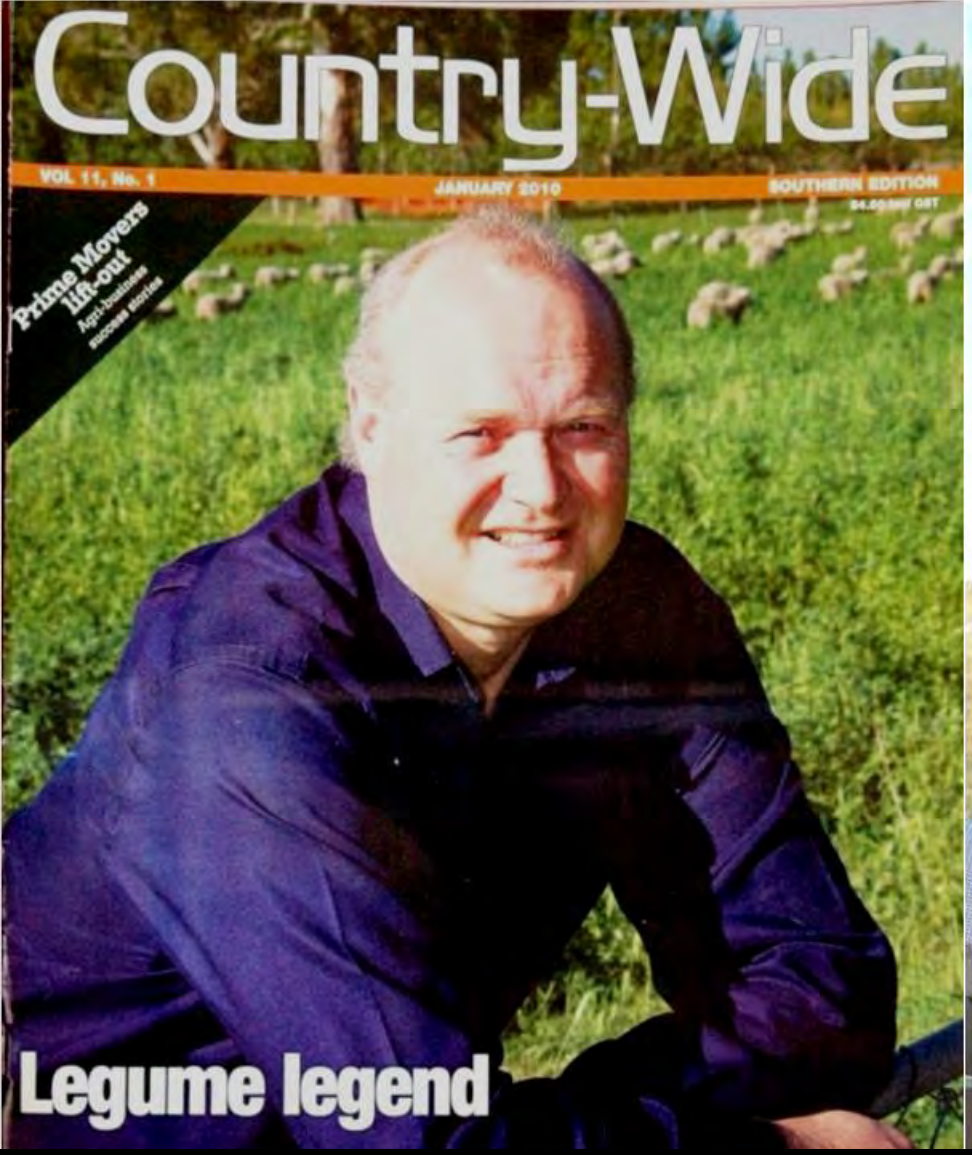
'God's plant' the saving grace

Lucerne myths exposed at Marlborough field day

Professor sings lucerne's praises

Subterranean clover key to farm system

Profits despite drought



Integrity & Trust

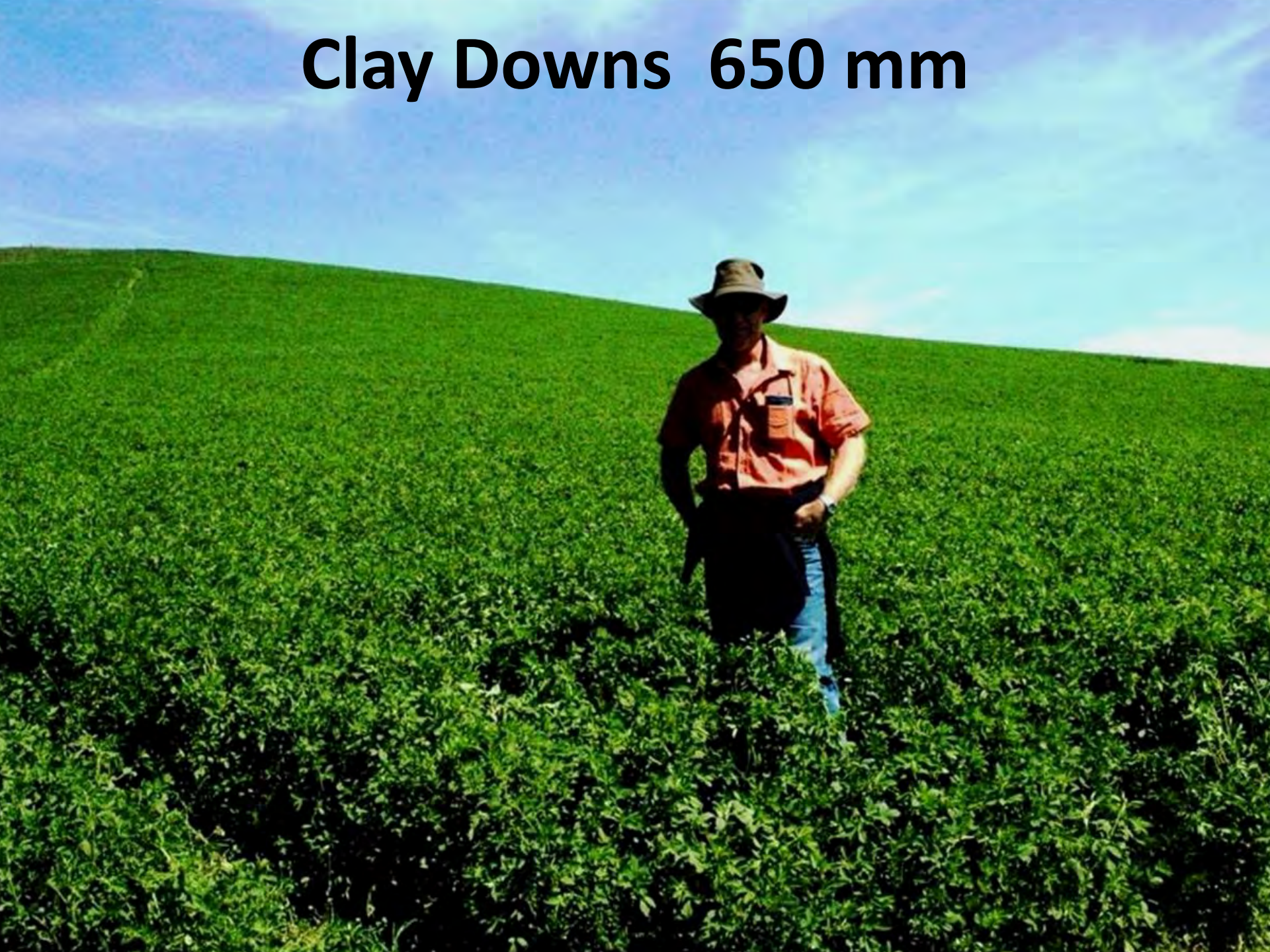
Diverse drought-proofed landscape

SI Farmer of the Year 2010


By 2030 - Drier:
Drought – increased duration and frequency
Warmer winters
Photo: DJ Moot

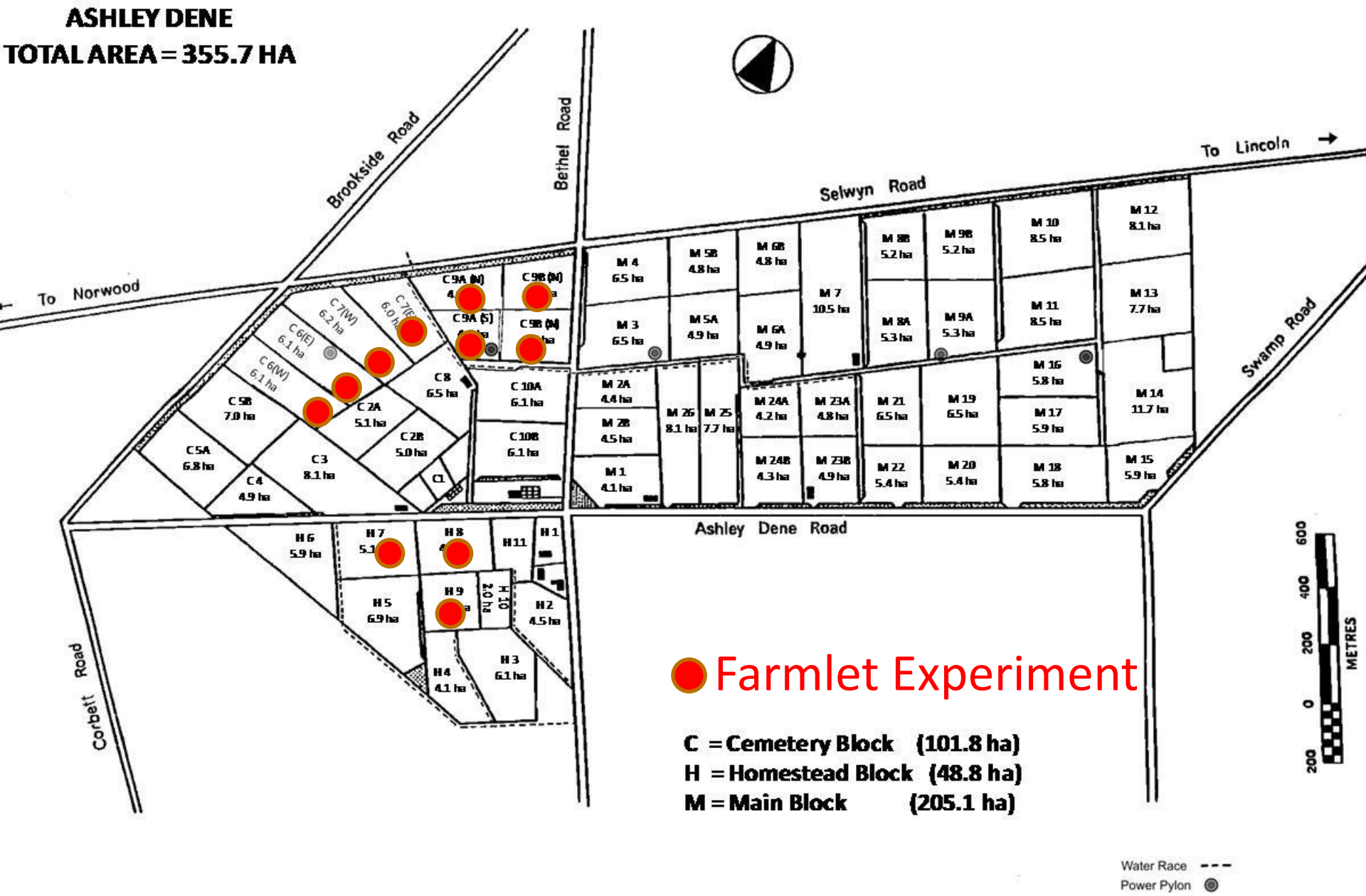
Lucerne + cocksfoot – 350 mm

Clay Downs 650 mm



Research questions 2012 - ...

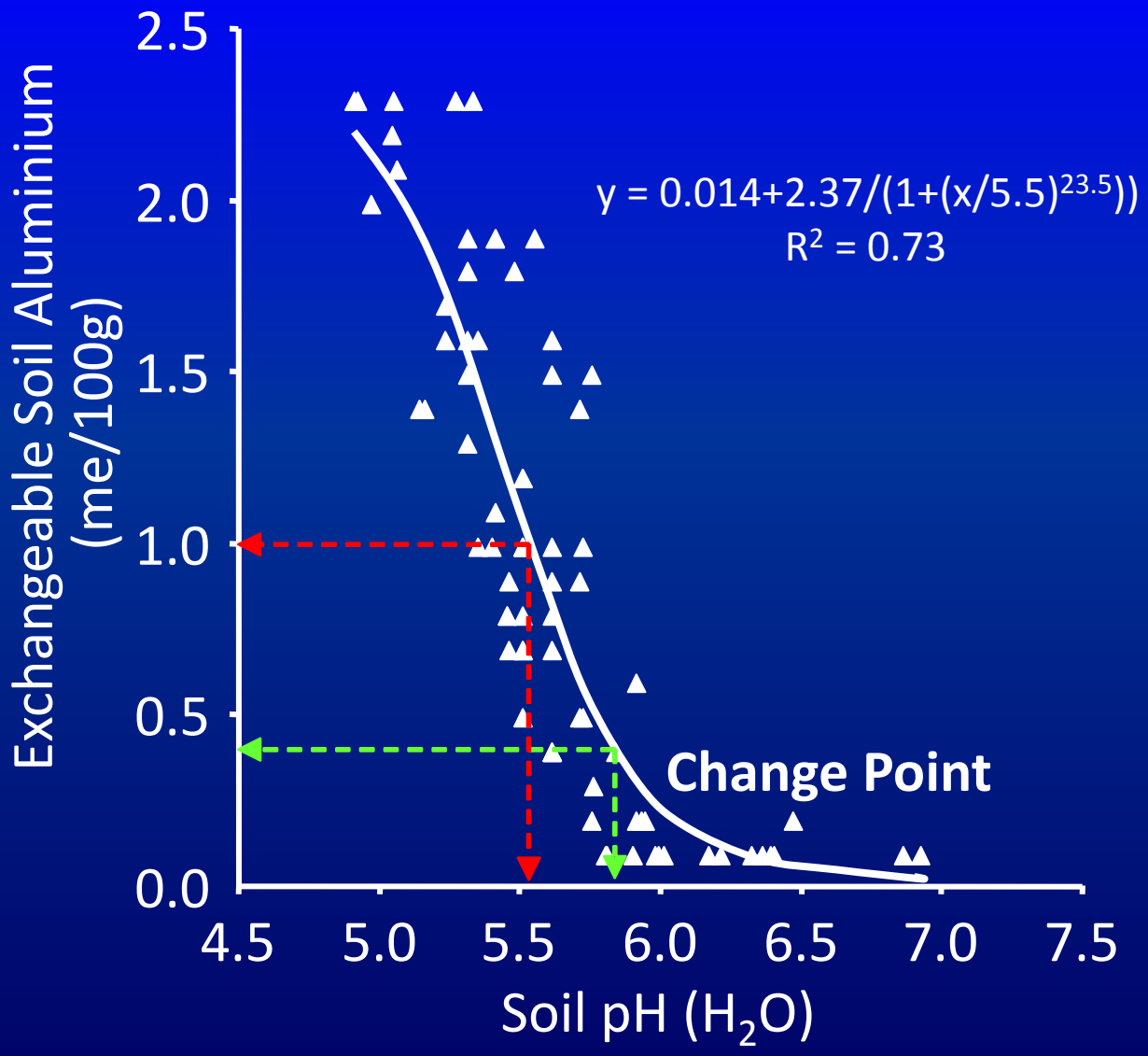
- Animal and pasture production and persistence
- Lucerne vs. luc/grass – N use, H_2O use, quality
- Management of annual clovers in mixed pastures, N cycling, WUE.
- Role of Caucasian clover


ASHLEY DENE
TOTAL AREA = 355.7 HA
Brookside Road
Bethel Road
Selwyn Road
To Lincoln
To Norwood
Swamp Road
Ashley Dene Road
Corbett Road
C9A (N)
C9B (N)
C9A (S)
C9B (M)
C7(NW) 6.2 ha
C7(E) 6.0 ha
C6(E) 6.1 ha
C6(NW) 6.1 ha
C5B 7.0 ha
C5A 6.8 ha
C4 4.9 ha
C3 8.1 ha
C2A 5.1 ha
C2B 5.0 ha
C8 6.5 ha
C10A 6.1 ha
C10B 6.1 ha
C1
M 4 6.5 ha
M 5B 4.8 ha
M 6B 4.8 ha
M 7 10.5 ha
M 8B 5.2 ha
M 9B 5.2 ha
M 10 8.5 ha
M 12 8.1 ha
M 3 6.5 ha
M 5A 4.9 ha
M 6A 4.9 ha
M 8A 5.3 ha
M 9A 5.3 ha
M 11 8.5 ha
M 13 7.7 ha
M 2A 4.4 ha
M 2B 4.5 ha
M 1 4.1 ha
M 26 8.1 ha
M 25 7.7 ha
M 24A 4.2 ha
M 23A 4.8 ha
M 21 6.5 ha
M 19 6.5 ha
M 16 5.8 ha
M 17 5.9 ha
M 14 11.7 ha
M 24B 4.3 ha
M 23B 4.9 ha
M 22 5.4 ha
M 20 5.4 ha
M 18 5.8 ha
M 15 5.9 ha
H6 5.9 ha
H7 5.1
H8
H11
H1
H5 6.9 ha
H9
H10 2.0 ha
H2 4.5 ha
H4 4.1 ha
H3 6.1 ha
Farmlet Experiment
C = Cemetery Block (101.8 ha)
H = Homestead Block (48.8 ha)
M = Main Block (205.1 ha)
600
400
200
0
200
METRES
Water Race
Power Pylon

High Country – Pasture Persistence

Photo: V Fasi
Lincoln University

Soil pH & exchangeable Aluminium



Source: Moir & Moot, 2010

Photo: K Pollock
Lincoln University

Caucasian Clover

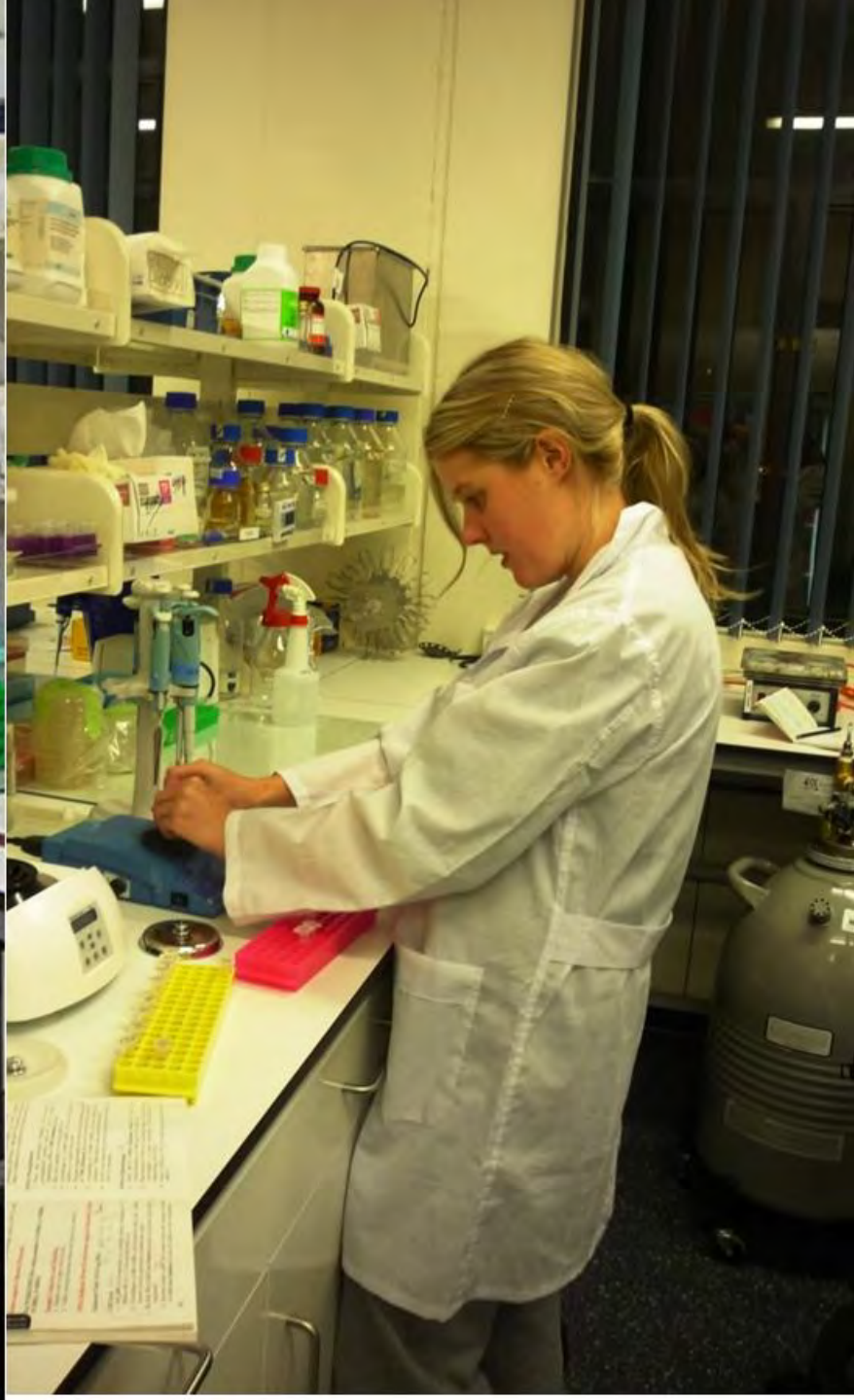
Source: Hurst *et al*. 2000

Gland clover

Soft seed please!

Plant nutrient requirements of Adventive and commercial annuals


Which rhizobia are in here?



Source: Wigley *et al* 2012

Conclusions

- Specific technical solutions and ongoing extension
- Dryland annual and perennial legume research across diverse topography
- Collaboration welcome!
- Publications in NZGA on web + LU website?!
- Insufficient graduates to meet the research needs?

References

Note: this presentation is associated with the accompanying published paper:

Moot, D. J. 2012. An overview of dryland legume research in New Zealand. *Crop and Pasture Science*, (In Press).

Brown, H. E. and Moot, D. J. 2004. Quality and quantity of chicory, lucerne and red clover production under irrigation. *Proceedings of the New Zealand Grassland Association*, **66**, 257-264.

Brown, H. E., Moot, D. J. and Pollock, K. M. 2005. Herbage production, persistence, nutritive characteristics and water use of perennial forages grown over 6 years on a Wakanui silt loam. *New Zealand Journal of Agricultural Research*, **48**, 423-439.

Brown, H. E., Moot, D. J. and Pollock, K. M. 2003. Long term growth rates and water extraction patterns of dryland chicory, lucerne and red clover. *In:* D. J. Moot (ed). Legumes for Dryland Pastures. Proceedings of a New Zealand Grassland Association(Inc.) Symposium held on 18-19 November 2003 at Lincoln Univrsity. Grassland Research and Practice Series No. 11. Palmerston North New Zealand: New Zealand Grassland Association, 91-99.

Hurst, R. G. M., Black, A. D., Lucas, R. J. and Moot, D. J. 2000. Sowing strategies for slow-establishing pasture species on a North Otago Dairy farm. *Proceedings of the New Zealand Grassland Association*, **62**, 129-135.

Mills, A. and Moot, D. J. 2010. Annual dry matter, metabolisable energy and nitrogen yields of six dryland pastures six and seven years after establishment. *Proceedings of the New Zealand Grassland Association*, **72**, 177-184.

Mills, A., Moot, D. J. and McKenzie, B. A. 2006. Cocksfoot pasture production in relation to environmental variables. *Proceedings of the New Zealand Grassland Association*, **68**, 89-94.

Moir, J. and Moot D.J. 2010. Soil pH, exchangeable aluminium and lucerne yield responses to lime in a South Island high country soil. Proceedings of the New Zealand Grassland Association 72: 191-196.

Monks, D. P., Moot, D. J., Smith, M. C. and Lucas, R. J. 2008. 'Bolta' balansa clover persistence in a grazed cocksfoot pasture depended on spring and summer grazing management. *Proceedings of the New Zealand Grassland Association*, **70**, 233-238.

Moot, D. J., Brown, H. E., Pollock, K. and Mills, A. 2008. Yield and water use of temperate pastures in summer dry environments. *Proceedings of the New Zealand Grassland Association*, **70**, 51-57.

Moot, D. J., Brown, H. E., Teixeira, E. I. and Pollock, K. M. 2003. Crop growth and development affect seasonal priorities for lucerne management. *In:* D. J. Moot (ed). Legumes for Dryland Pastures. Proceedings of a New Zealand Grassland Association Inc Symposium held at Lincoln University, 18-19 November, 2003, 201-208.

New Zealand Fertiliser Manufacturers' Research Association. 2011. Annual update (New Zealand Fertiliser Manufacturers' Research Association). 15 pp. Date Accessed: 5/5/2011. http://www.fertresearch.org.nz/resource-centre/annual-updates. Last Updated: Dec 2009.

Teixeira, E. I., Moot, D. J. and Brown, H. E. 2009. Modelling seasonality of dry matter partitioning and root maintenance respiration in lucerne (*Medicago sativa* L.) crops. *Crop & Pasture Science*, **60**, 778-784.

Wigley, K.; Moot, D.J.; Khumalo, Q.; Mills, A. 2012. Establishment of lucerne (*Medicago sativa* L.) sown on five dates with four inoculation treatments. *Proceedings of the New Zealand Grassland Association 74*: *In Press.*

Dryland Legumes: an overview of research in New Zealand

Professor Moot gave this presentation at:

the William Angliss Conference Centre, Melbourne, Australia

(Invited Speaker)

On:

8/2/2012

For:

Australian Scientific Symposium on Legumes

8-9 Feb 2012