



**Lincoln
University**

Te Whare Wānaka o Aoraki

AOTEAROA • NEW ZEALAND



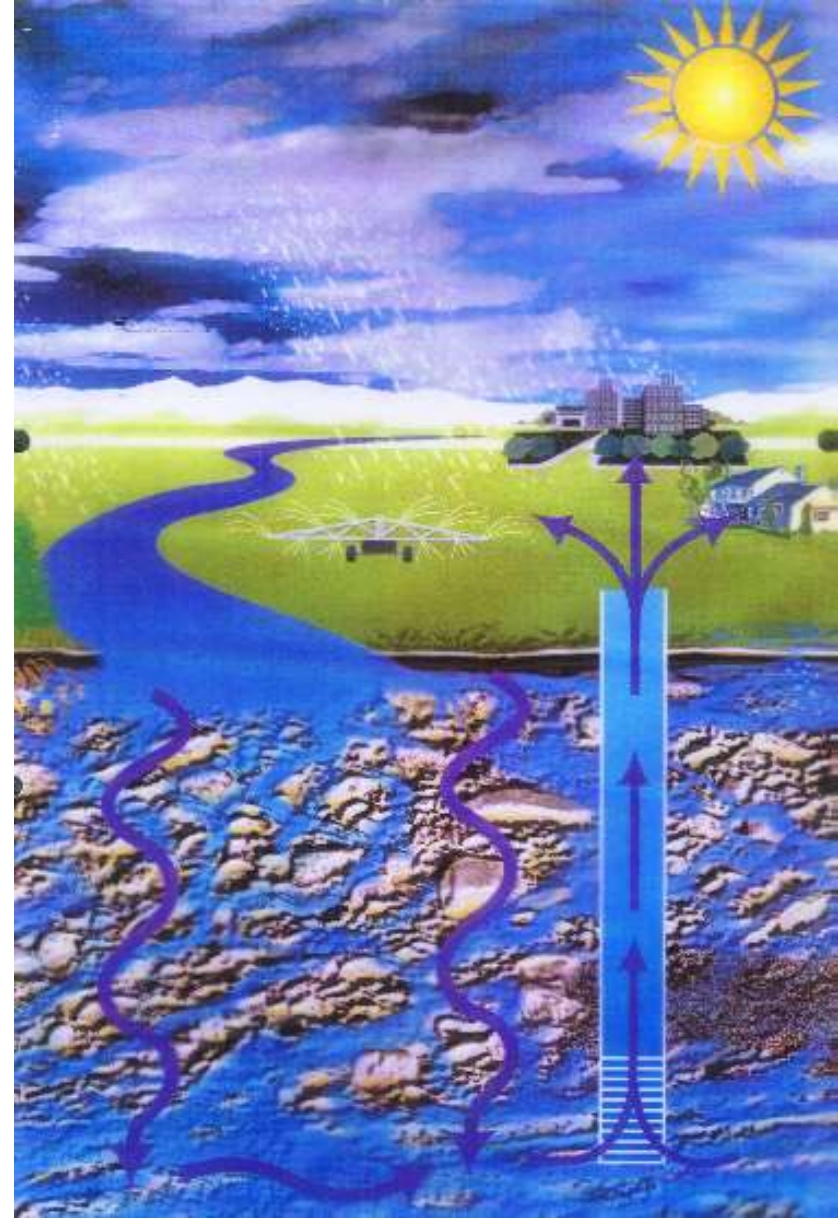
What Soils and What Farming Activities are Leaching Hotspots and Why?

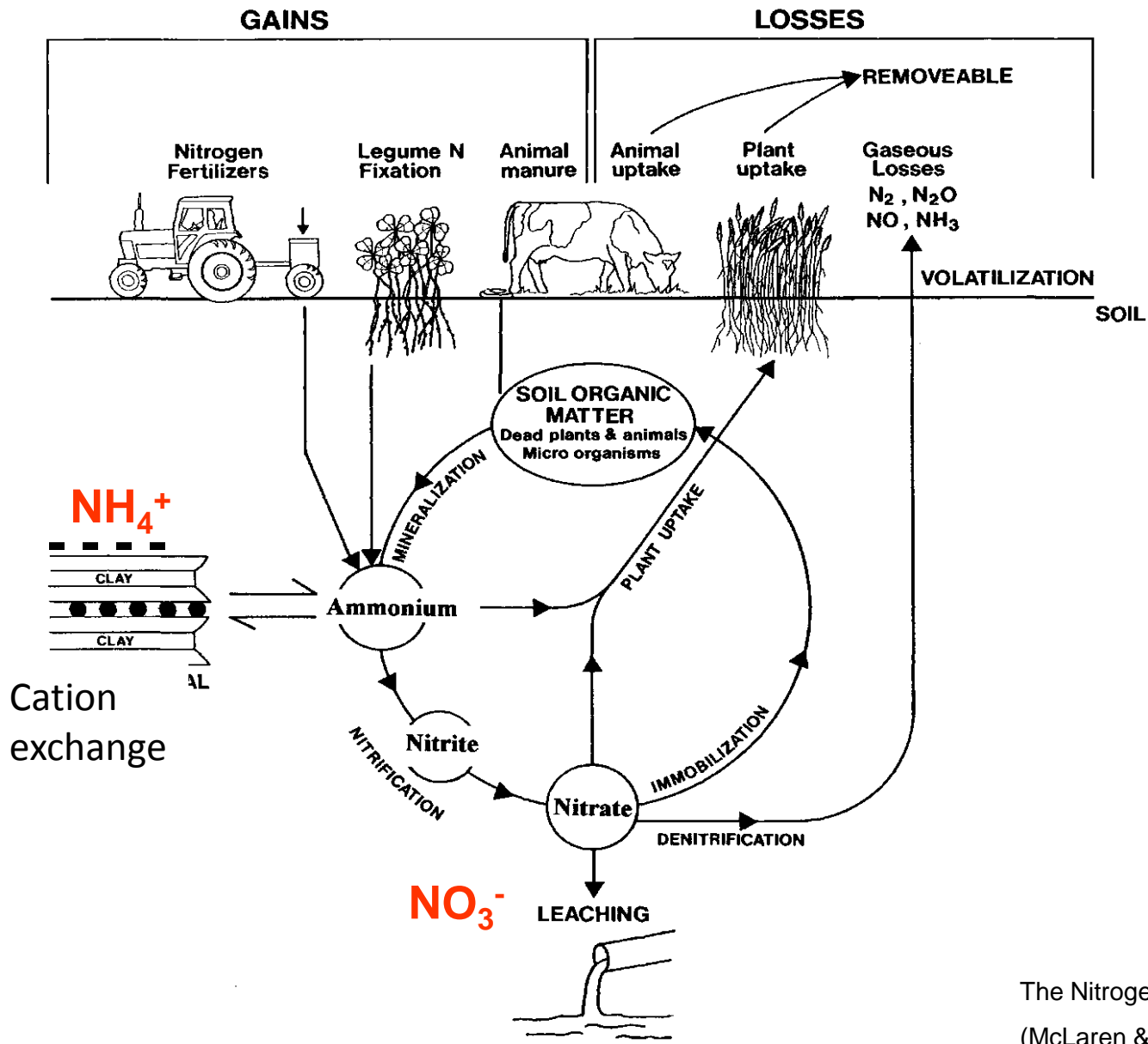
Keith Cameron and Hong Di
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Lincoln University

New Zealand's specialist land-based university

Nitrate (NO_3^-) leaching :

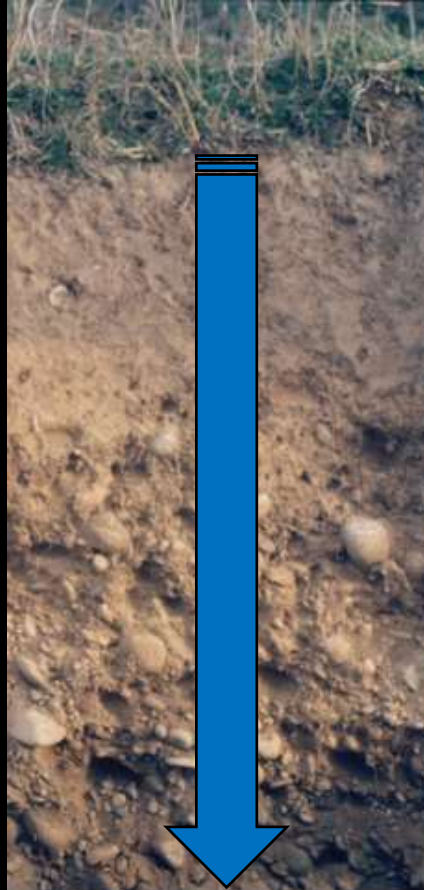
- Risk to drinking water;
- Can cause surface water eutrophication (aquatic weeds)





The Nitrogen Cycle
(McLaren & Cameron, 1996)

Nitrate is not held by soil and leaches easily



Key factors that affect leaching from soil

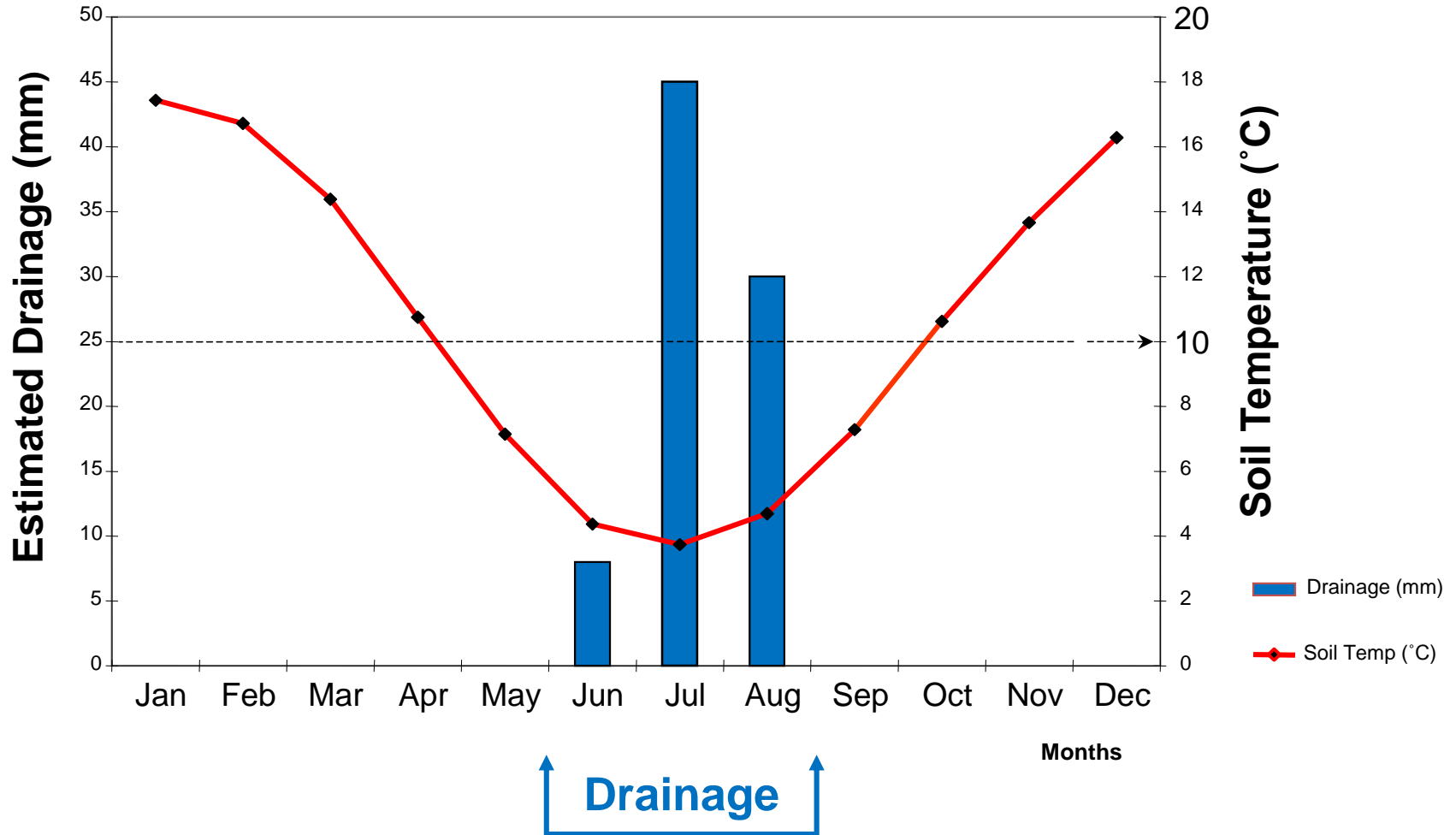
- **Rainfall & drainage**
- **Soil type and depth**
- **Land use**
- **Fertiliser rate and timing**
- **Effluent rate and timing**
- **Irrigation**
- **Plant uptake**
- **Stocking rate**

Rainfall & Drainage

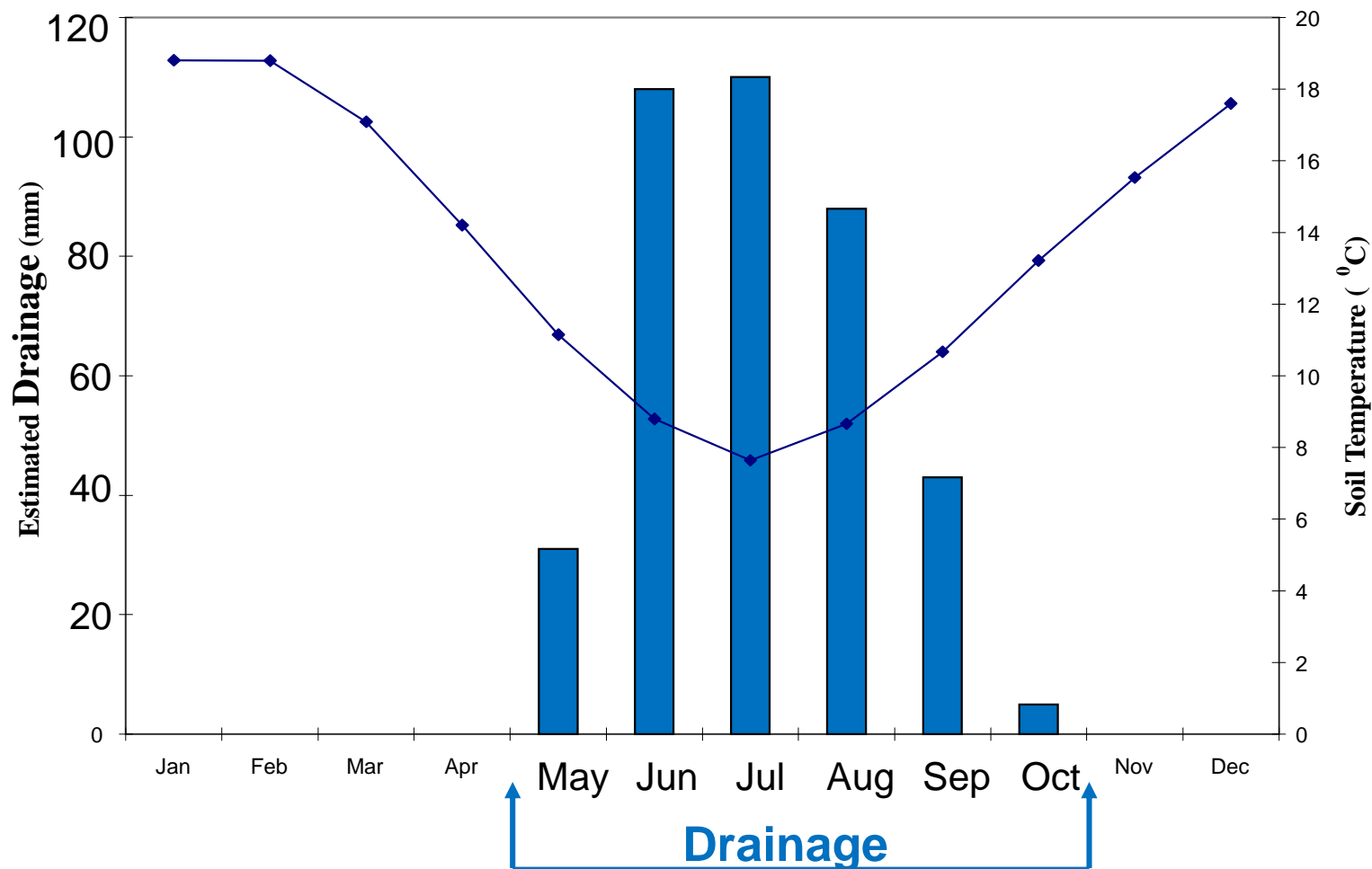
Most leaching occurs in winter & early spring

CHRISTCHURCH:

Mean soil temperature (at 10cm) & estimated drainage (mm)



HAMILTON



Soil type affects nitrate leaching loss



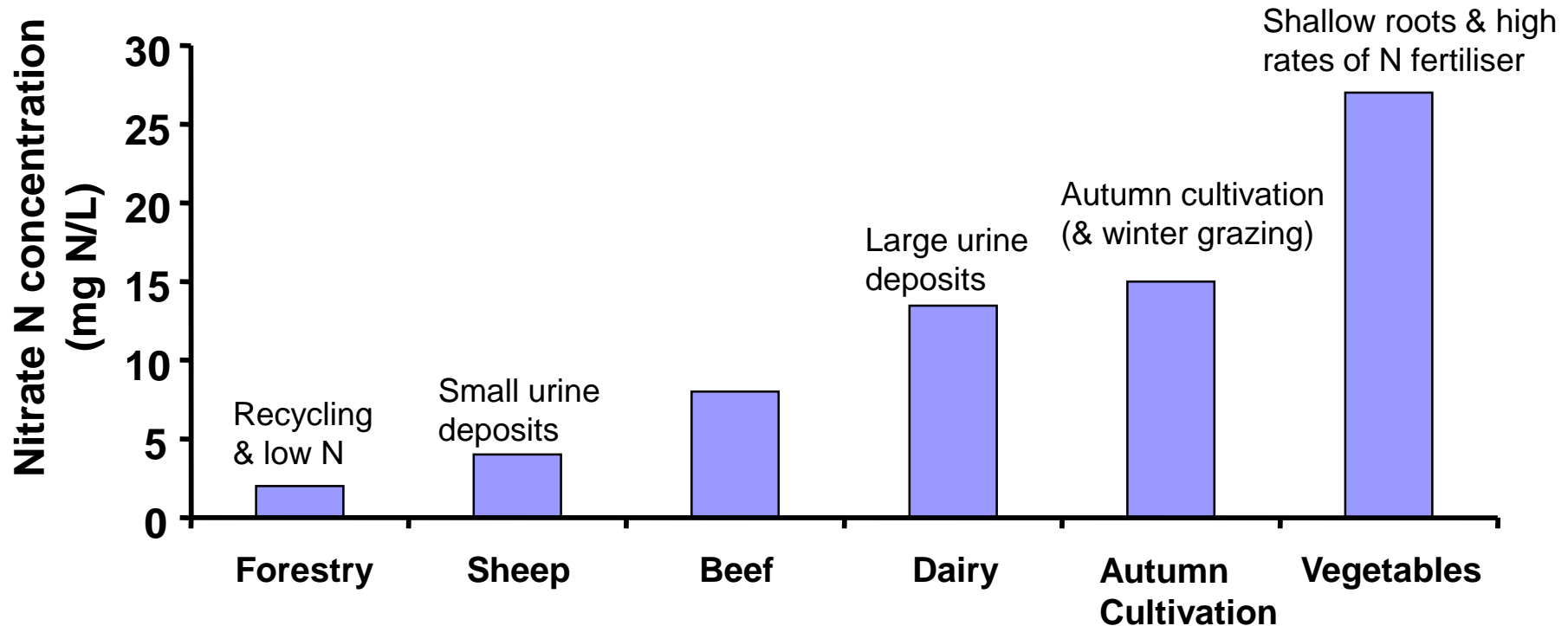
**Fast draining shallow
stony Lismore soil**



**Slow draining deep
Wakanui silt loam**

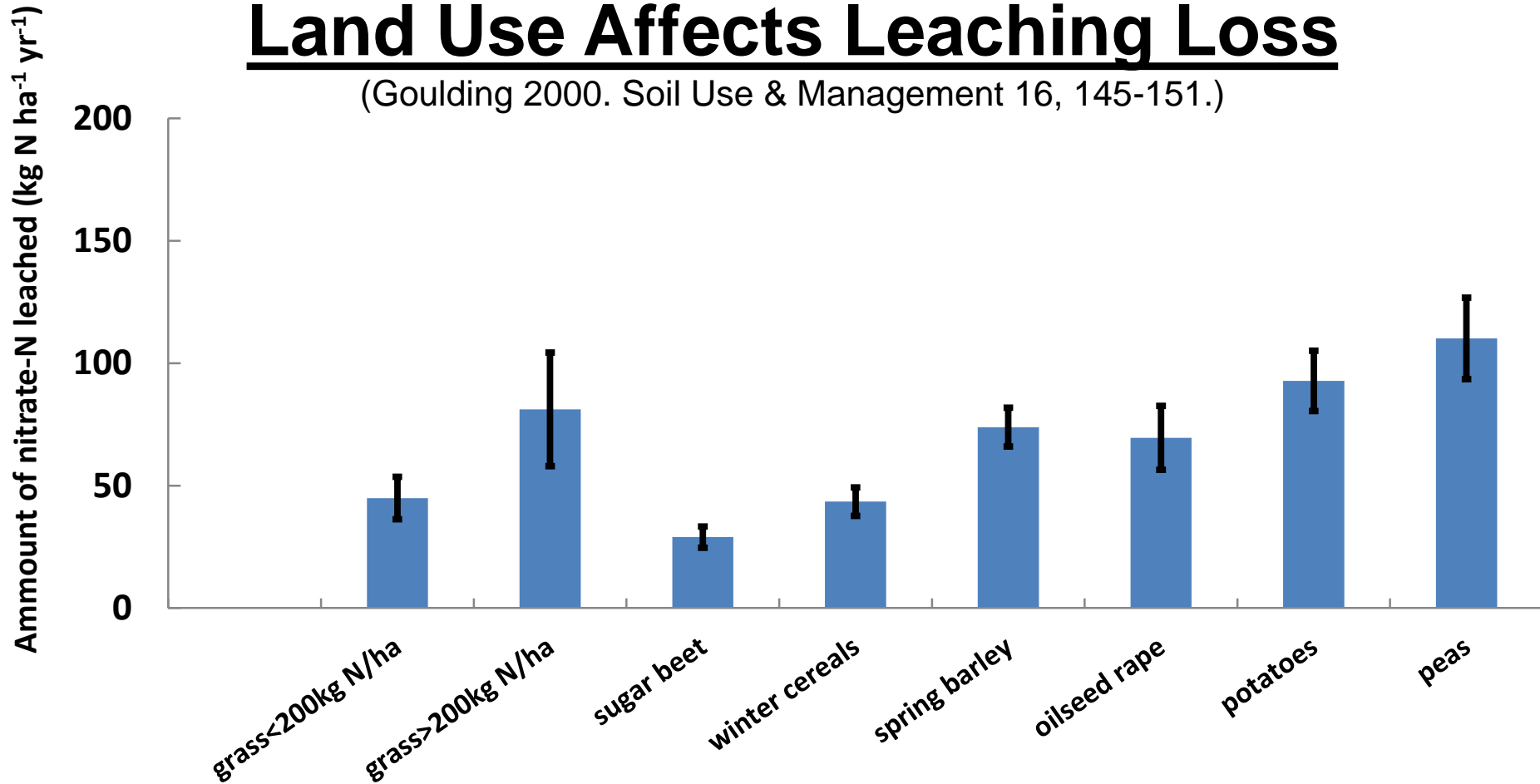
Land Use Affects Leaching Loss

(Di et al. 2005. *Mgmt of Enviro. Quality* 16.)



Land Use Affects Leaching Loss

(Goulding 2000. Soil Use & Management 16, 145-151.)



Nitrate leached, mean (■, and standard error, I) from arable crops and grass growing in the Pilot NSAs under 'good nitrate practice', i.e. no more fertilizer than necessary for the economic optimum yield .

In grazed pastures urine patches are the main sources of nitrate leaching



700 kg N/ha in urine patch

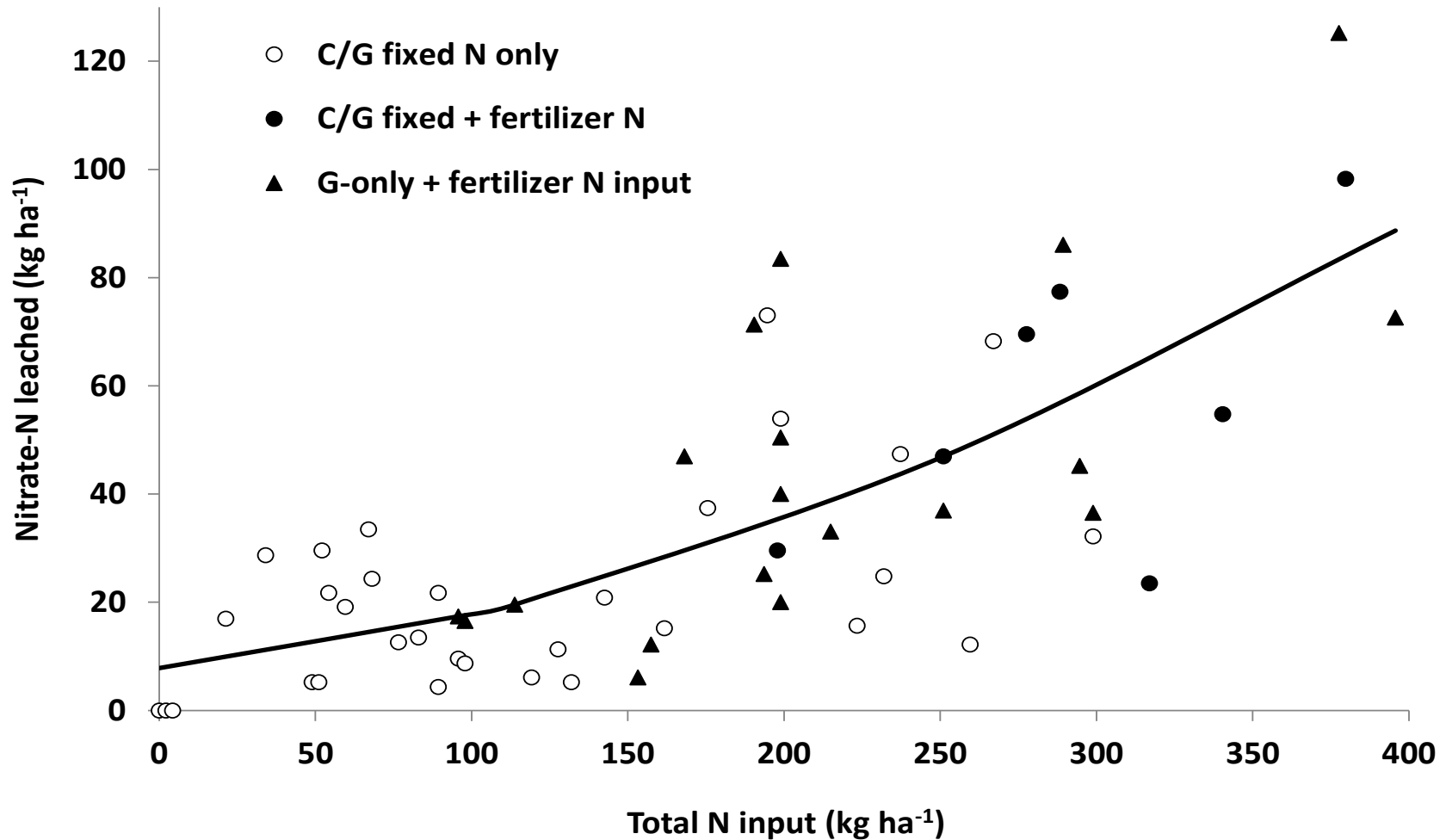
**Urea fertiliser only applied at
30 kg N/ha**

Nappies for cows?

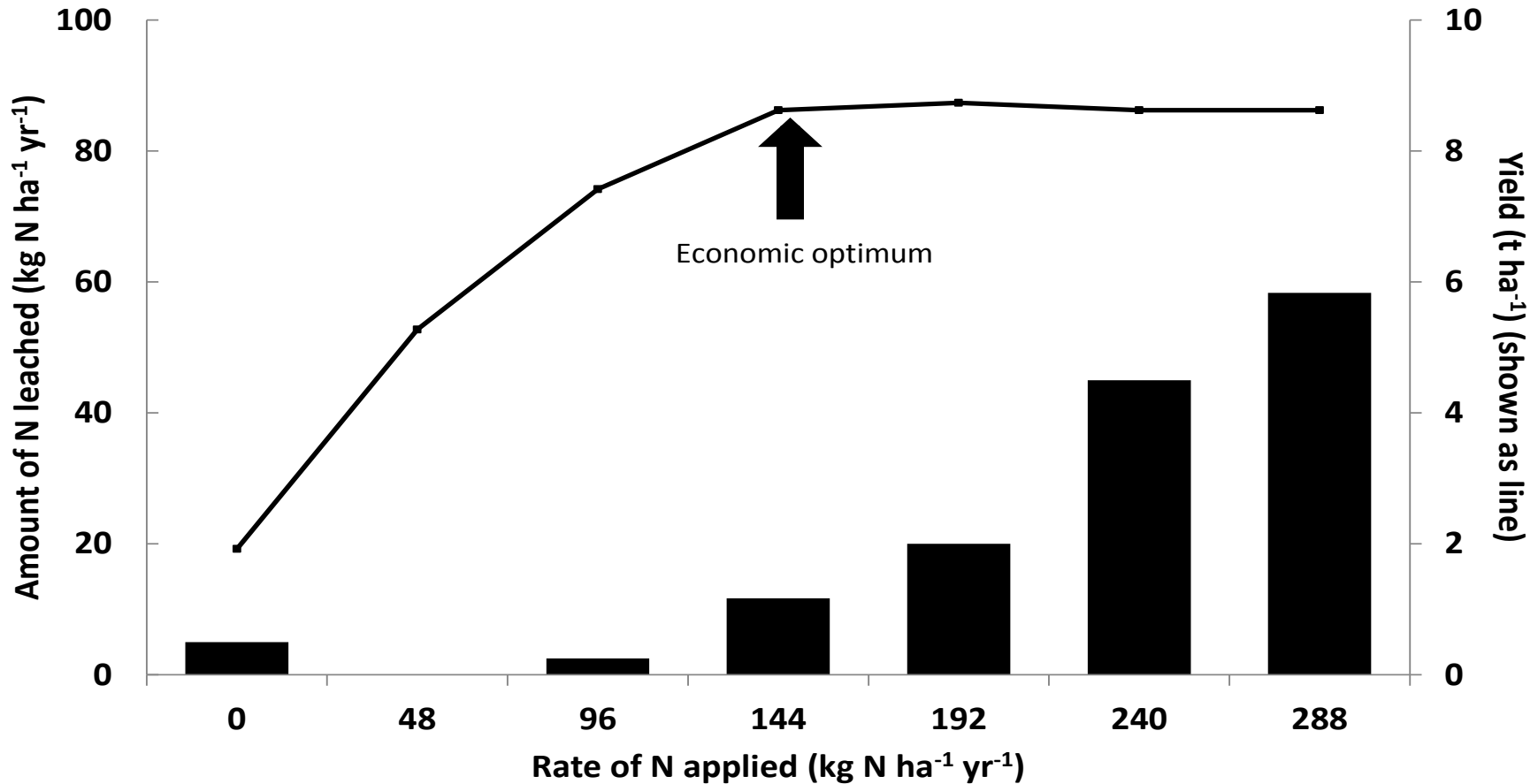


Total N Input on Pasture Affects Leaching Loss

(Ledgard et al, 2001 & 2009; Peoples et al. 2004)



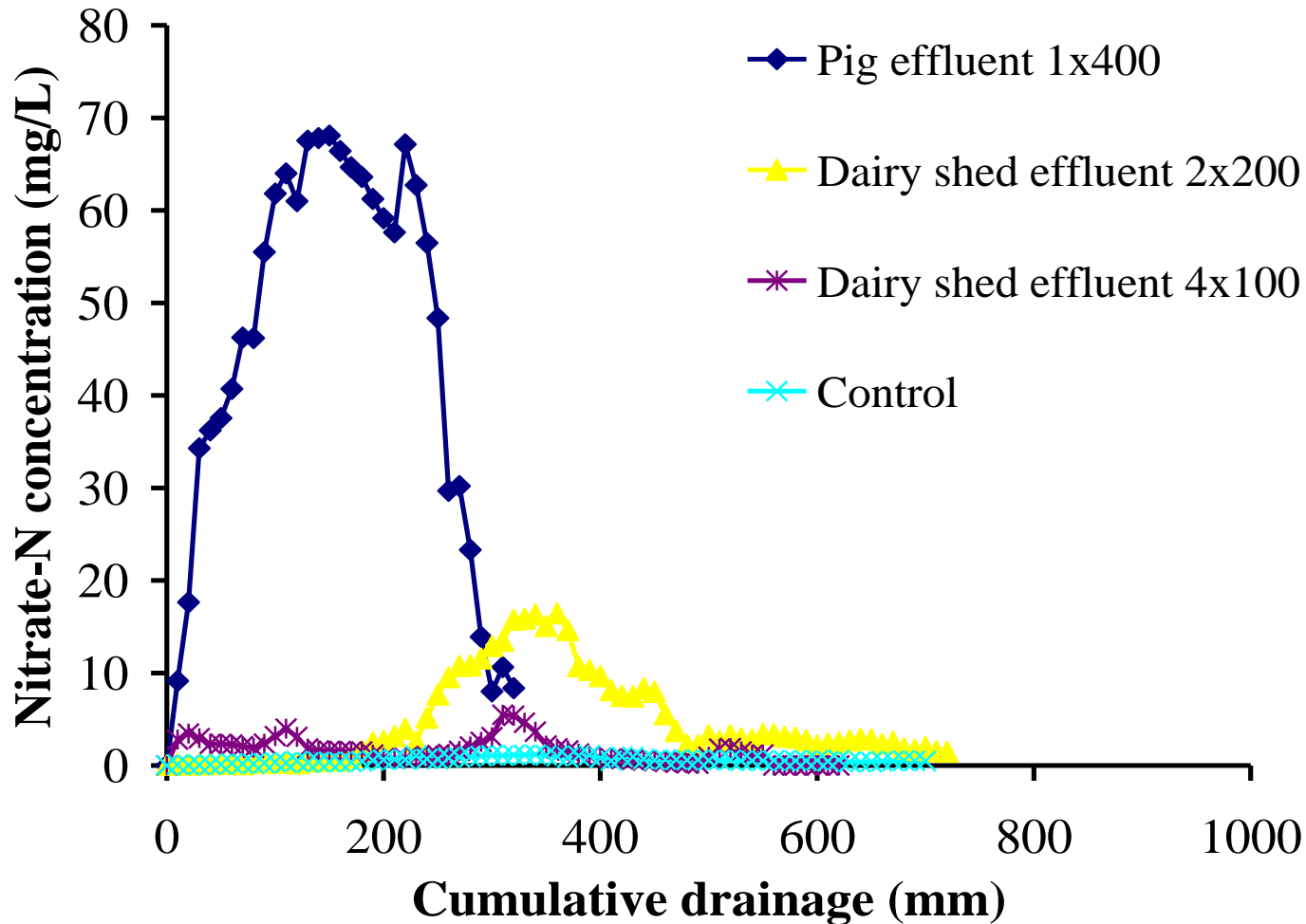
N Fertiliser Rate on Crop Affects Leaching Loss



Rothamsted (Broadbalk) winter wheat experimental plots with same N fertiliser treatments applied since 1843 (Goulding 2000)

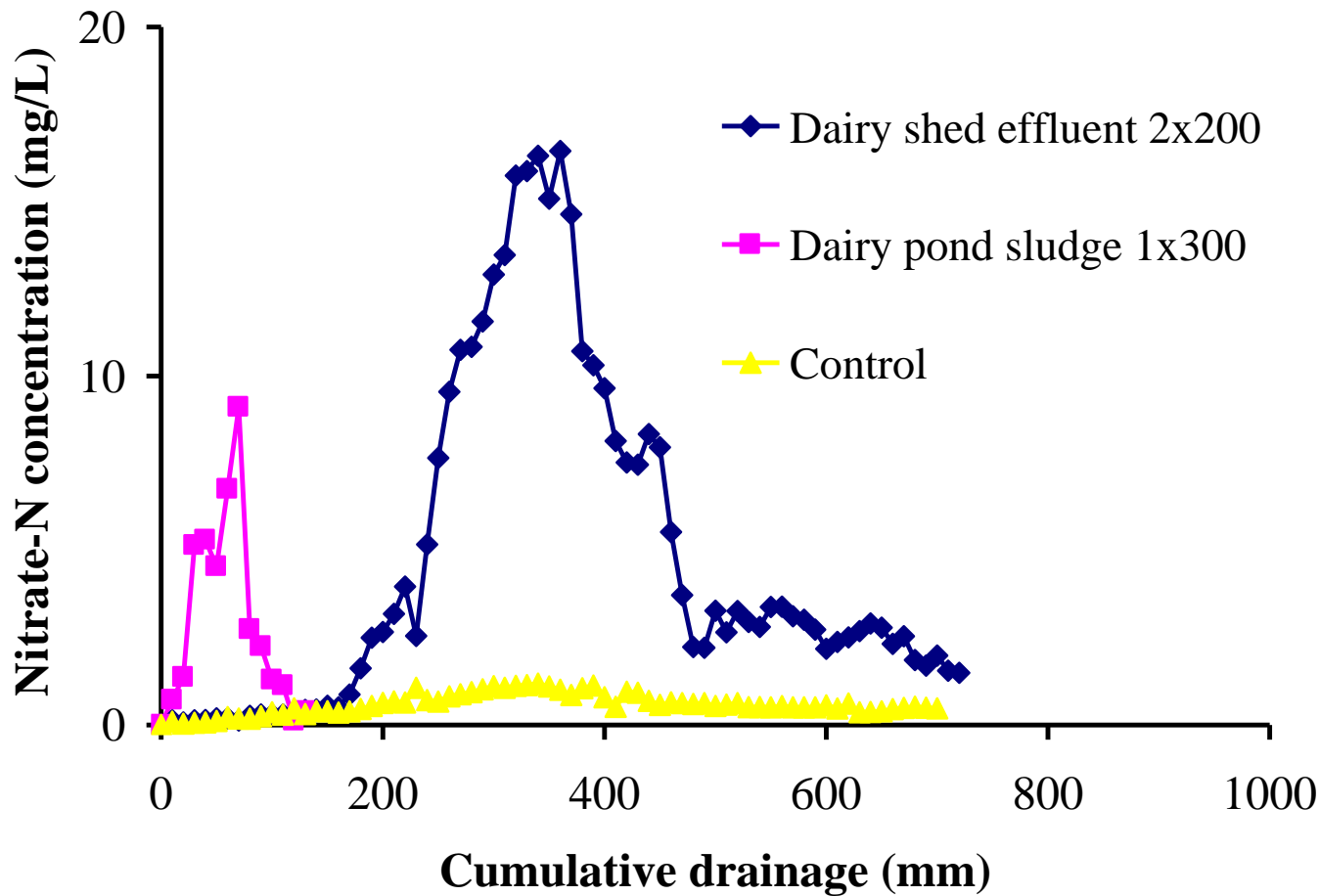
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Effluent Rate & Type Affects N Leaching Loss



(Cameron and Di, 2004)

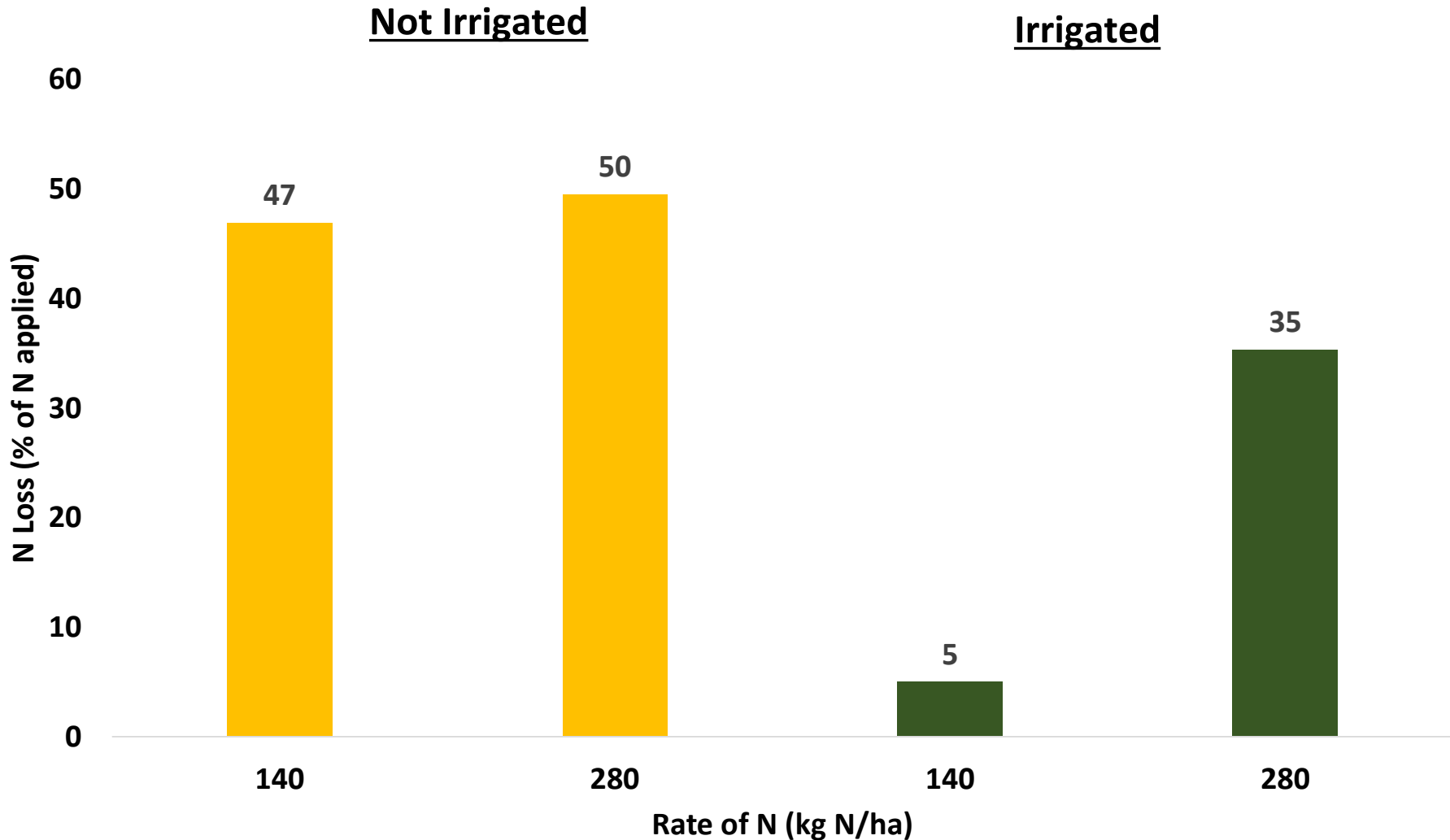
Effluent Rate & Type

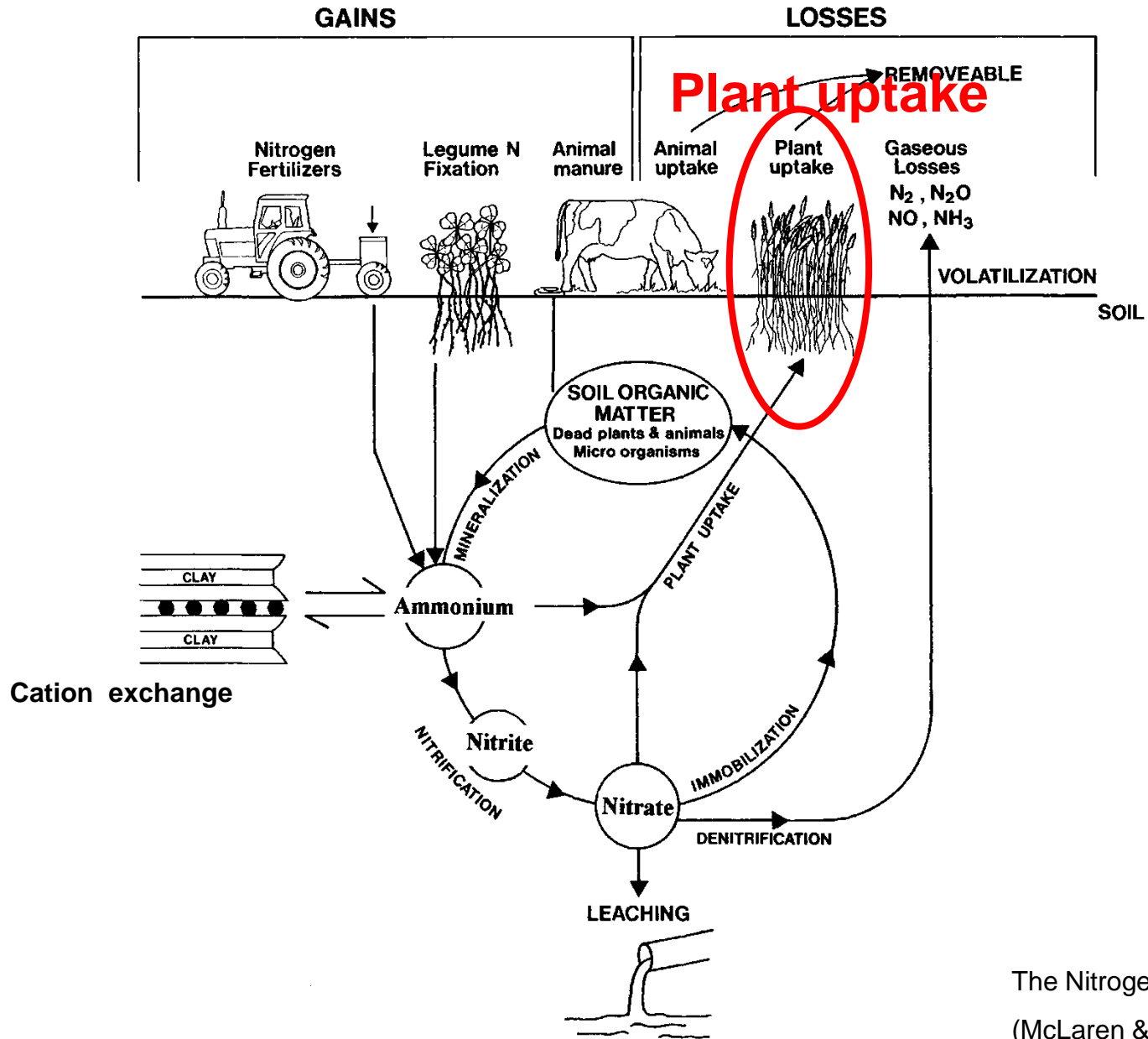


(Cameron and Di, 2004)

Irrigation can reduce N leaching losses

(Hahne et al. 1977, SSAJ 41, 562-567) (Continuous corn/maize)

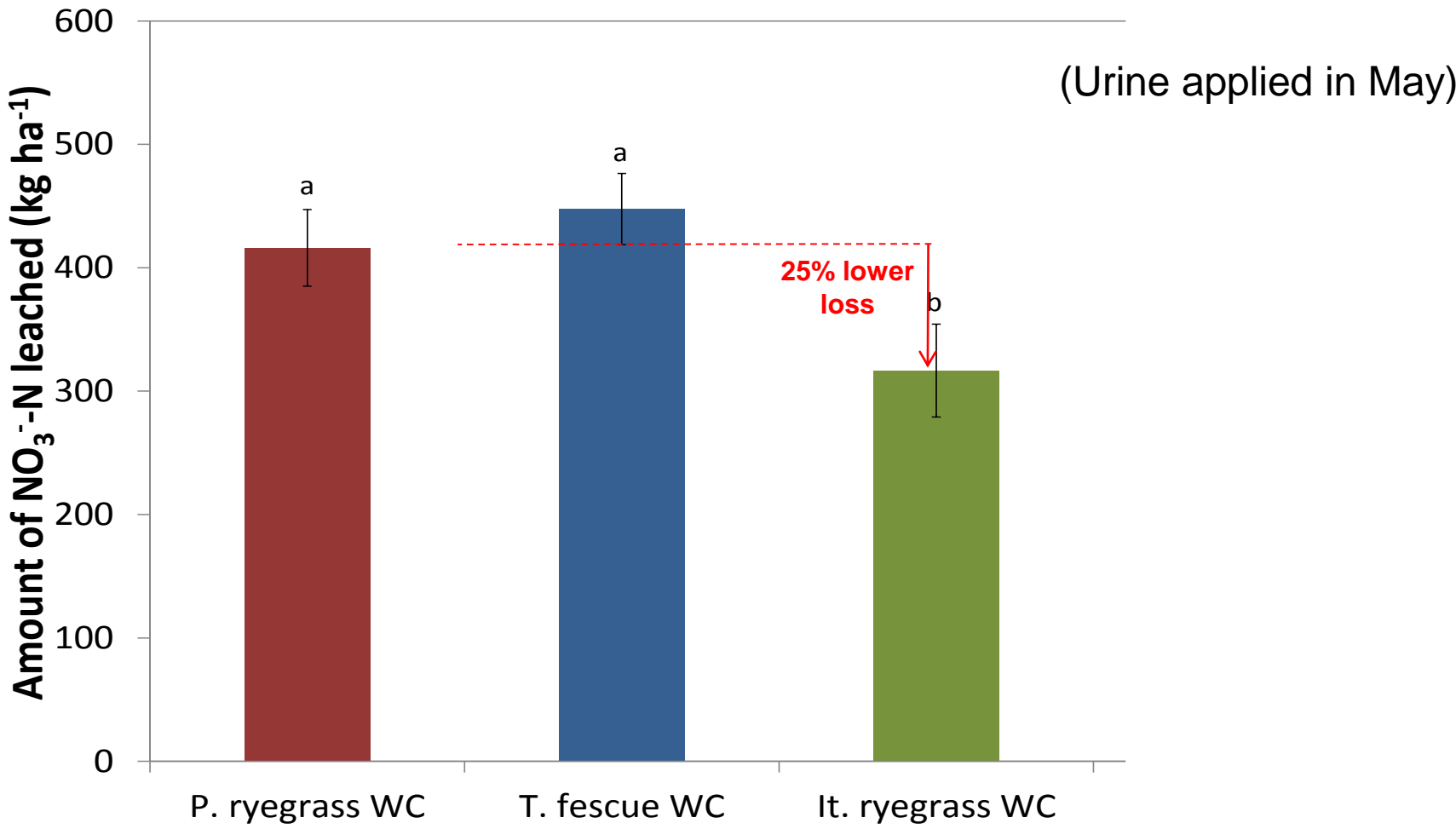




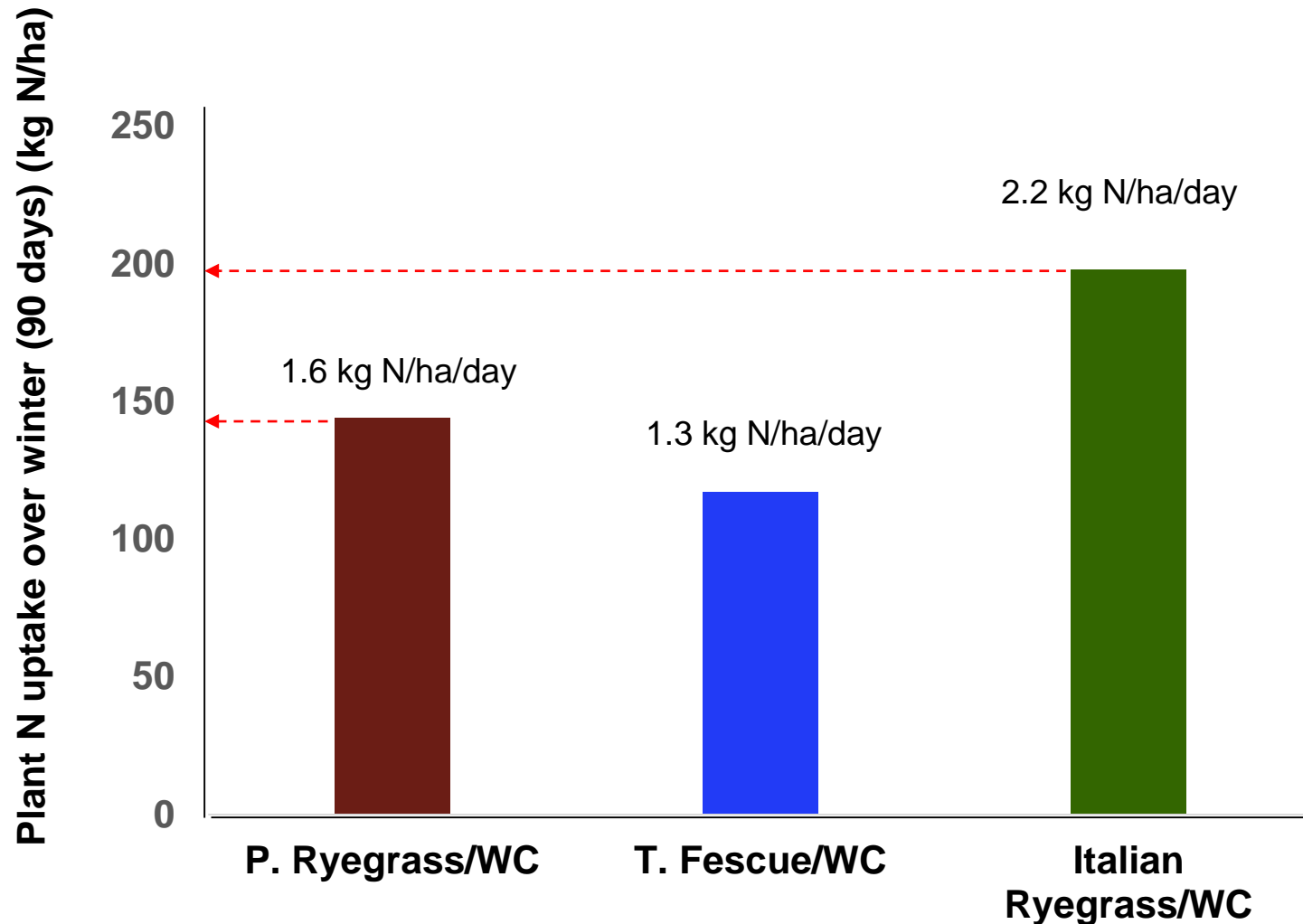
The Nitrogen Cycle
 (McLaren & Cameron, 1996)

Plant Uptake Can Reduce N Leaching

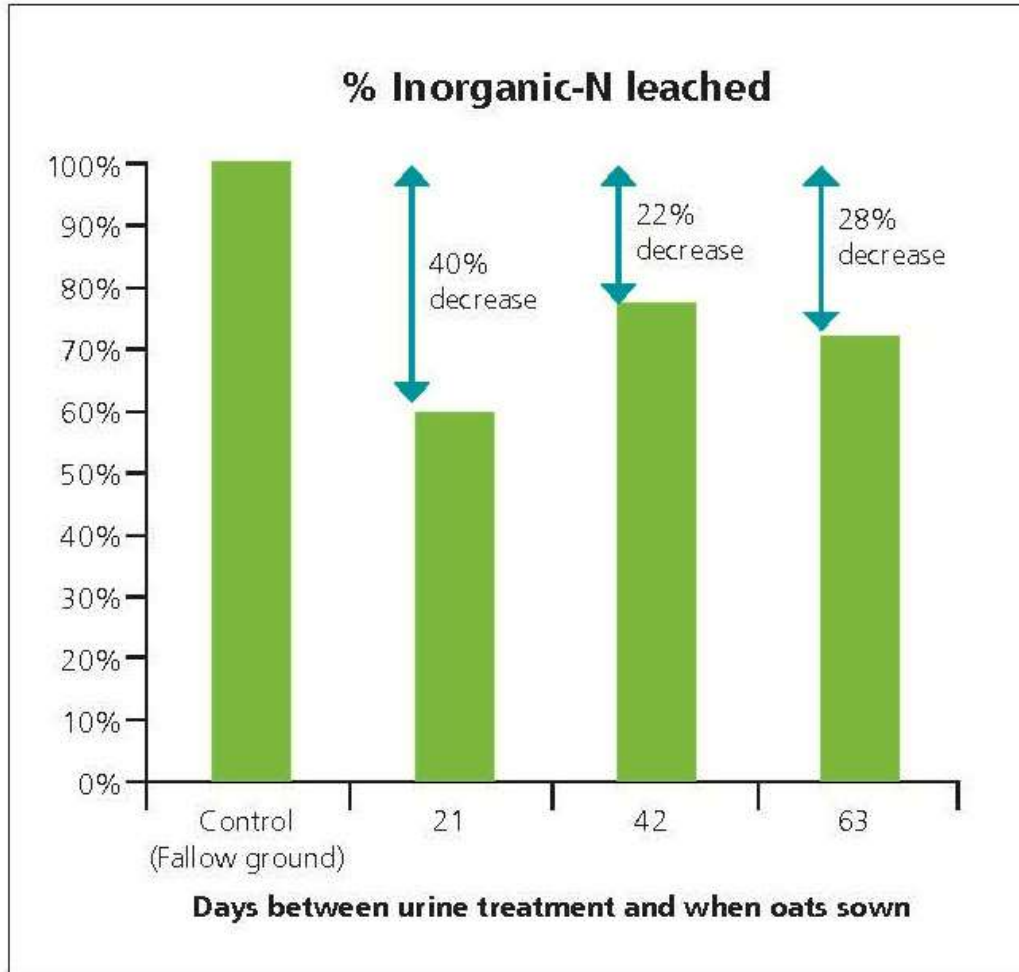
(Malcolm *et al.*, 2014. Soil Use & Management, 30, 58-68)



Plant N uptake rates in late-autumn & winter are important (Malcolm *et al.*, 2014)



'Catch crop' can reduce nitrate losses from winter forage crops



Recent work by Carey et al. (2016) has shown 40% reductions in nitrate leaching losses are possible.

Work funded by P21 investors (DairyNZ, Fonterra, Beef & LambNZ, DCANZ and MBIE)

Best Management Practices to Minimise Losses

- **Fertiliser and Effluent**– applied at rates and times to meet plant demand and avoid losses
- **Wintering** – sow a ‘catch crop’ of oats asap after grazing; or use a stand off pad?
- **Irrigation**- BMP irrigation can reduce the risk of leaching (by increasing N uptake)
- **Alternative pasture species** – some alternative species can reduce N excretion and/or increase plant uptake of N
- **Reduce stocking rate?**

Thank You



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