



**Lincoln
University**

Te Whare Wānaka o Aoraki

AOTEAROA • NEW ZEALAND



Climate change - Pastoral Responses

27 June 2019

U3A - Dunedin

(Session B)

Professor Derrick Moot

New Zealand's specialist land-based university

Mertonian Norms of Science (1942)



- **C** – Communal – common ownership from collaboration
- **U** – Universal – evaluated independently
- **D** – Disinterested – uncorrupted by self interest, financial gain
- **OS** – Organized Scepticism – transparent
- judged by society using accepted norms

Overseer fails these norms - PCE!

New Zealand's specialist land-based university

Science or “fake news” and emotion to lead the 21st Century?



Photo source: https://upload.wikimedia.org/wikipedia/commons/thumb/7/7f/Marine_Le_Pen_%282017-03-24%29_01_cropped.jpg/220px-Marine_Le_Pen_%282017-03-24%29_01_cropped.jpg



Photo source: https://en.wikipedia.org/wiki/Donald_Trump#/media/File:Donald_Trump_official_portrait.jpg



Photo source: [https://en.wikipedia.org/wiki/Vladimir_Putin#/media/File:Vladimir_Putin_\(2017-07-08\)_cropped.jpg](https://en.wikipedia.org/wiki/Vladimir_Putin#/media/File:Vladimir_Putin_(2017-07-08)_cropped.jpg)

Jan 28 1986

Primary industry
Climate change – Jan Wright
Fonterra
B+LNZ
MPI
Meat Companies
LU

**Politicians talk with lobbyists
not scientists**

Meth houses
Glyphosphate
Chlorinated water
Fluoride
Nitrate
Nuclear energy
Vaccinations
GM plants

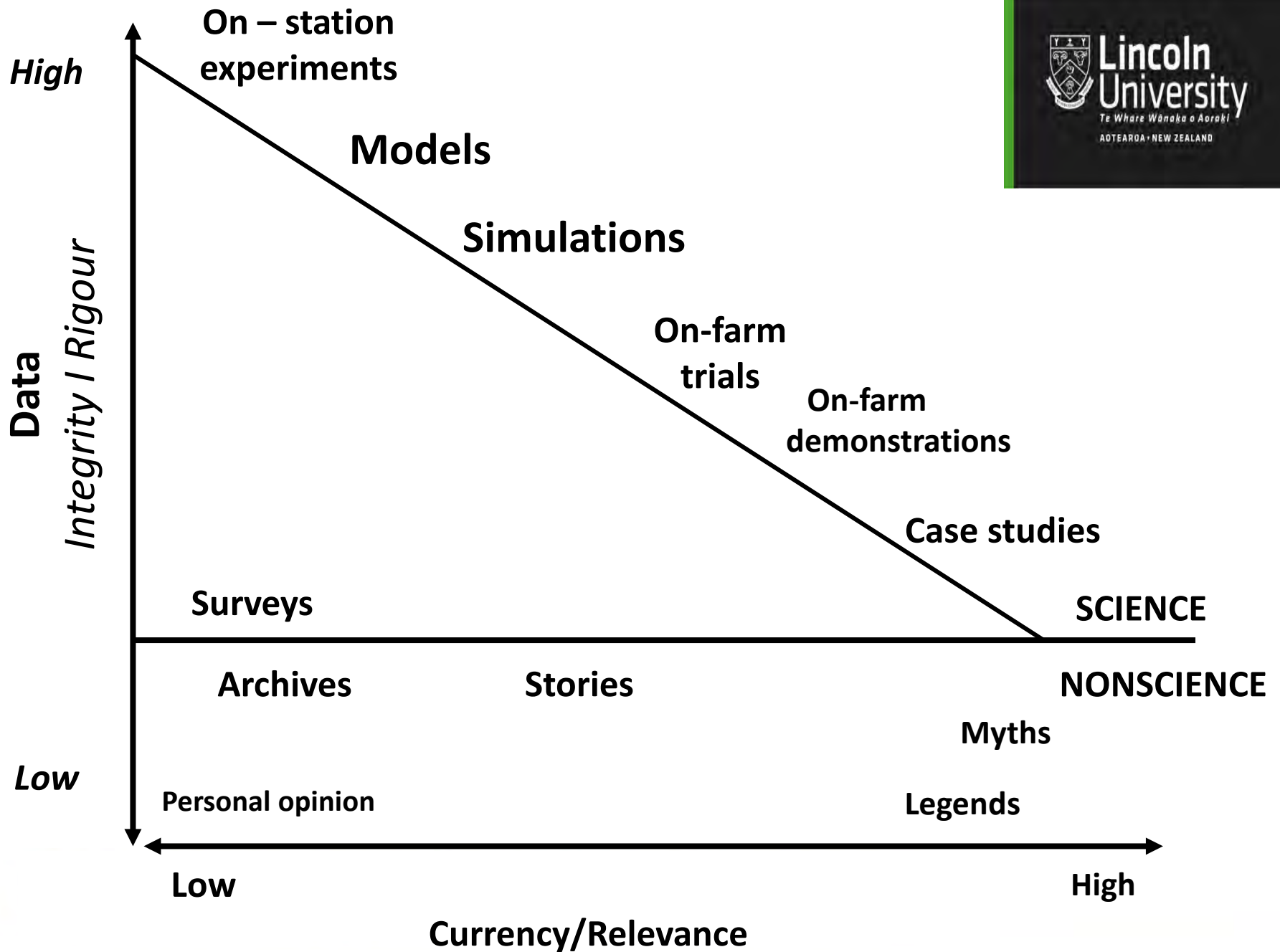
**“The people who know how things really operate
are always at the bottom of these organizations”**

Dryland pastures

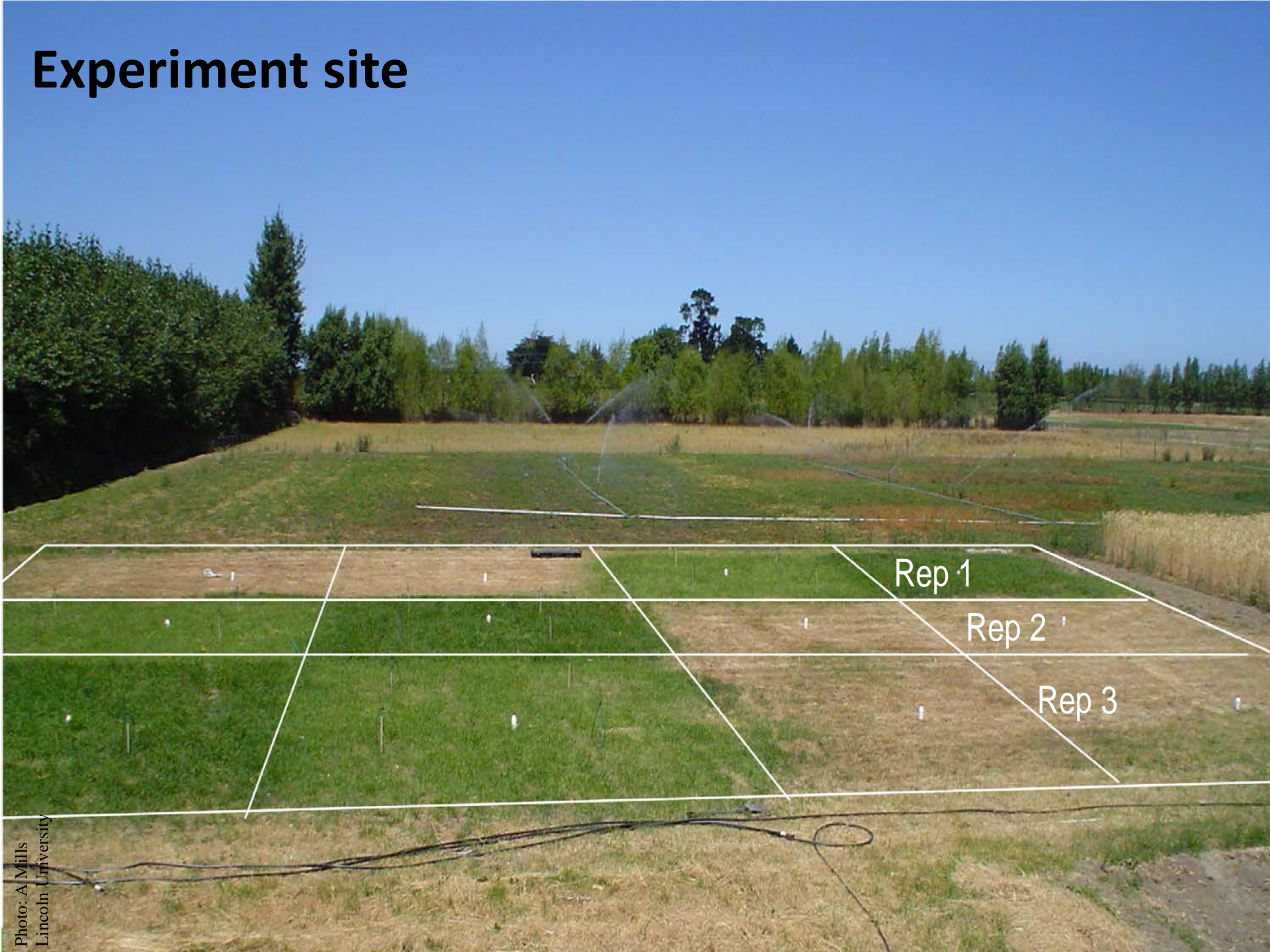
- Limited water supply
- N to make plants grow!
- Meet animal demand (lactation)
- Minimize impact on air, soil, water
- Productive and profitable
- Socially acceptable

Legume dominant

New Zealand's specialist land-based university



Experiment site

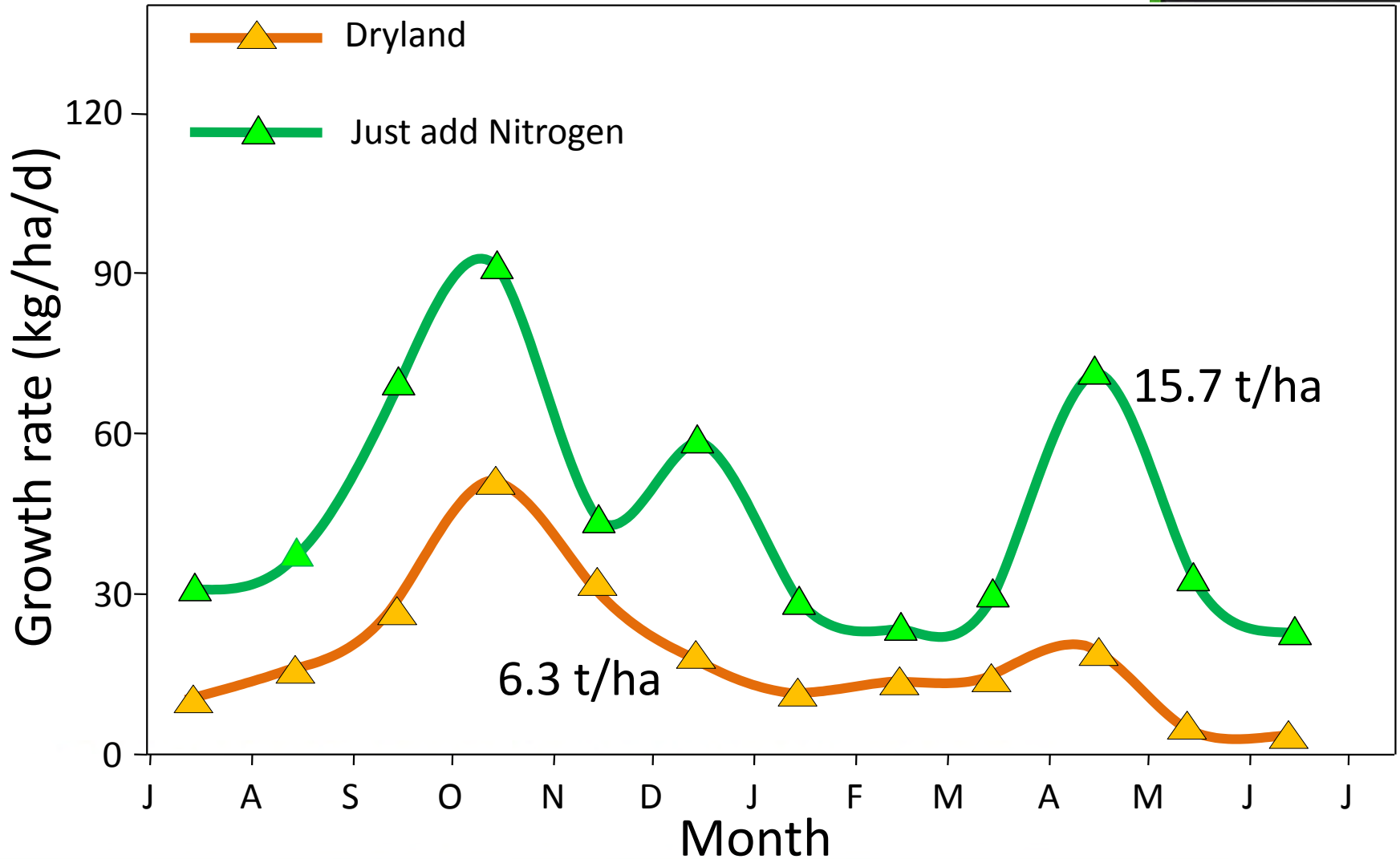


Rep 1

Rep 2

Rep 3

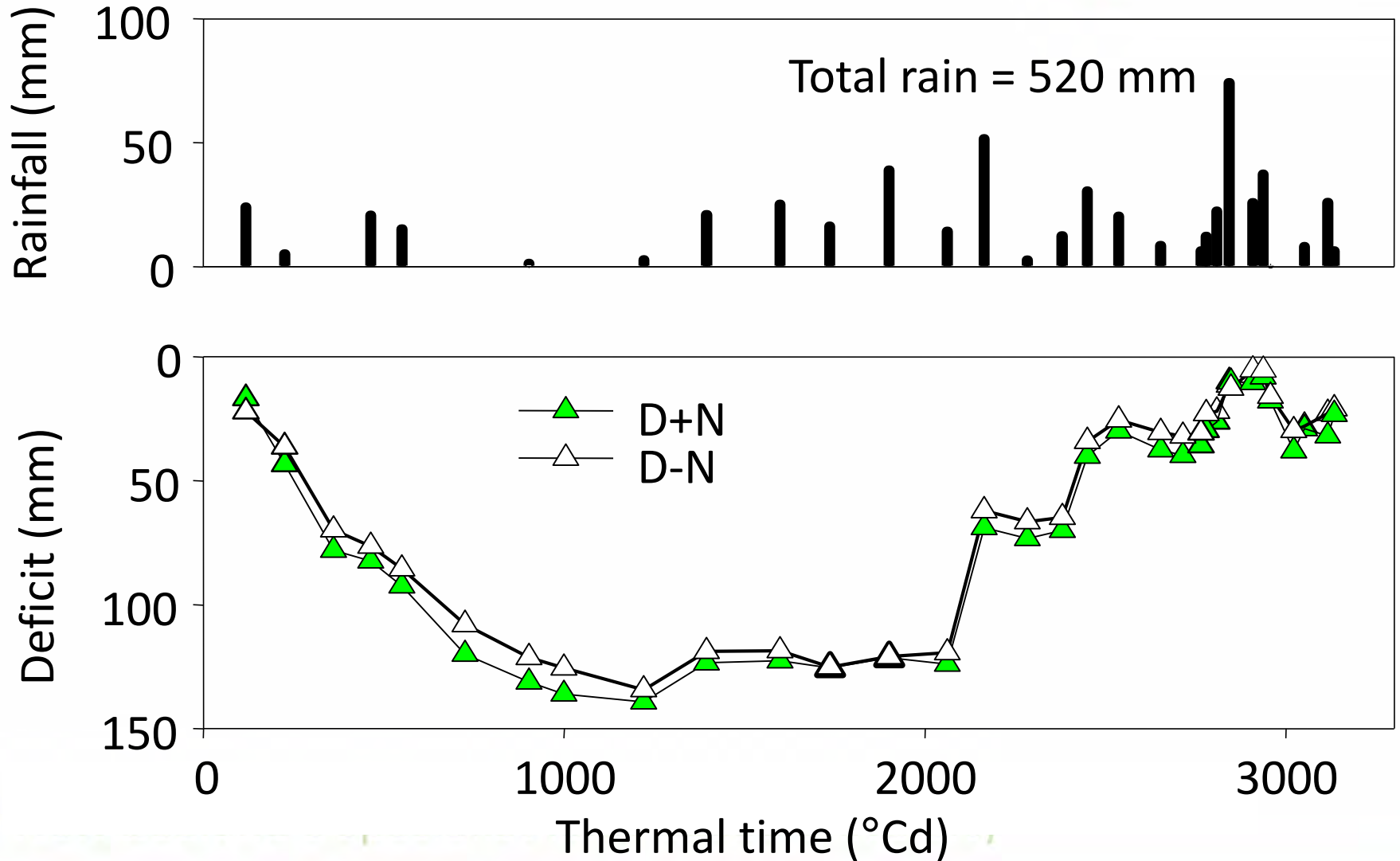
Growth rates (2 year means)



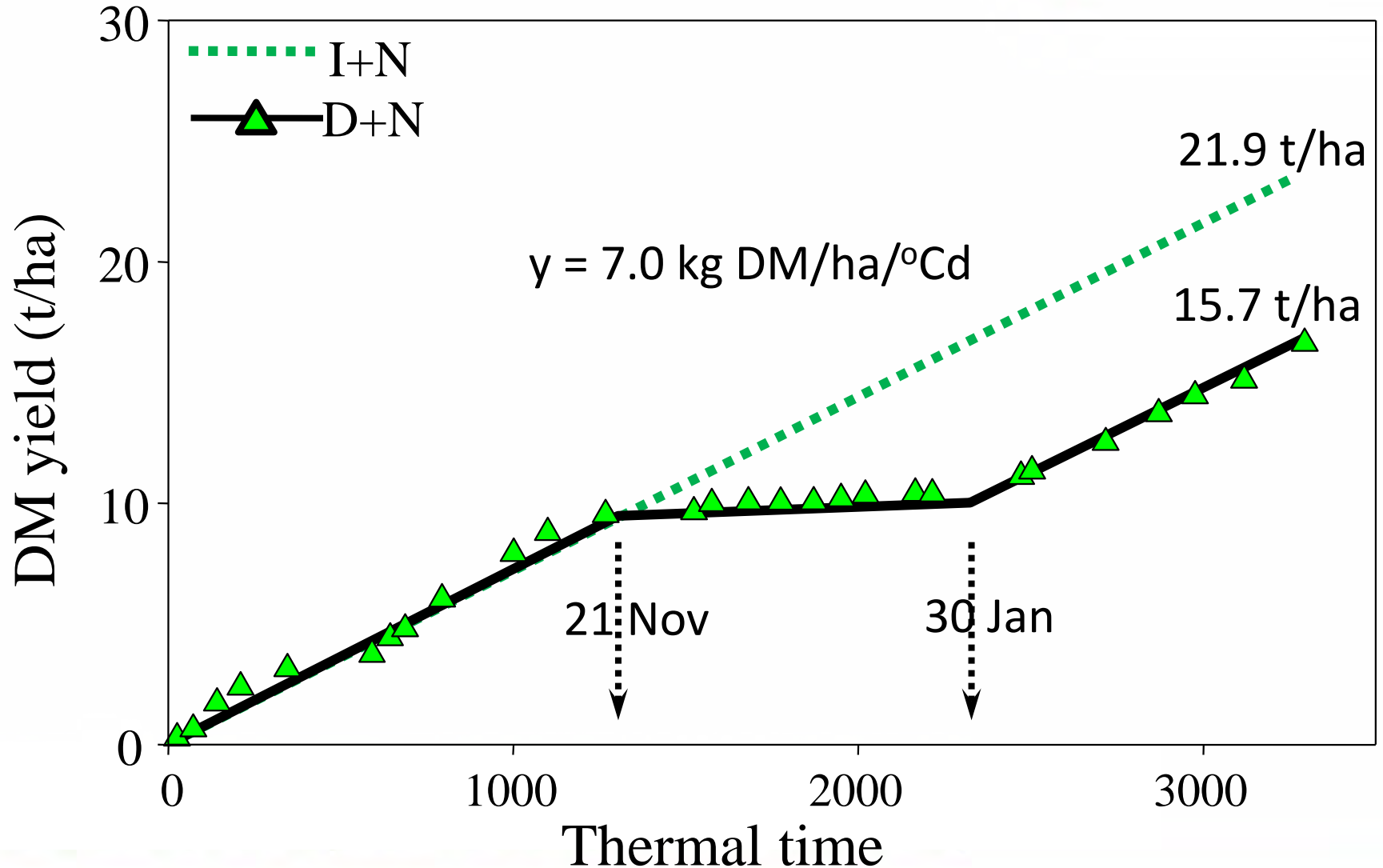


Summer \Rightarrow moisture response

Soil moisture deficit 2003/04



Water stress effect on yield



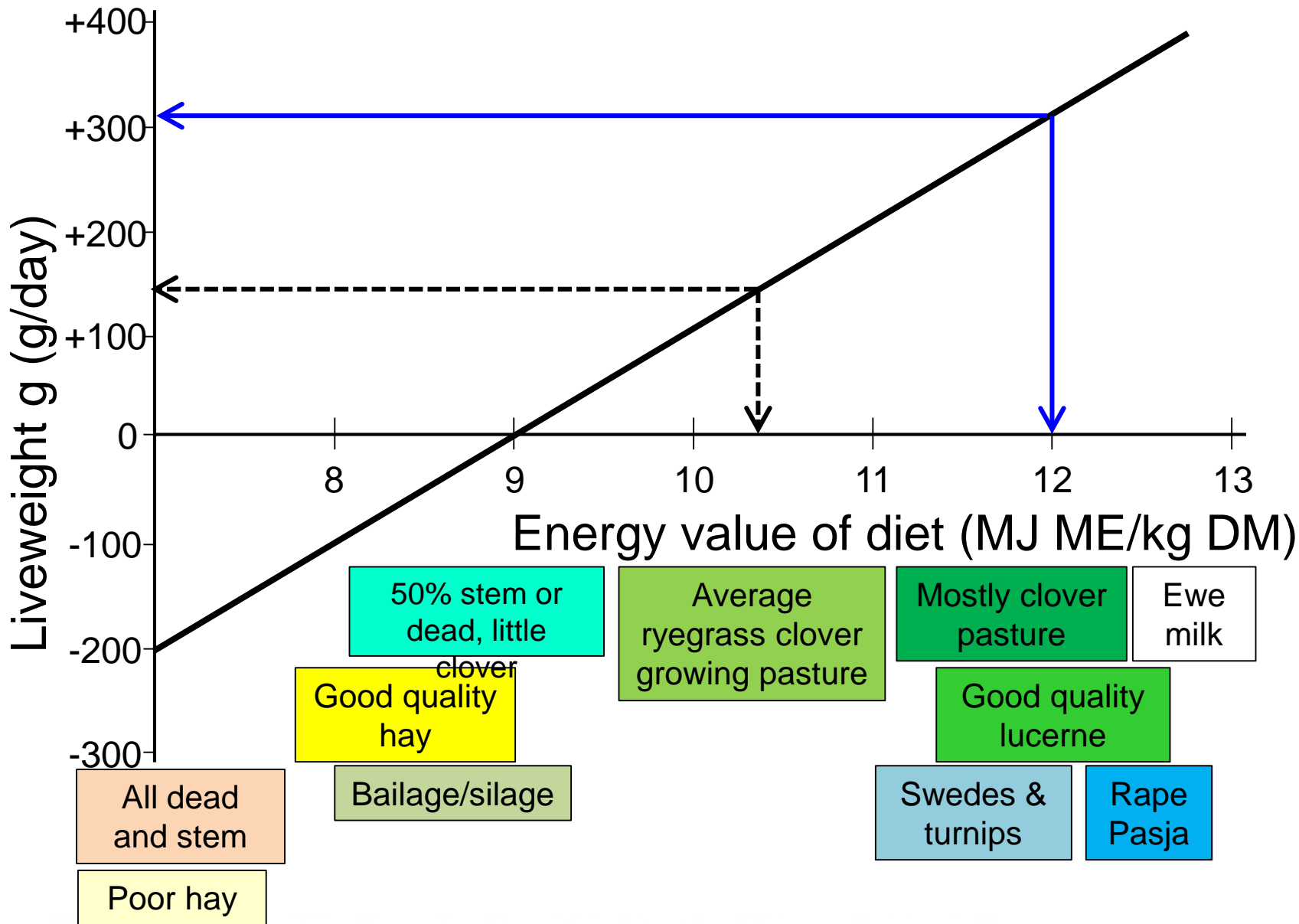
Ashley Dene

9 Jan 2015

**Required lamb growth =
5 to 35 kg
in ~100 days**



Nitrogen fixation
25-30 kg N/t DM



New Zealand's specialist land-based university

Lucerne Objectives

- Understand the plant response to the environment
- Use that information to design farm systems
- Document changes in systems as proof of concept
- Answer any dryland questions on any species

Growth:

is dry matter accumulation as a result of light interception and photosynthesis

Development:

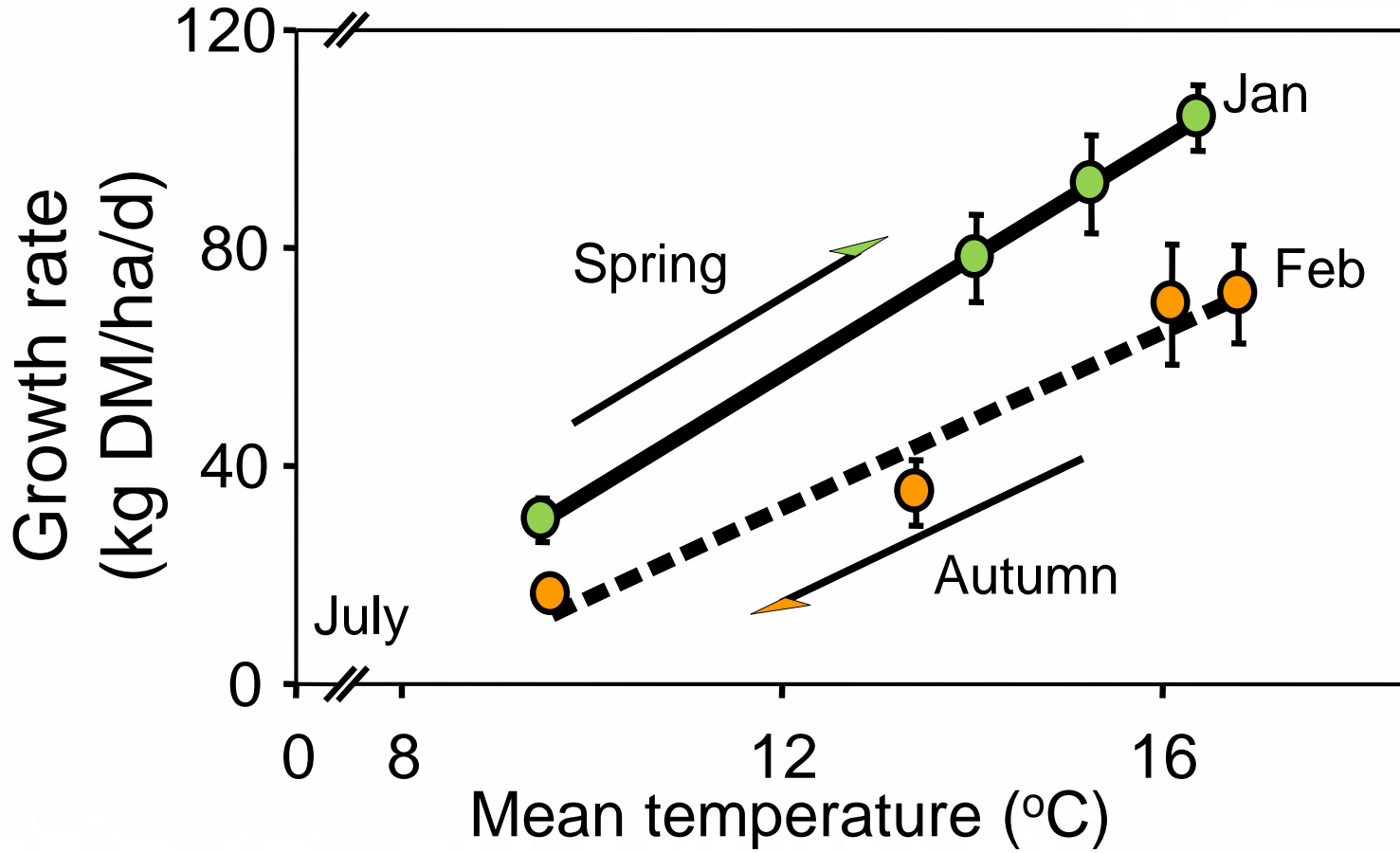
is the 'age' or maturity of the regrowth crop
e.g. leaf appearance, flowering

Growth and development are both influenced by environmental signals

The canopy: the energy capture device



Vegetative growth



Experiment 2

flexible grazing

38 days resting

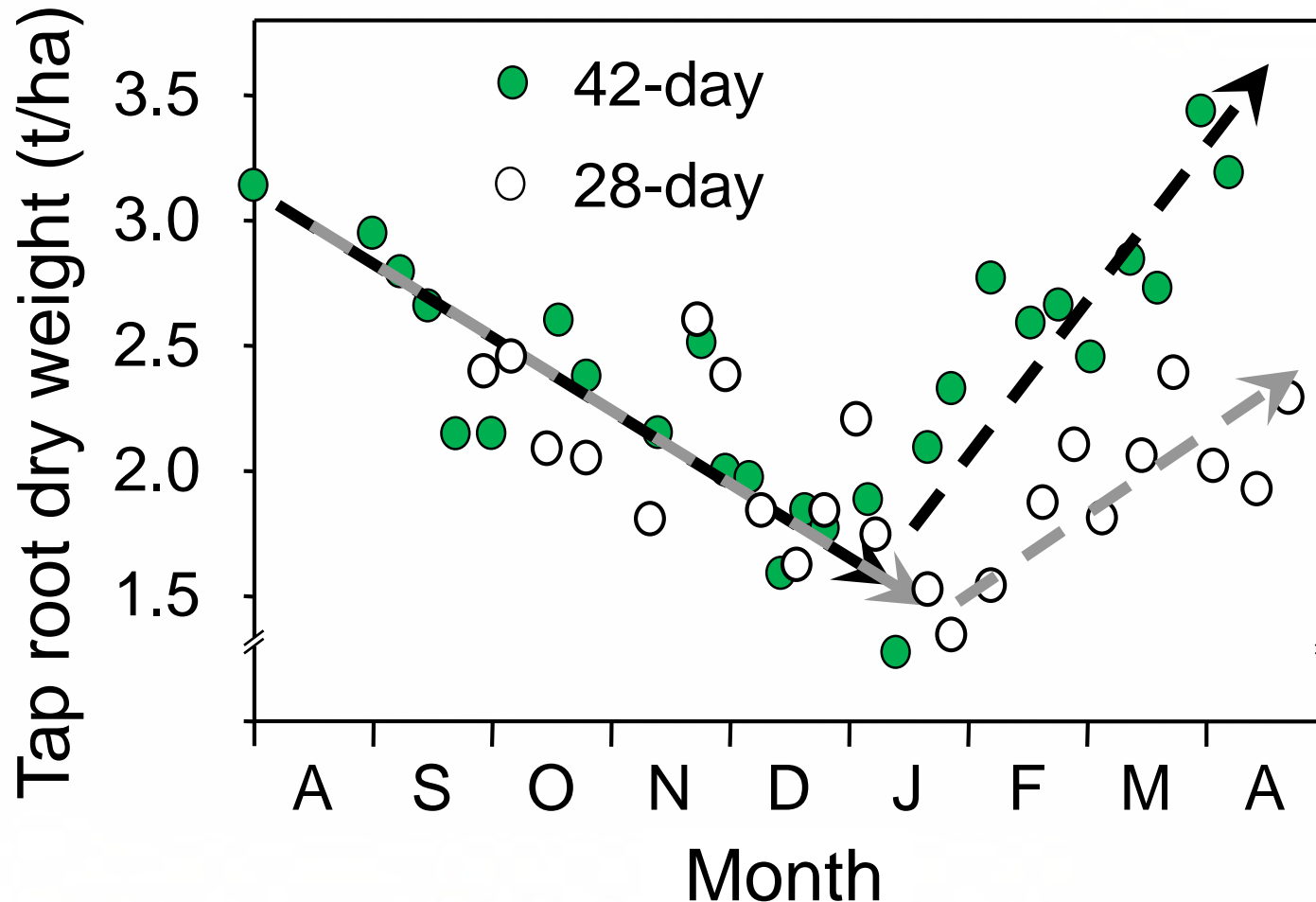
4 days grazing

25 days resting

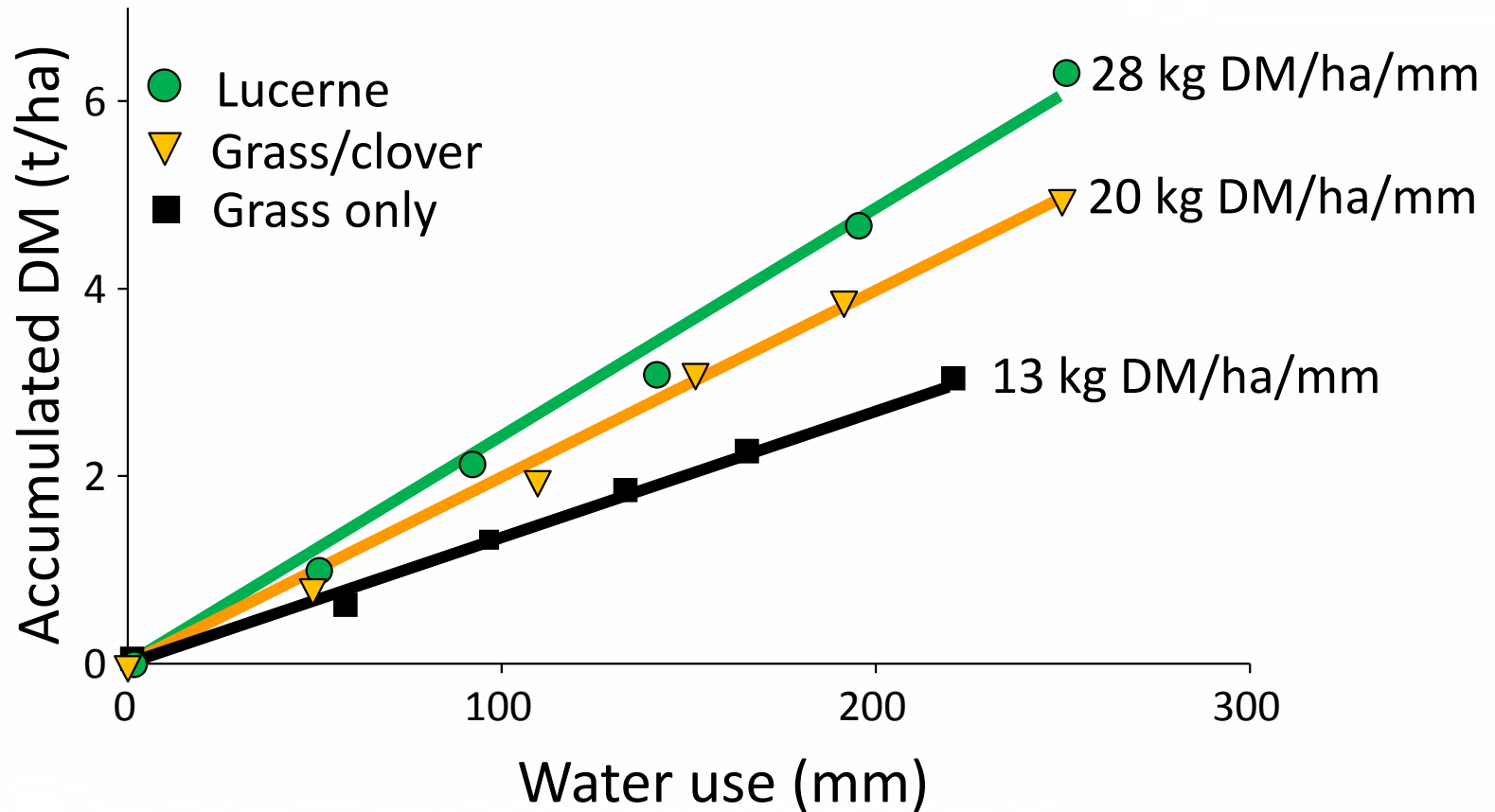
3 days grazing



Partitioning to roots



Spring WUE



Seasonal grazing management

Spring

- 1st rotation aided by root reserves to produce high quality vegetative forage.
- can graze before flowers appear (~1500 kg DM/ha) ideally ewes and lambs but

Growing point at the top of the plant

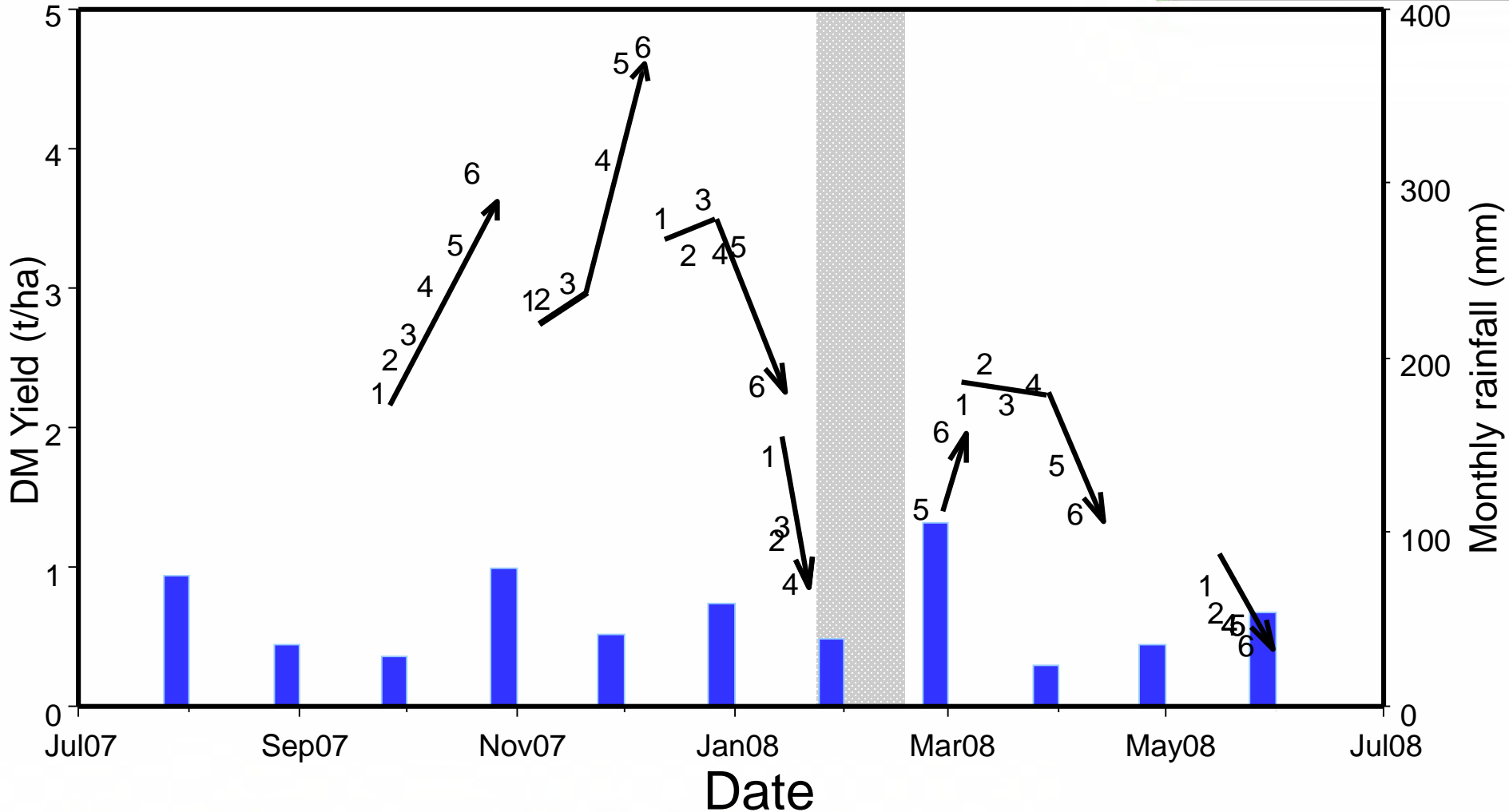
Photo: M. Smith
Lincoln University

Rotation 1 Pre-graze
Plot 1 (21/9/07)
2.3 t DM/ha
20-25 cm tall



New Zealand's specialist land-based university

MaxClover – 38-42 day rotation



New Zealand's specialist land-based university

5th September 2011 – Cave, South Canterbury



Photo: D.J. Moor
Lincoln University

New Zealand's specialist land-based university



Spring grazing at 'Bonavaree', Marlborough

New Zealand's specialist land-based university



Photo: B.J. Moot
Lincoln University

14 ewes + twins/ha

New Zealand's specialist land-based university

High numbers for 7-10 days



Photo: D.J. Moot
Lincoln University

New Zealand's specialist land-based university



Fibre and salt

Photo: Doug Avery
Bonavaree, Marlborough

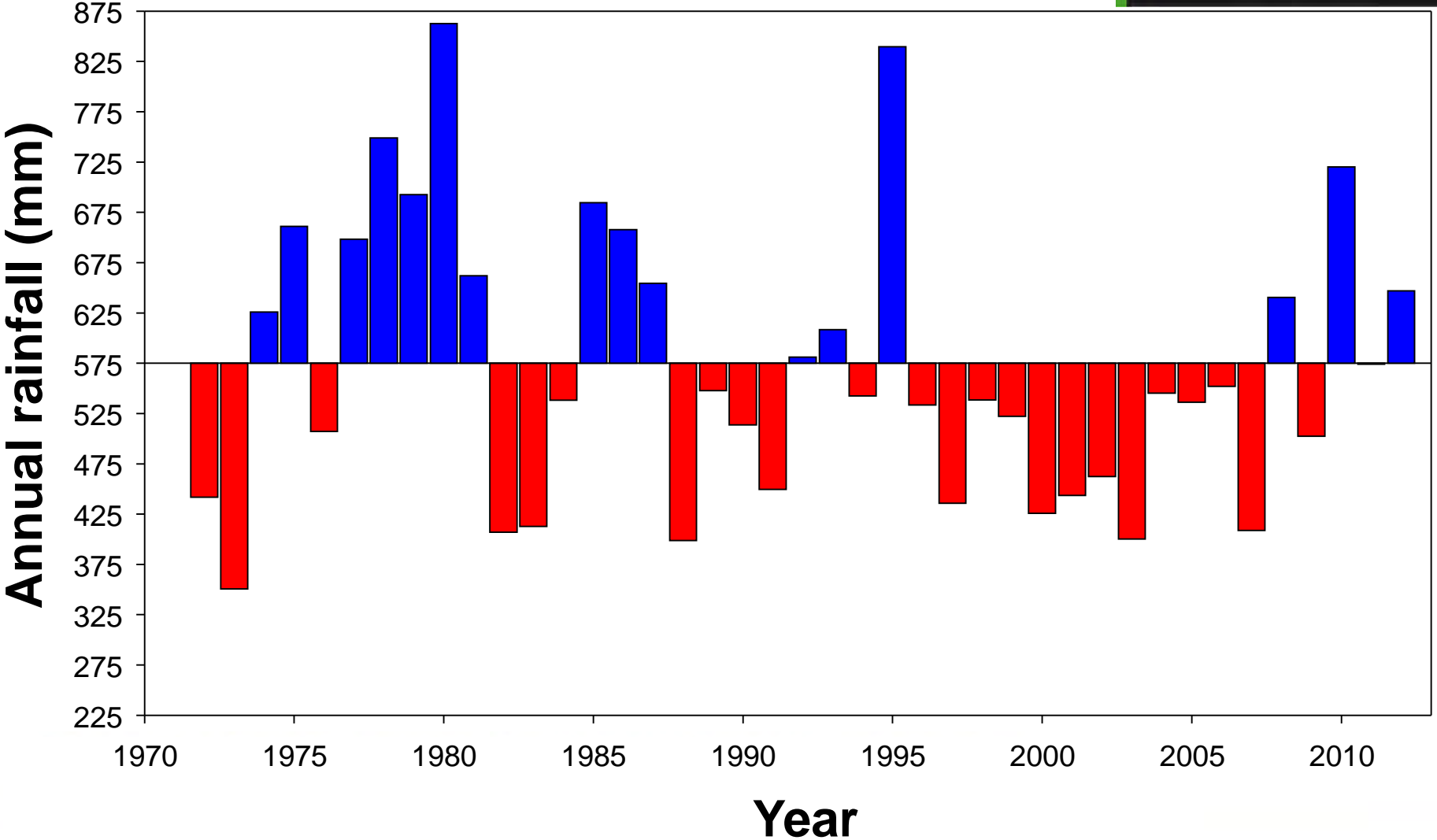
New Zealand's specialist land-based university

**Case study – Bonavaree farm,
Marlborough
Over grazed – high erosion risk
Financially – no return
Dryland lucerne conversion**



Photo: Doug Avery
'Bonavaree', Marlborough

Annual rainfall at 'Bonavaree'



Bonavaree 14/8/2017



Photo: DJ Moot
Lincoln University

New Zealand's specialist land-based university



Photo: Doug Avery,
Bonavaree, Marlborough

26/10/2016

Doug and Fraser Avery “Bonavaree”

Photo: Doug Avery,
Bonavaree, Marlborough

23/01/2005

New Zealand's specialist land-based university

Diverse drought-proofed landscape



SI Farmer of the Year 2010



**Marlborough District Council Farming Environment Award
2011**

'Bonavaree' production change over 10 years

	2002	2012	Change
Land area (ha)	1100	1800	↑ 64%
Sheep numbers	3724	4158	↑ 12%
Lambing (%)	117	145	↑ 24%
Lamb weights (kg)	13.3	19	↑ 43%
Lamb sold (kg)	38324	74460	↑ 94%
Wool (kg)	18317	20869	↑ 14%
Sheep:cattle	70:30	50:50	
Gross trading profit (ha)	\$317	\$792	↑ 149%

THE RESILIENT FARMER

Weathering the
challenges of life
and the land

DOUG AVERY

'Both Doug and his story are hugely inspirational.' SIR JOHN KIRWAN

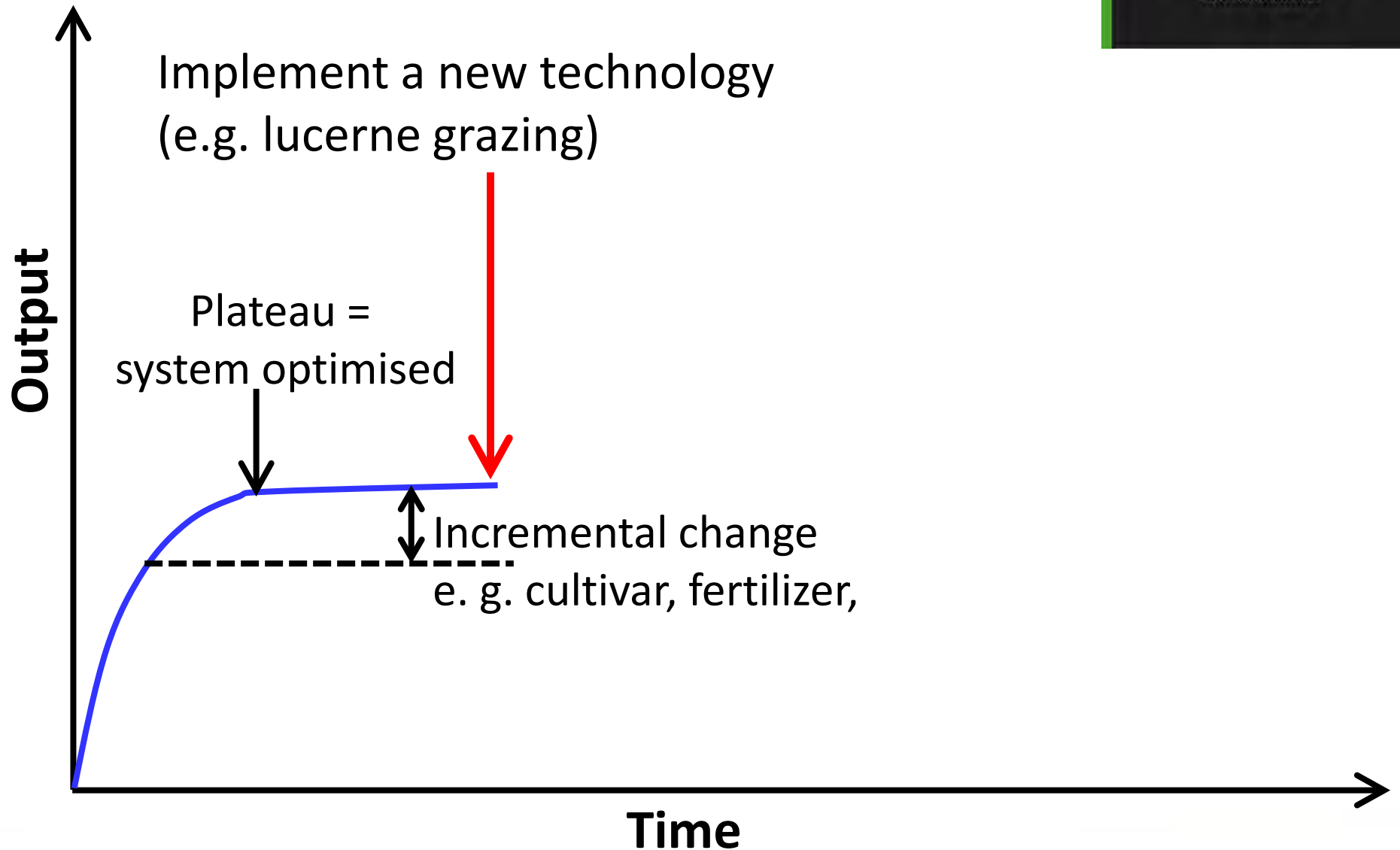


**Lincoln
University**

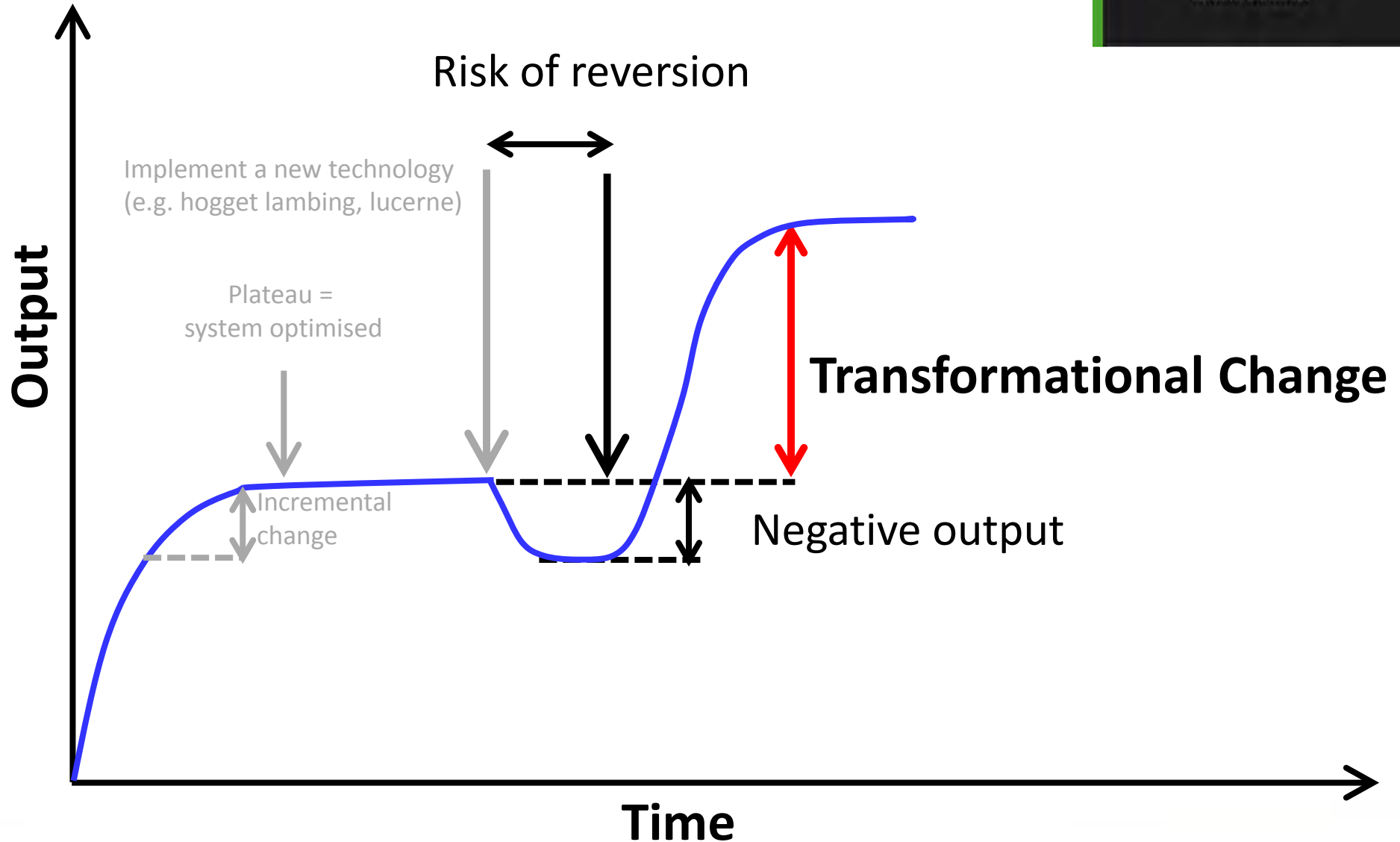
Te Whare Wānaka o Aoraki
AOTEAROA • NEW ZEALAND

New Zealand's specialist land-based university

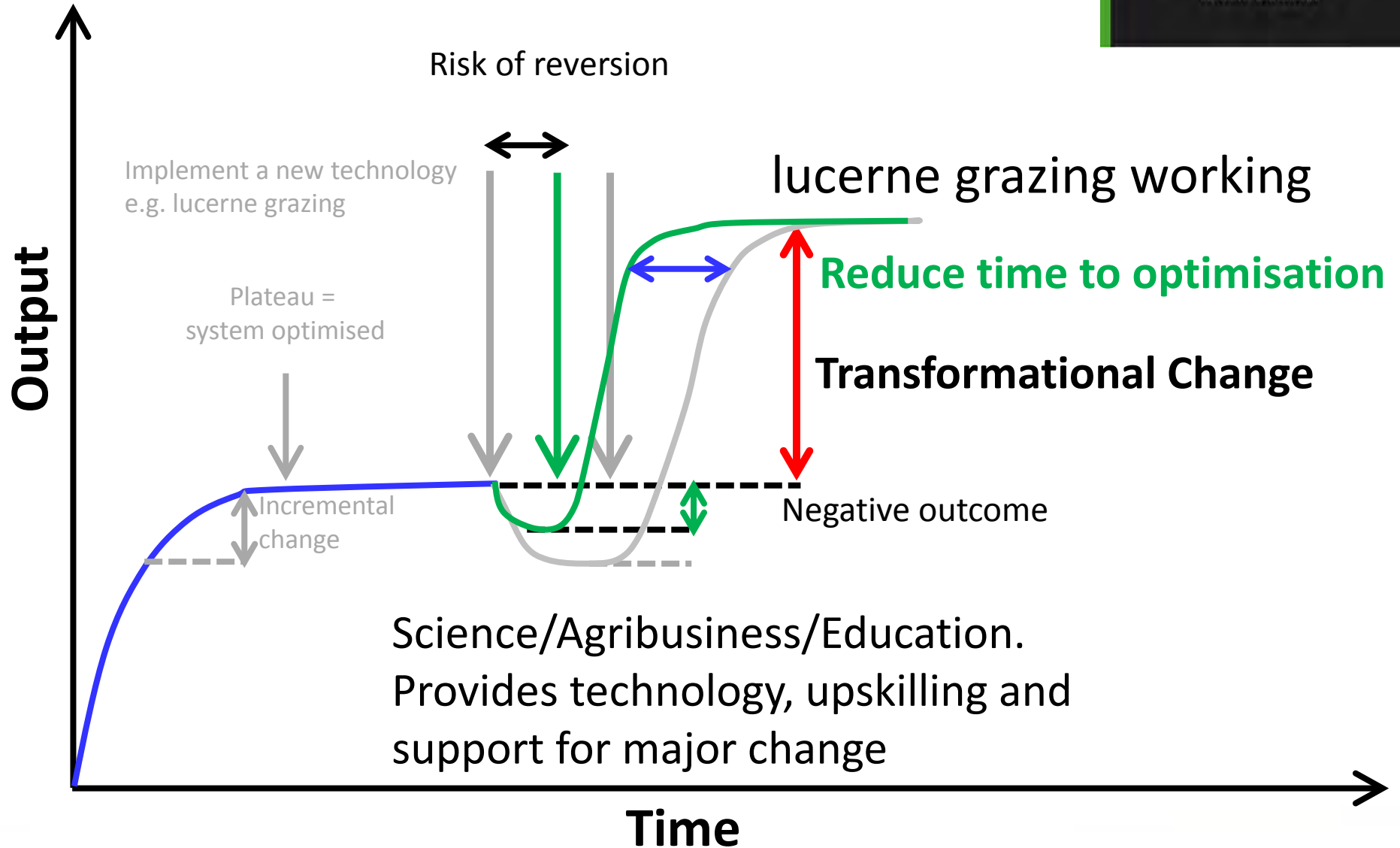
Pathway to change



System optimisation



Pathway to change





BOG ROY

EST. 1891

**400 mm rainfall
environment**

Old System

- Set-stocked
- Constant grass chasing
- Hill country in decline
- 100 day supplement winter feeding
- Peak feed demand and supply misaligned



New Zealand's specialist land-based university

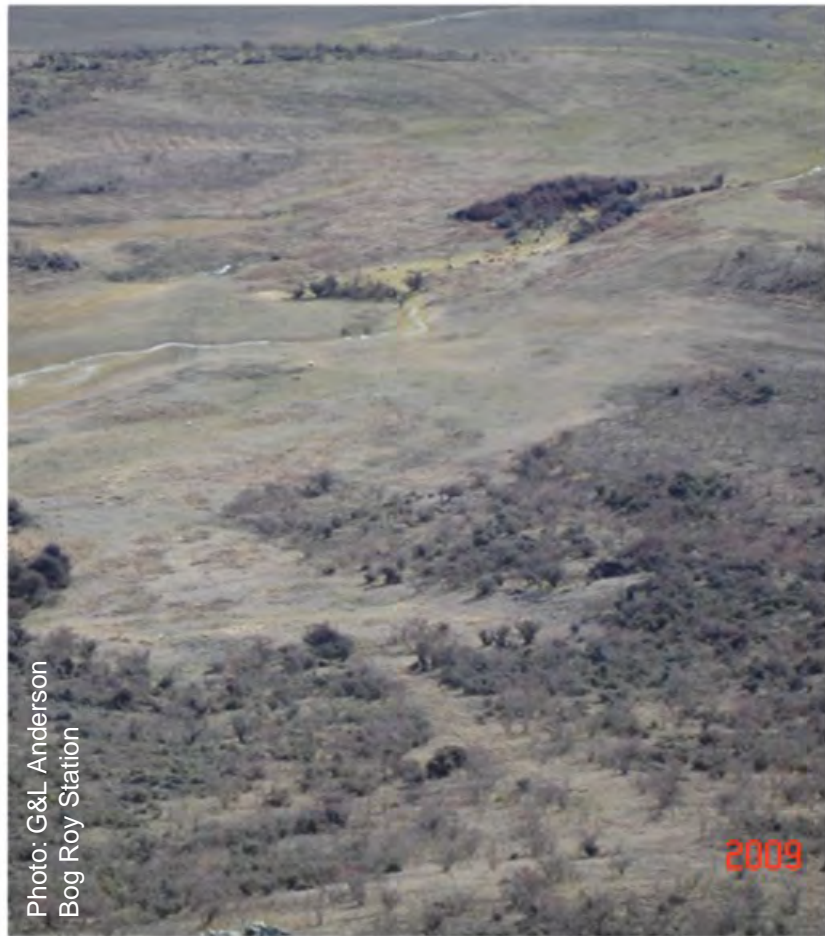
Landscape farming – Bog Roy Station



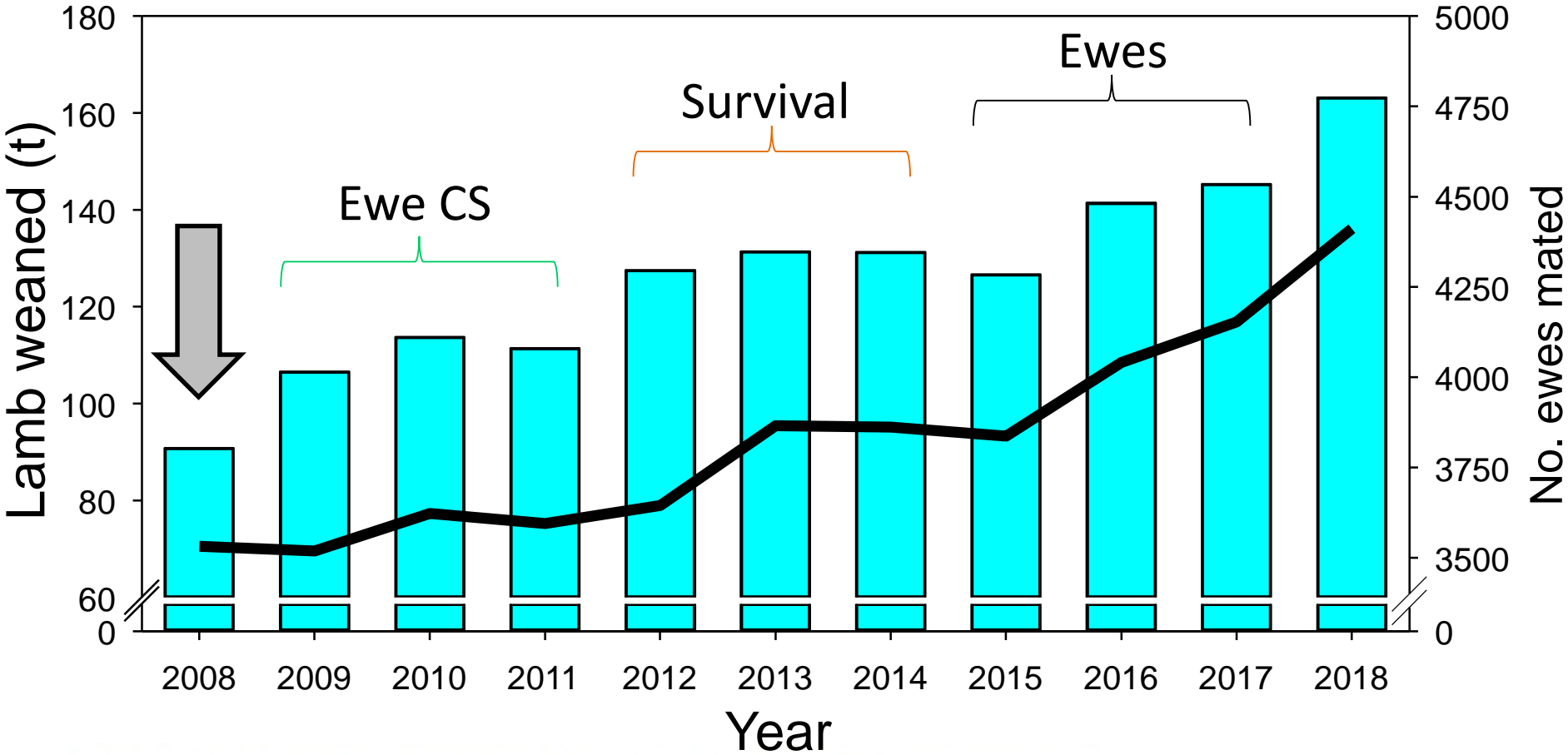
Photo: DJ Moe
Lincoln University

New Zealand's specialist land-based university

Landscape farming

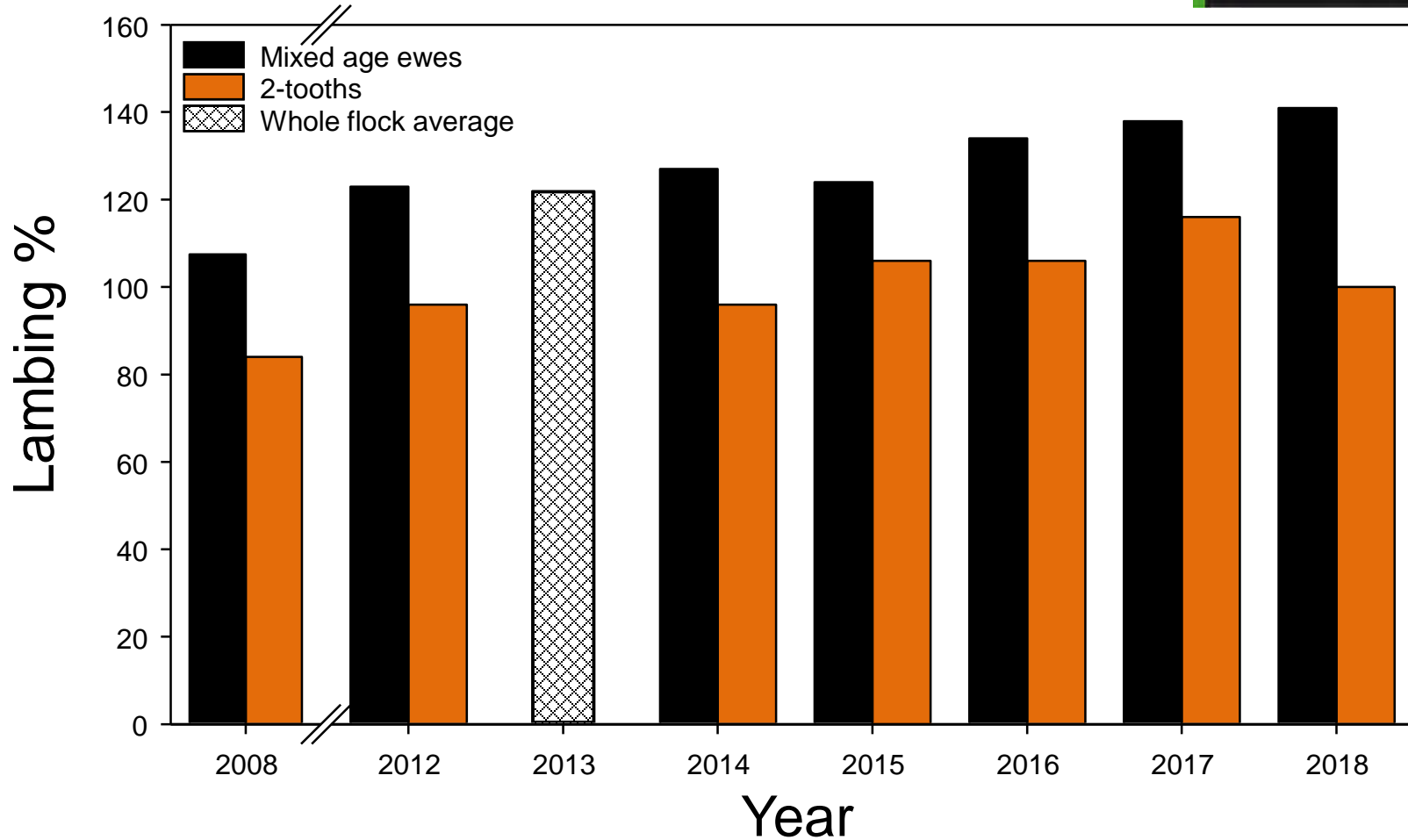


Change in LWt produced at Bog Roy

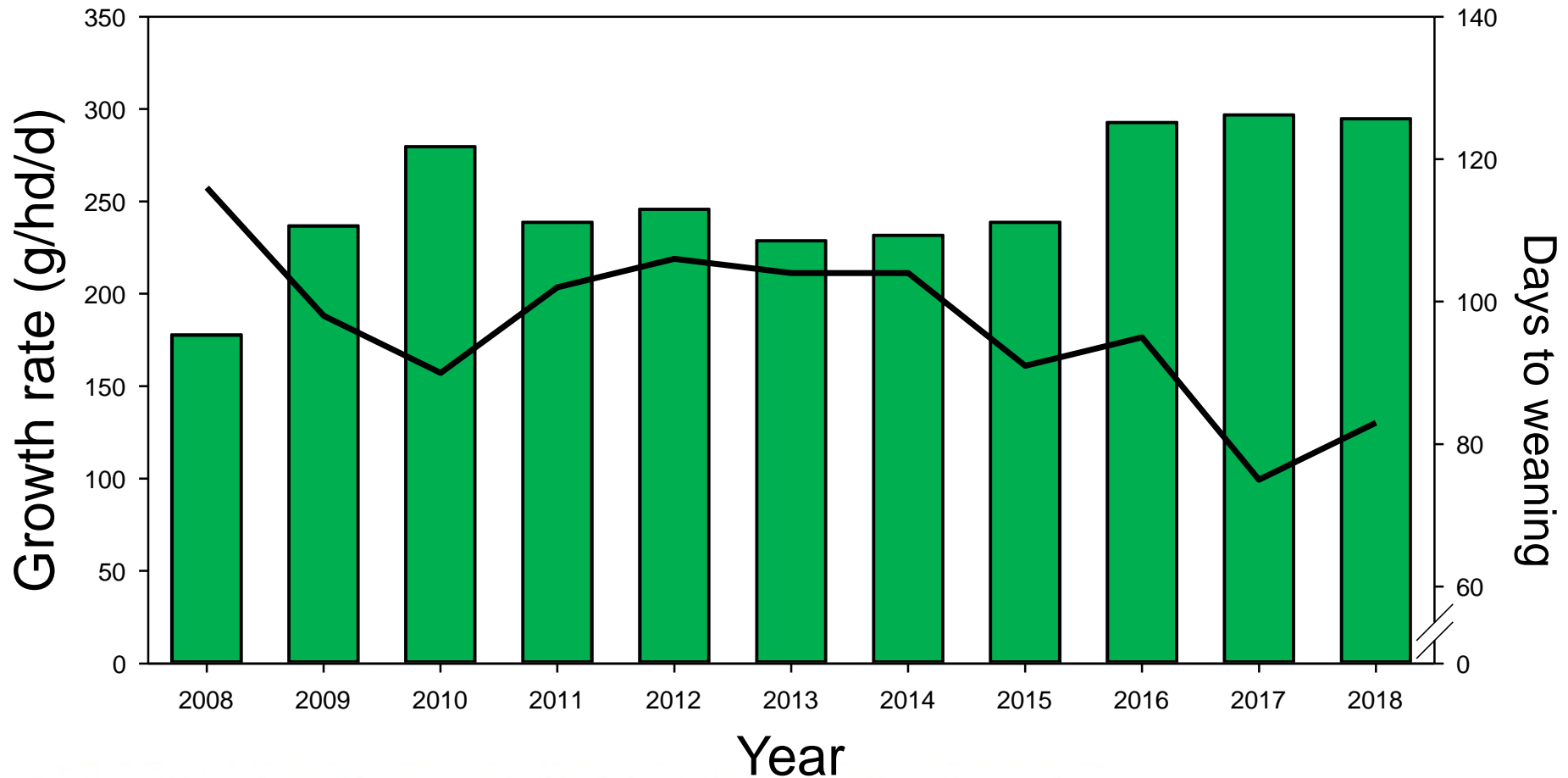


New Zealand's specialist land-based university

Change in lambing% at Bog Roy



Mean daily lamb growth rate



New Zealand's specialist land-based university

Transformational change at Bog Roy

- Change to lucerne grazing priority
- Increased per head performance of ewes
- Increased dry matter grown with new lucerne
- Less winter feed made
- Weaned lambs sold at heavier weights
- More ewes as the system allowed

“We listened to advice and acted on it”

New Zealand's specialist land-based university



Photo: D.J. Moot
Lincoln University

New Zealand's specialist land-based university

150,000 ha sown - lucerne seed from 20 to 200 t/yr

**“35% Rate of return on investment”
1000 people on txt alerts
Defined system after 15 years**

Tempello

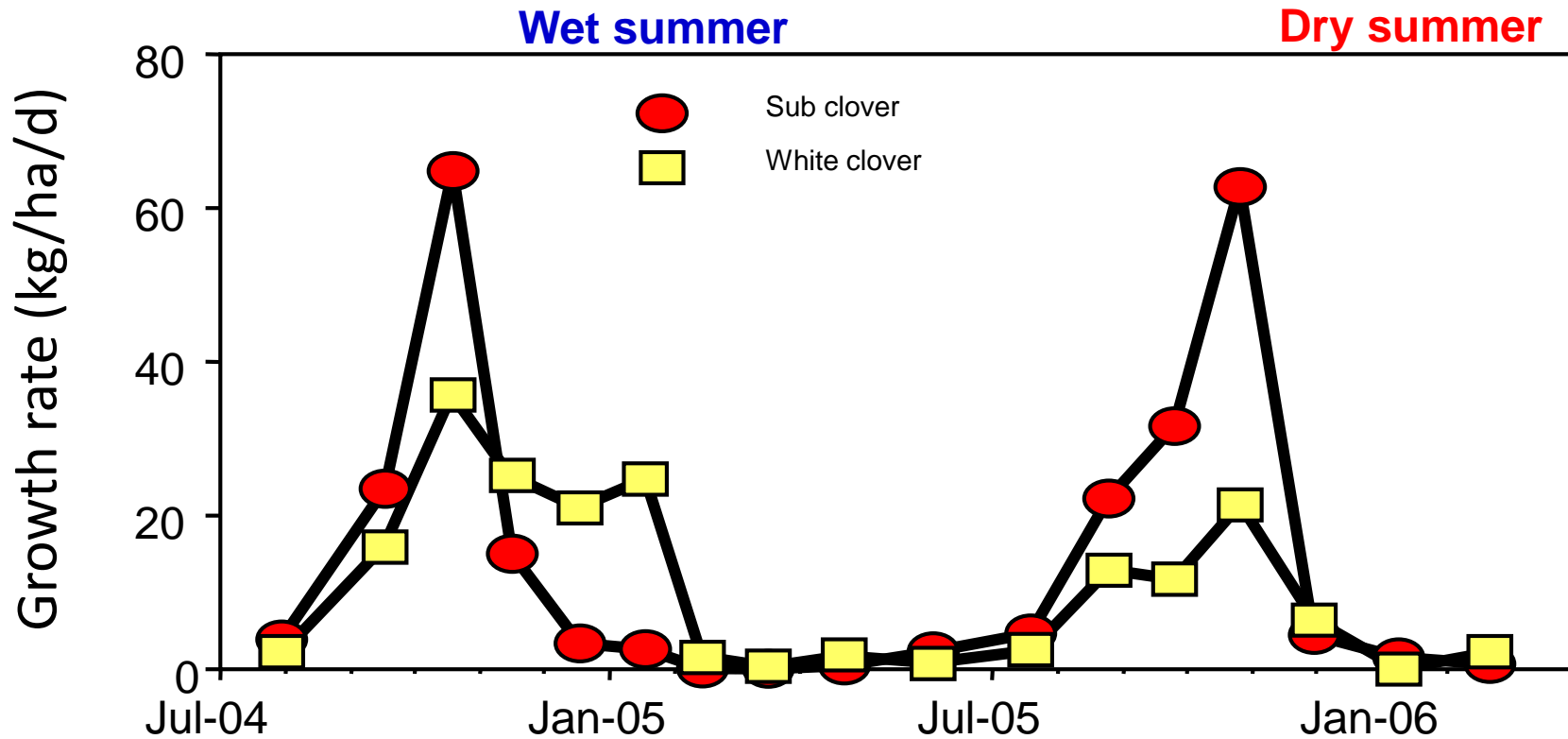
A large flock of sheep is grazing on a lush green hillside. The sheep are of various breeds, including some with thick wool and some that are smaller. The background shows rolling green hills and a valley with a town and mountains in the distance under a clear blue sky.

meat - wool - wine

Subterranean Clover



Seasonal clover growth



New Zealand's specialist land-based university

Uncultivated – grazing only – no seed...



Reap the benefits in the following years. You probably only need to repeat this every 10-15 years or so.



Photo: Jo Grigg
Tempello

Over 560 ha Tempello Corrie area



In poor price year with \$4.40/kg CW and \$1.80/kg store ...
\$40,000 ahead if lambs 7 kg heavier at weaning.

Tonnes meat from 60 to 76 tonnes despite fewer ewes.

New Zealand's specialist land-based university



01/10/2016

Photo: Doug Avery
Bonavaree

N deficient North Island Hill Country!



Photo: D. J. Moor
Lincoln University

New Zealand's specialist land-based university





Photos: DJ Moot
Lincoln University



Direct drilled during the drought autumn 2017

Inverary Station

- Aerial No til = Low carbon footprint
- N to break down thatch (40:1 C:N ratio)
- Minimal Risk of N leaching from hills
- High rainfall – red + white clover – no herbs



Photo: Paul Muir
On Farm Research

Legume/herb mixes for hill country – spray and delay
New Zealand's specialist land-based university



Photo: D. J. Moot
Lincoln University

Port Hills - what happened?

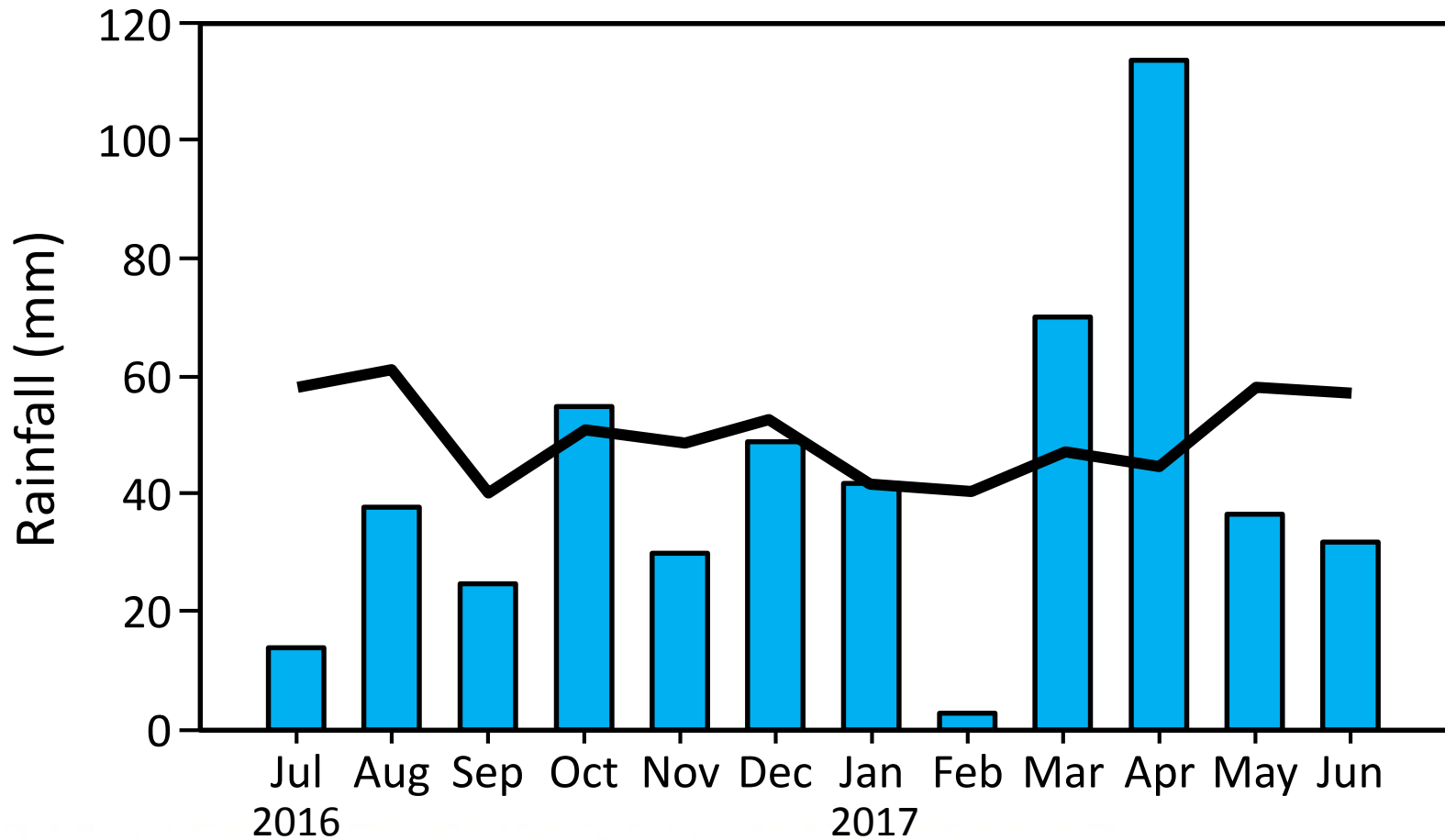
- 1645 ha of land burnt
- Native and exotic forest, 11 houses
- Fencing, stock water, yards
- Gorse blocks highly flammable – 40 years old
- Erosion risk from bare ground
- Peri urban – multiple land owners
- No single entity to deal with recovery
- Contacted on 20/2/2017 for advice

New Zealand's specialist land-based university

Wet spring followed by < 10 mm of rain in Feb



Rainfall (Jul 2016 –Jun 2017)



New Zealand's specialist land-based university



Photo: Derrick Moot
Lincoln University
9/3/2017



New Zealand's specialist land-based university

Photo: Derrick Moot
Lincoln University
9/3/2017



Photo: Derrick Moot
Lincoln University
9/3/2017



New Zealand's specialist land-based university

Photo: Derrick Moot
Lincoln University
9/3/2017



New Zealand's specialist land-based university

Photo: Derrick Moot
Lincoln University
9/3/2017



New Zealand's specialist land-based university


Photo: Derrick Moot
Lincoln University
9/3/2017



Photo: Derrick Moot
Lincoln University



Photo: Derrick Moot
Lincoln University
17/3/2017



Burnt pasture area

Burnt gorse area



New Zealand's specialist land-based university

Photo: Derrick Moot
Lincoln University
17/3/2017

35 mm of rain on 12/13 March 2017



Photo: Derrick Moot
Lincoln University
17/3/2017



New Zealand's specialist land-based university

Photo: Derrick Moot
Lincoln University
17/3/2017

Californian thistle



Photo: Derrick Moot
Lincoln University
21/03/17

Photo: Derrick Moot
Lincoln University
21/03/17

Yarrow





Photo: Derrick Moot
Lincoln University
21/03/17







Photo: D.J. Moot
Lincoln University



Photo: D.J. Moot
Lincoln University

No ground cover in ex gorse areas -



Photo: D.J. Moot
Lincoln University



Photo: D.J. Moot
Lincoln University



Photo: D.J. Moot
Lincoln University

New Zealand's specialist land-based university

Photo: Derrick Moot
Lincoln University
17/3/2017





10 kg Italian ryegrass
5 kg perennial ryegrass
5 kg sub clover
2 kg cocksfoot



Photo: D.J. Moot
Lincoln University

New Zealand's specialist land-based university

Photo: Derrick Moot
Lincoln University
17/3/2017



Photo: D.J. Moot
Lincoln University

21/3/17 – recovering pasture – no fences

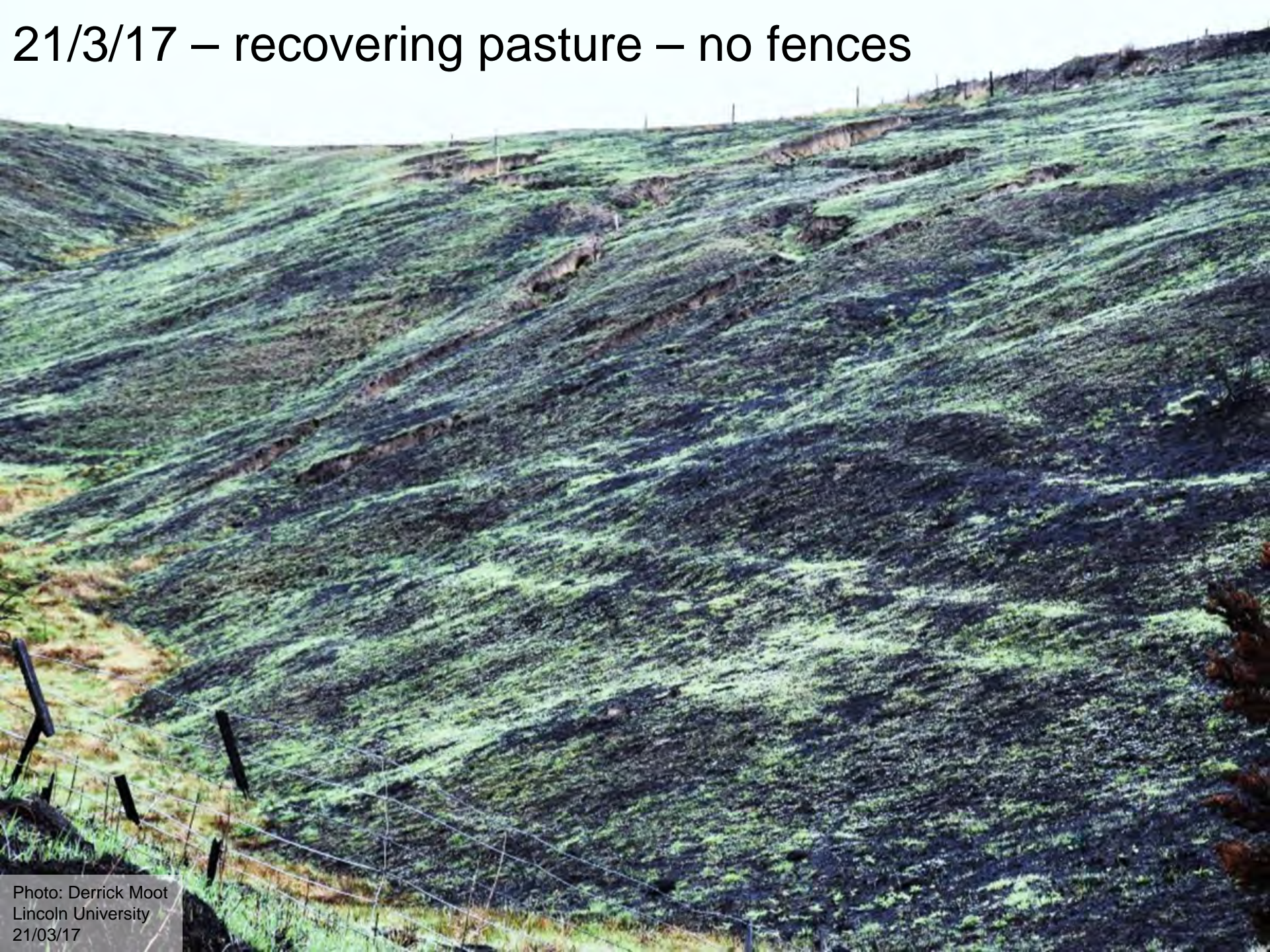


Photo: Derrick Moot
Lincoln University
21/03/17



650 sub clover seedlings/m²



Gorse seedlings ~100/m² emerging 21 March 2017



Photo: D.J. Moot
Lincoln University

29 March 2017

70 mm of April rainfall and warm autumn days



Photo: D.J. Moot
Lincoln University

21 April 2017



Photo: D.J. Meof,
Lincoln University

21 April 2017



Photo: D.J. Moot
Lincoln University

21 April 2017



Photo: D.J. Moot
Lincoln University

21 April 2017 – South Face - oversown



Photo: D.J. Moot
Lincoln University

21 April 2017 – 350 Italian ryegrass seedlings/m²



Photo: D.J. Moot
Lincoln University

21 April 2017 plus and minus oversowing



Photo: D.J. Moot
Lincoln University

21 April 2017 – 650 seedlings/m²



Burnt Pasture recovering – sub clover no seed

Photo: D.J. Moot
Lincoln University

29 August 2017





Photo: D.J. Moot
Lincoln University

Gorse gully on 29 August 2017 –South slope



Photo: D. J. Moot
Lincoln University

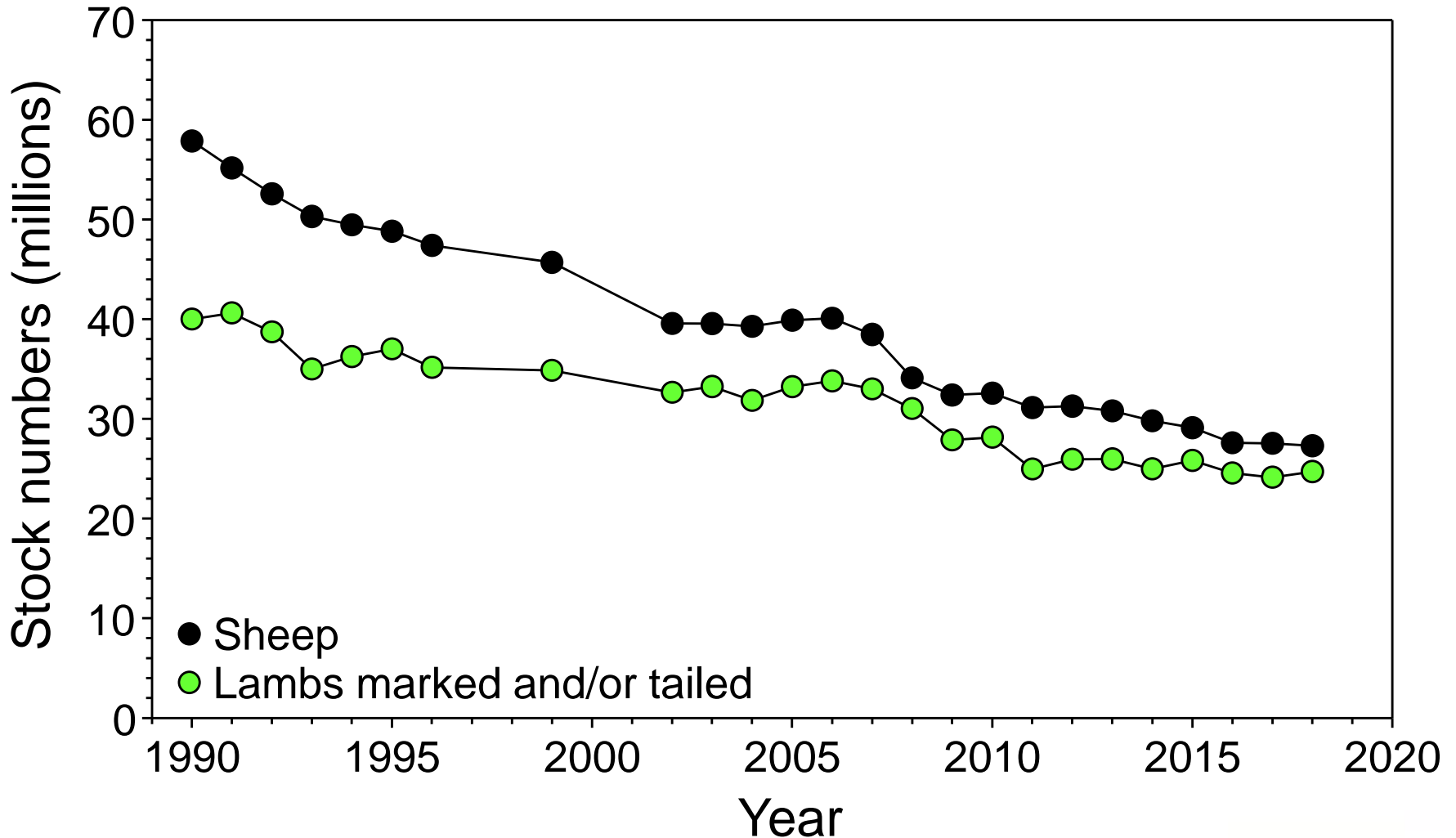
Gorse gully on 29 August 2017 –South slope

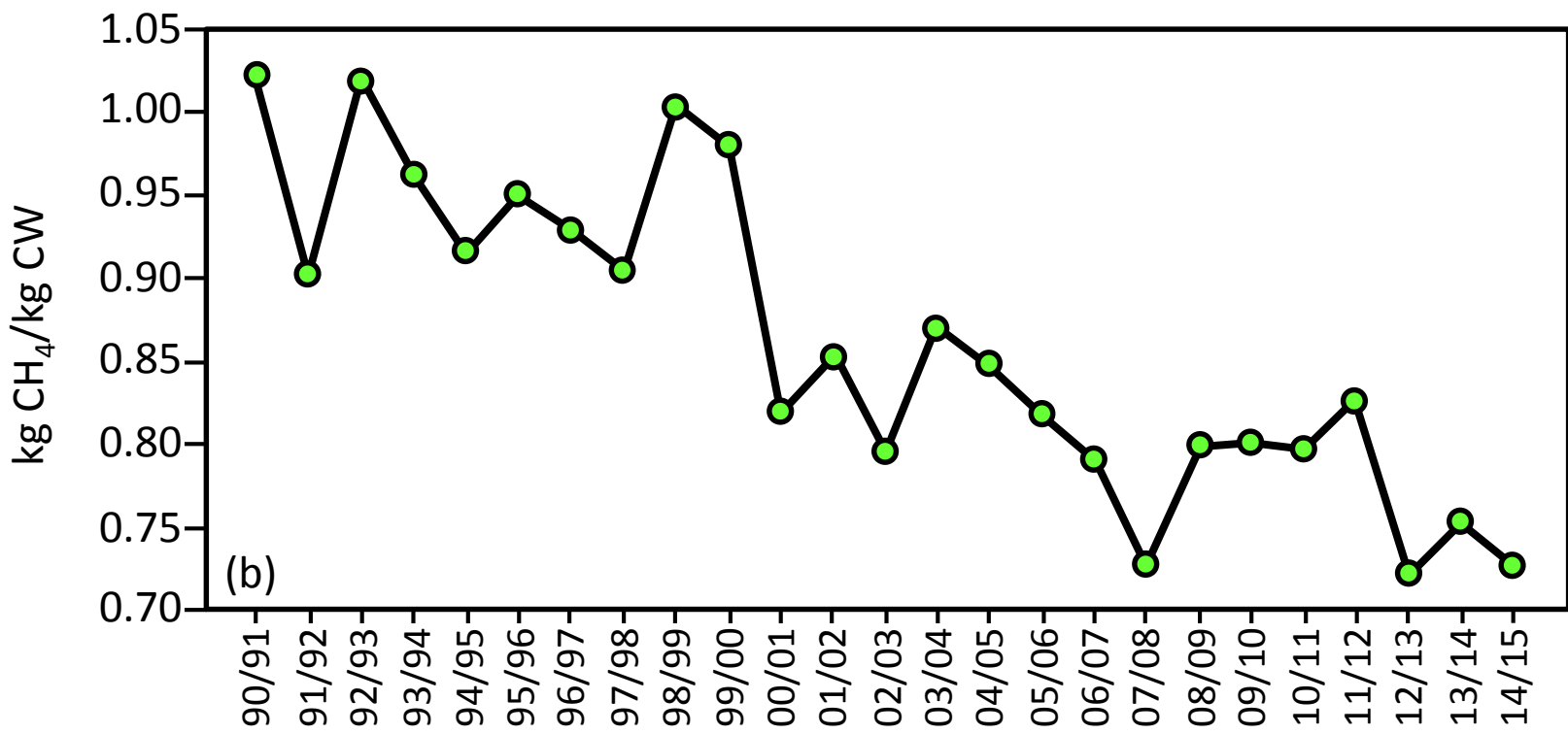
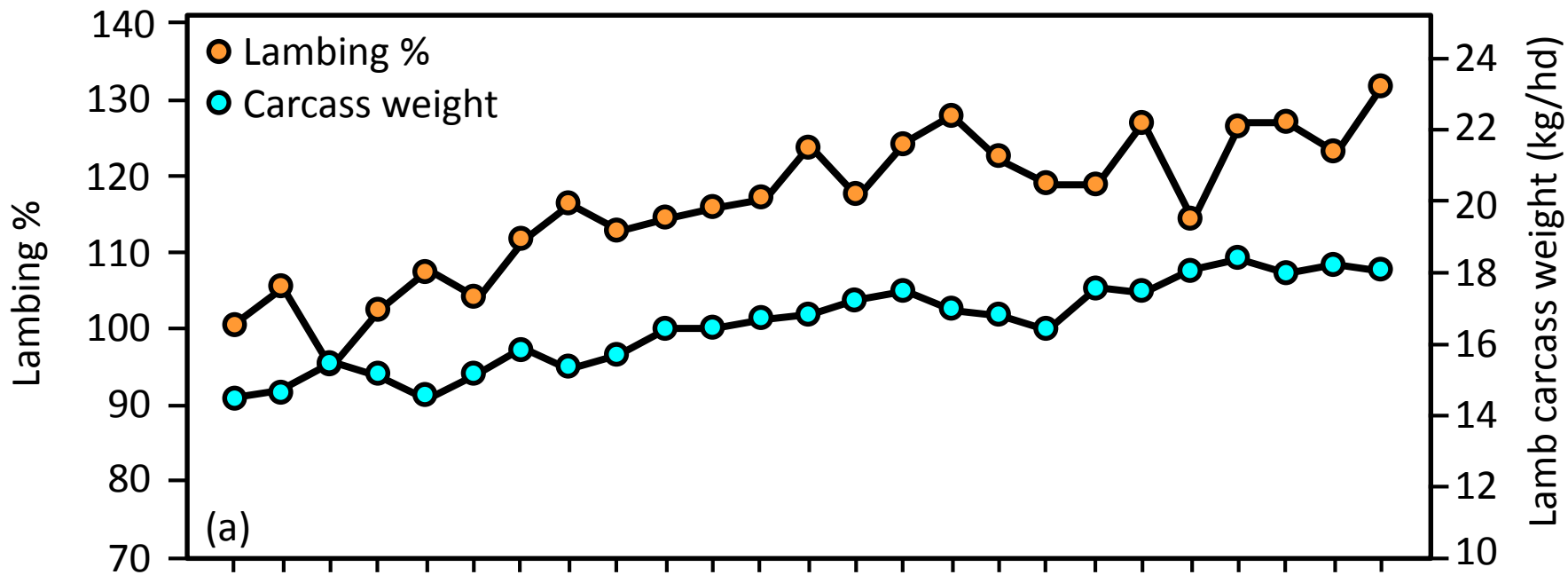


Photo: D.J. Moot
Lincoln University

Gorse gully on 29 August 2017 –South slope

Sheep numbers in New Zealand





Dryland Conclusions

- Nitrogen drives animal and plant production
- Nitrogen from legumes can transform dryland farms
- Climate change = greater risk of fire
- Burnt pasture regenerated with no intervention
- Sub clover seed regenerated in large numbers
- Gorse seedlings suppressed by Italian ryegrass
- Sheep has a low GHG footprint

References



- Bonoma, T. V. 1985. Case research in Marketing: Opportunities, problems and a process. *Journal of Marketing Research*, **22**, 199-208.
- Brown, H.E., Moot, D.J., Lucas, R.J. and Smith, M., 2006. Sub clover, cocksfoot and lucerne combine to improve dryland stock production. *Proceedings of the New Zealand Grassland Association*, **68**: 109-115.
- Kerr, P., 2010. [400 plus - a guide to improved lamb growth](#). New Zealand Sheep Council in association with WoolPro and Meat New Zealand. 107 pp.
- Ledgard, S.F., 2017. Assessing the environmental impact of sheep production. In: J. Greyling (Editor), *Achieving sustainable production of sheep*. Burleigh Dodds Science Publishing Limited, Cambridge, United Kingdom, pp. 407-430.
- Lucas, R. J., Smith, M. C., Jarvis, P., Mills, A. and Moot, D. J. 2010. Nitrogen fixation by subterranean and white clovers in dryland cocksfoot pastures. *Proceedings of the New Zealand Grassland Association*, **72**, 141-146.
- Merton, R.K. 1942. The normative structure of science. In: R.K. Merton (ed.). *The sociology of science: Theoretical and empirical investigations*. University of Chicago Press. ISBN 978-0-226-52091-9, OCLC 755754.
- Mills, A. 2007. Understanding constraints to cocksfoot (*Dactylis glomerata* L.) based pasture production, PhD thesis, Lincoln University, Canterbury. Online access: http://researcharchive.lincoln.ac.nz/dspace/bitstream/10182/32/1/mills_phd.pdf. 202 pp.
- Mills, A., Moot, D. J. and Jamieson, P. D. 2009. Quantifying the effect of nitrogen of productivity of cocksfoot (*Dactylis glomerata* L.) pastures. *European Journal of Agronomy*, **30**, 63-69.
- 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.
- Moot, D. J., Anderson, D., Anderson, L. and Pollock, K. M. 2018. Problems and solutions for High Country sheep farmers in New Zealand. *Proceedings of the XVe European Society for Agronomy Congress. Geneva, Switzerland: August 27-31 2018. Abstract book: PS-9.3-02. p 82.*
- Moot, D.J., Anderson, P.V.A., Anderson, L.J. and Anderson, D.K., 2019. Animal performance changes over 11 years after implementing a lucerne grazing system on Bog Roy Station. *Journal of New Zealand Grasslands*, **81**: XXX-XXX.
- Moot, D. J. and Avery, D. 2013. Sustainable intensification of livestock grazing systems in low rainfall regions of New Zealand. *First International Conference on Global Food Security*, O3.O3 (4 pgs).
- 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*. Christchurch: New Zealand Grassland Association, 201-208.
- Moot, D. J. and Smith, M. Practical Lucerne Management Guide. Date Accessed: 6/8/2019. <http://dotnetrest.lincoln.ac.nz/O365flowClient/cache/sites/www-content/Lincoln%20WWW/Documents/DPR/Field-Day-Handouts/2011/Lucerne-management-guide-Col.pdf>
- Statistics New Zealand. 2018. InfoShare: Variable by Regional Council. Stats NZ, Wellington. Online: <http://archive.stats.govt.nz/infoshare/SelectVariables.aspx?pxID=42e35cfd-dcc5-45ed-864a-cc7e261146fd>. Date Accessed: Various.