Solutions to Environmental Challenges

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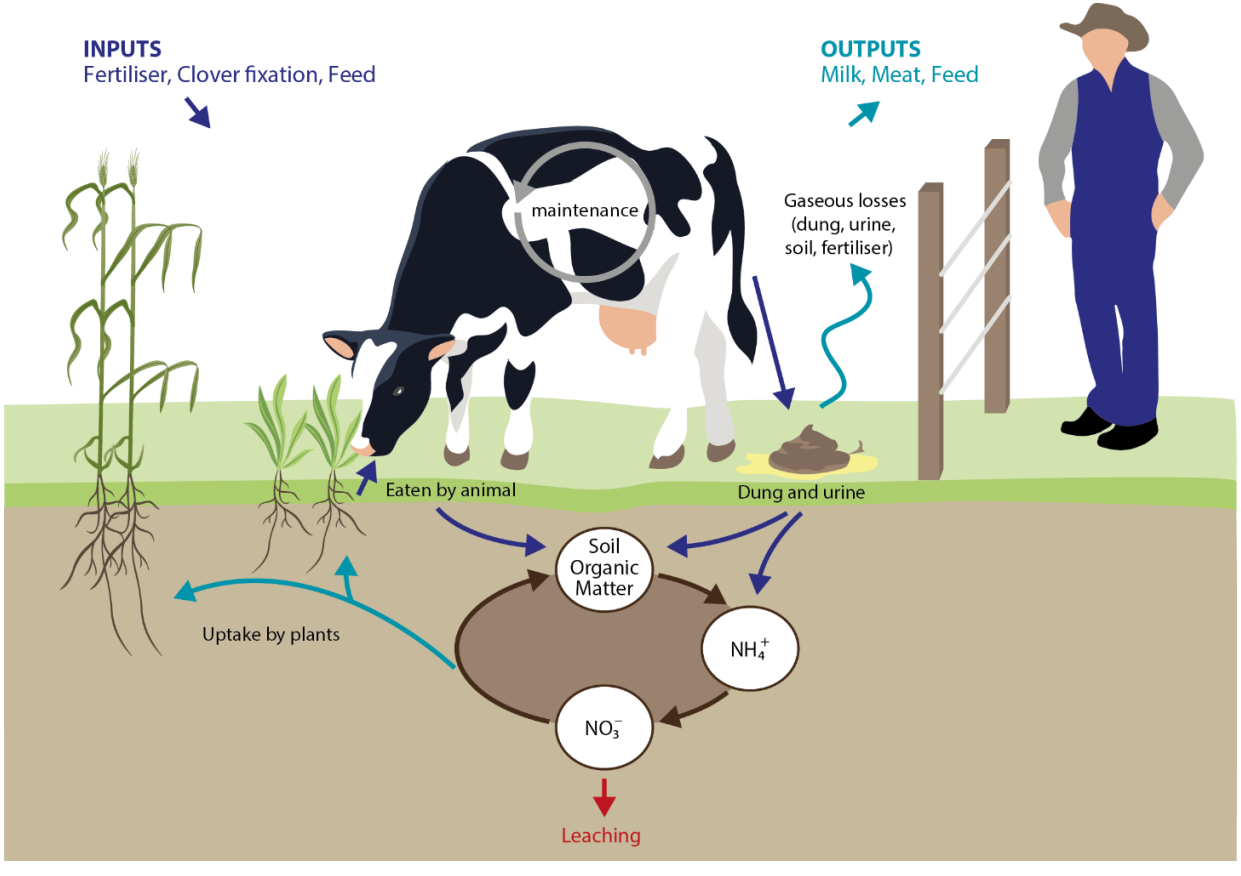
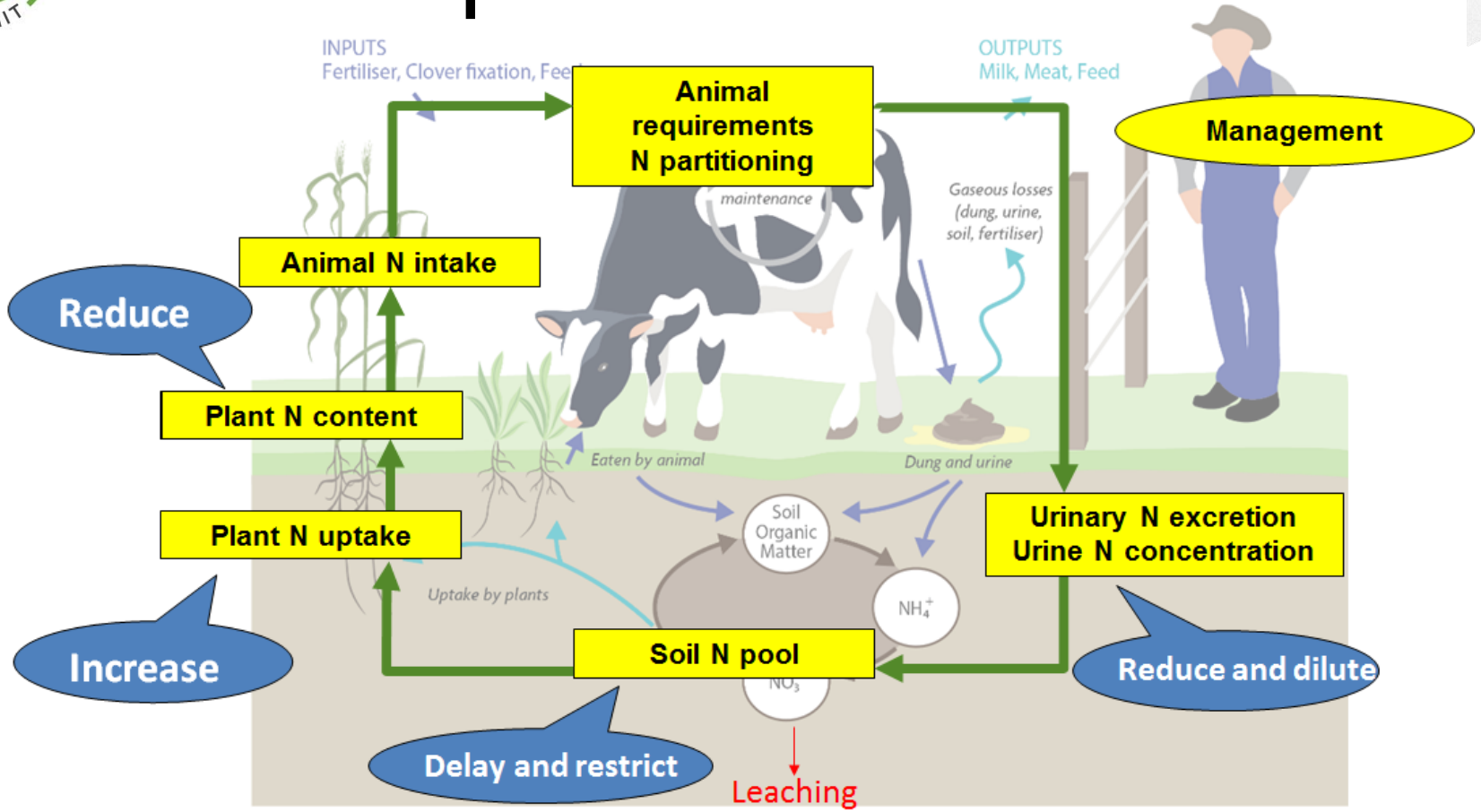
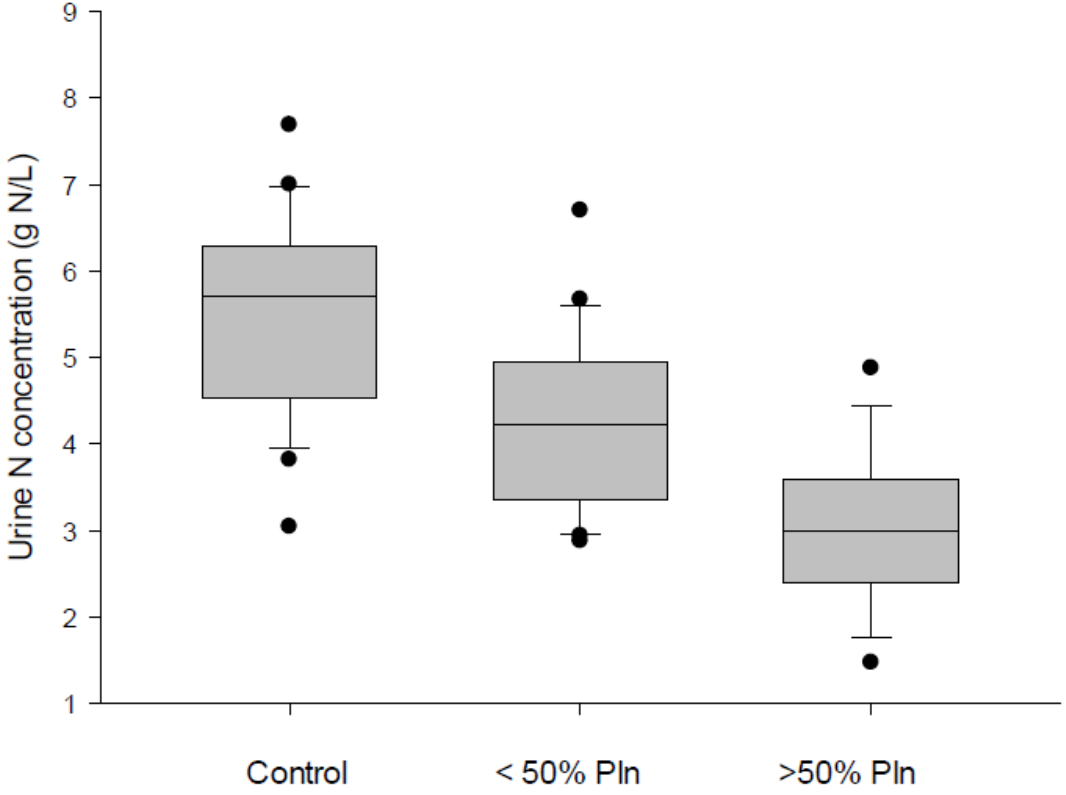
The nitrogen cycle



Proposed solutions



Plantain (cv Tonic) reduces urine N concentration



Bryant et al. 2017

Urine N loading is lower from cows grazing plantain

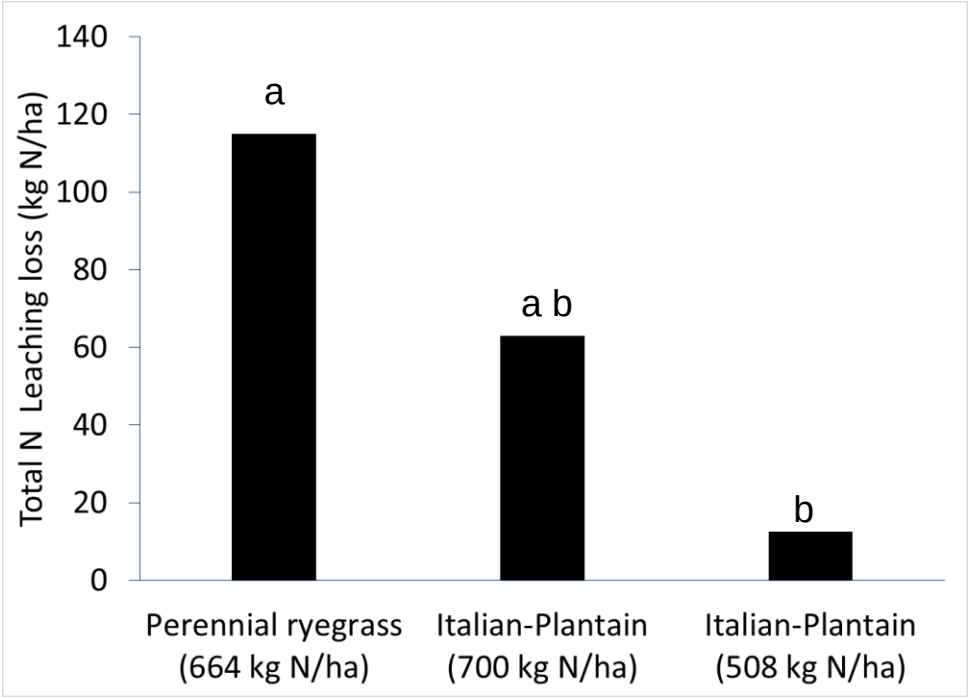
	Ryegrass-white clover	50% Plantain	100% Plantain
Autumn			
Urine N (g N/L)*	5.4	3.6	2.4
Urine volume (L/cow/day)	46	59	74
Urine patch load (kg N/ha)	**698**	**579**	**450**
Spring			
Urine N (g N/L)*	4.7	3.4	2.2
Urine volume (L/cow/day)	44	34	54
Urine patch load (kg N/ha)	**666**	**503**	**321**

*spot samples

Box et al. 2017, NZJAR, Box et al. 2016 Proc NZSAP

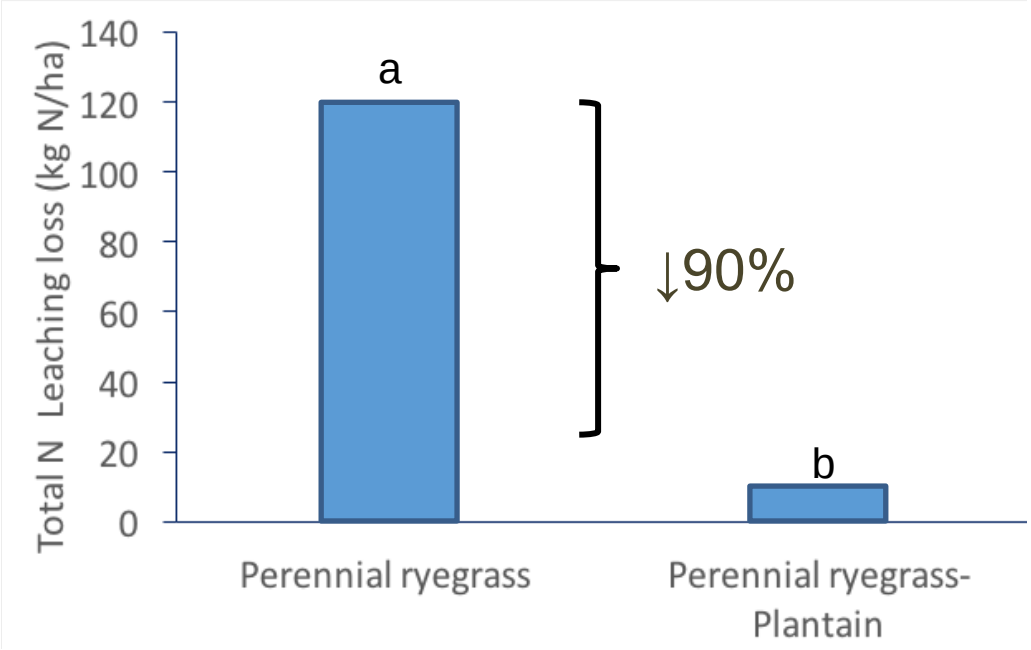
Reduced leaching from Italian ryegrass/plantain/white clover partly due to better plant N uptake, lower urinary N load from animals, and…

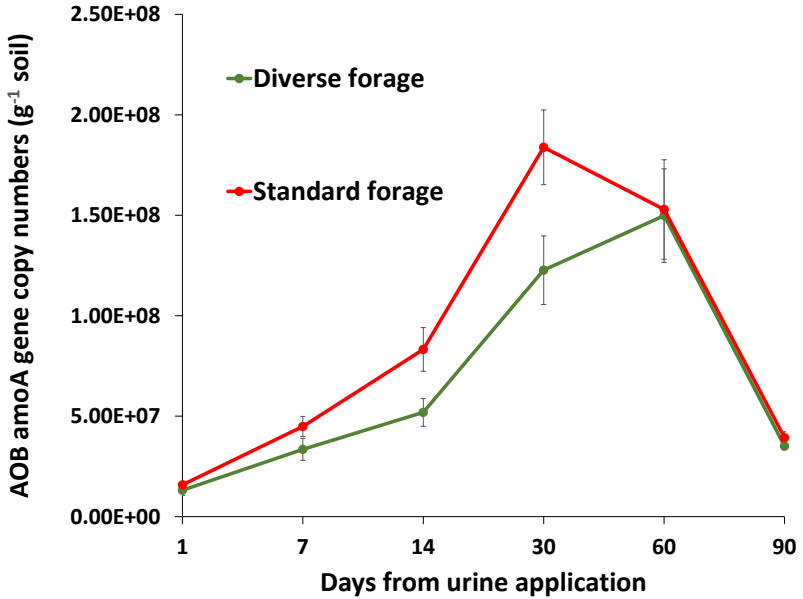
The reduction was much stronger when urine was used from cows grazing the Italian/plantain/white clover mixture.



Woods et al. 2018

…reduction in nitrification in the soil from plantain-based pasture





Urine for both treatments was collected from cows grazing PR/WC pasture. Thus the reduced leaching loss was attributed to the release of a biological nitrification inhibitor from plantain into the soil (this is supported by soil molecular biology analysis).

Carlton et al. (2018)

Farm Systems Trial

Ashley Dene Research and Development Station

Farmlets/treatments	Plantain 150N	Ryegrass 150N
Stocking rate (cows/ha)	3.5 (80 cows)	3.5 (80 cows)
N fertilization (kg/ha/y)	150	150
Forage type	50% Mix (RG+PL+WC) 50% Pure Plantain	Ryegrass/WC
Measurements and monitoring	Pasture and milk production Milk composition N cycle (inputs and losses) N leaching 'Scalar' Decision rules	
<u>Milk production</u> kg MS/cow	475	472
kg MS/ha	1,663	1,652

Can lower input systems reduce the N loss and still be profitable? (Chapman *et al.* 2017)

Chapman *et al.* (2013) SIDE proceedings	Low Stocking Efficient	High Stocking Efficient
Milking platform		
Stocking rate (cows/ha)	3.5	5.0
N fertiliser application (kg N/ha/year)	150	400
Total pasture harvested (t DM/ha/year)	16.0	18.1
Grain supplement (kg/cow/year)	100	800
MS produced (kg/cow/year)	453	437
MS produced (kg/ha/year)	1,588	2,184
Operating profit ($/ha)	4,334	4,810
Farm gate N surplus (kg/ha)	154	339
N leached (kg N/ha) (calculated with OVERSEER)	24	38
Wintering support land		
Main winter crop	Kale	Fodder beet
Crop area (ha / 100 cows)	8.0	2.2
Other winter feed	Cereal silage	Pasture silage

P21/MBIE funded research "Next Generation Dairy Systems" (Fonterra, DairyNZ, DCANZ, Beef & Lamb NZ, MBIE) led by Dr Mark Shepherd of AgResearch with Dr David Chapman of DairyNZ as Science Leader in Canterbury

Lincoln University Dairy Farm (LUDF)

(Pellow 2017)

New System

2012 -13

- 3.9 cows/ha
- 350 kg N fertiliser/ha
- 430 kg DM/cow imported supplement

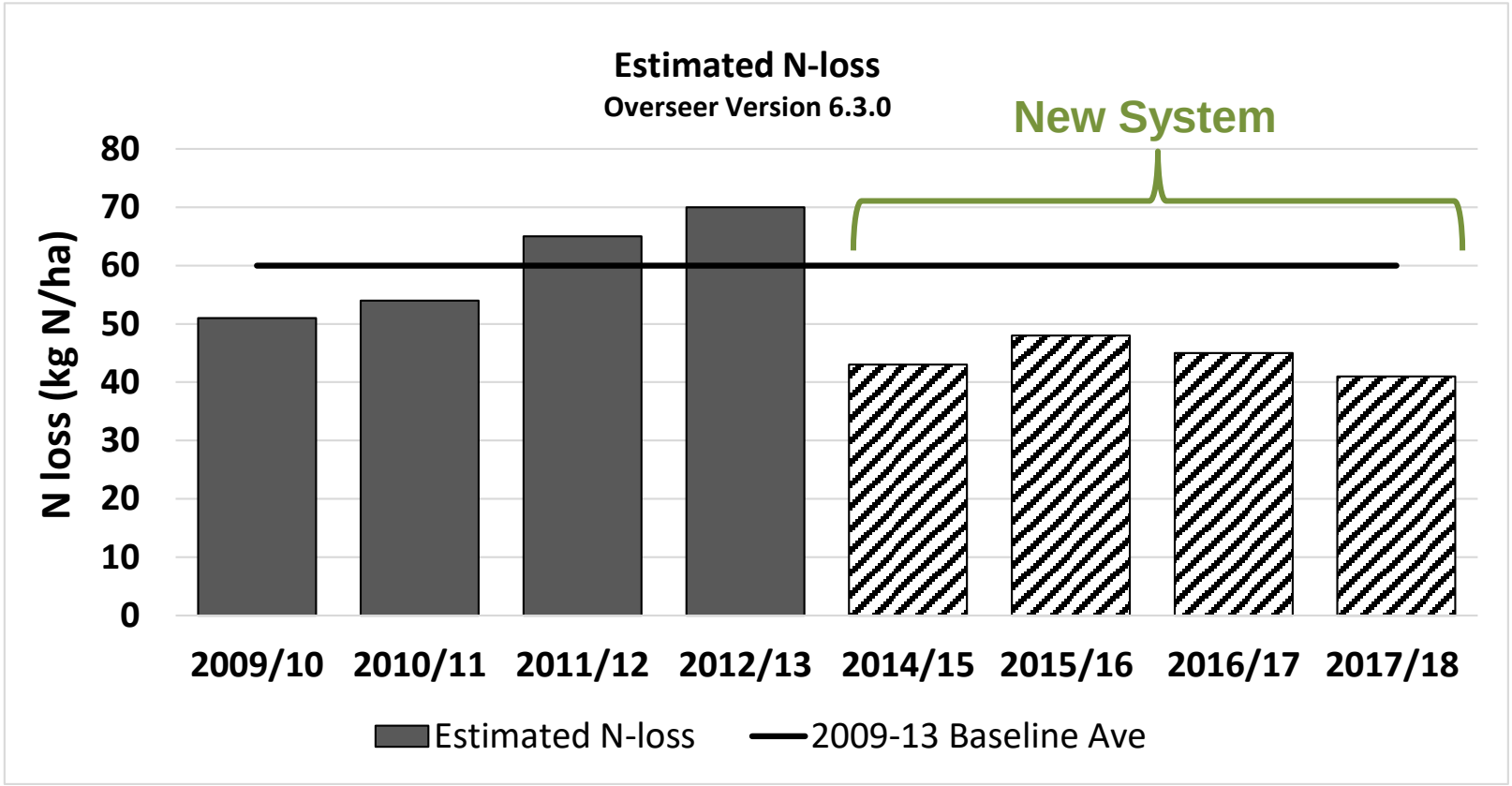
versus

2014 -18

- 3.5 cows /ha
- 143 kg N fertiliser/ha
- < 300 kg DM/cow imported supplement

LUDF reduced nitrogen loss to water

Latest data from Ron Pellow

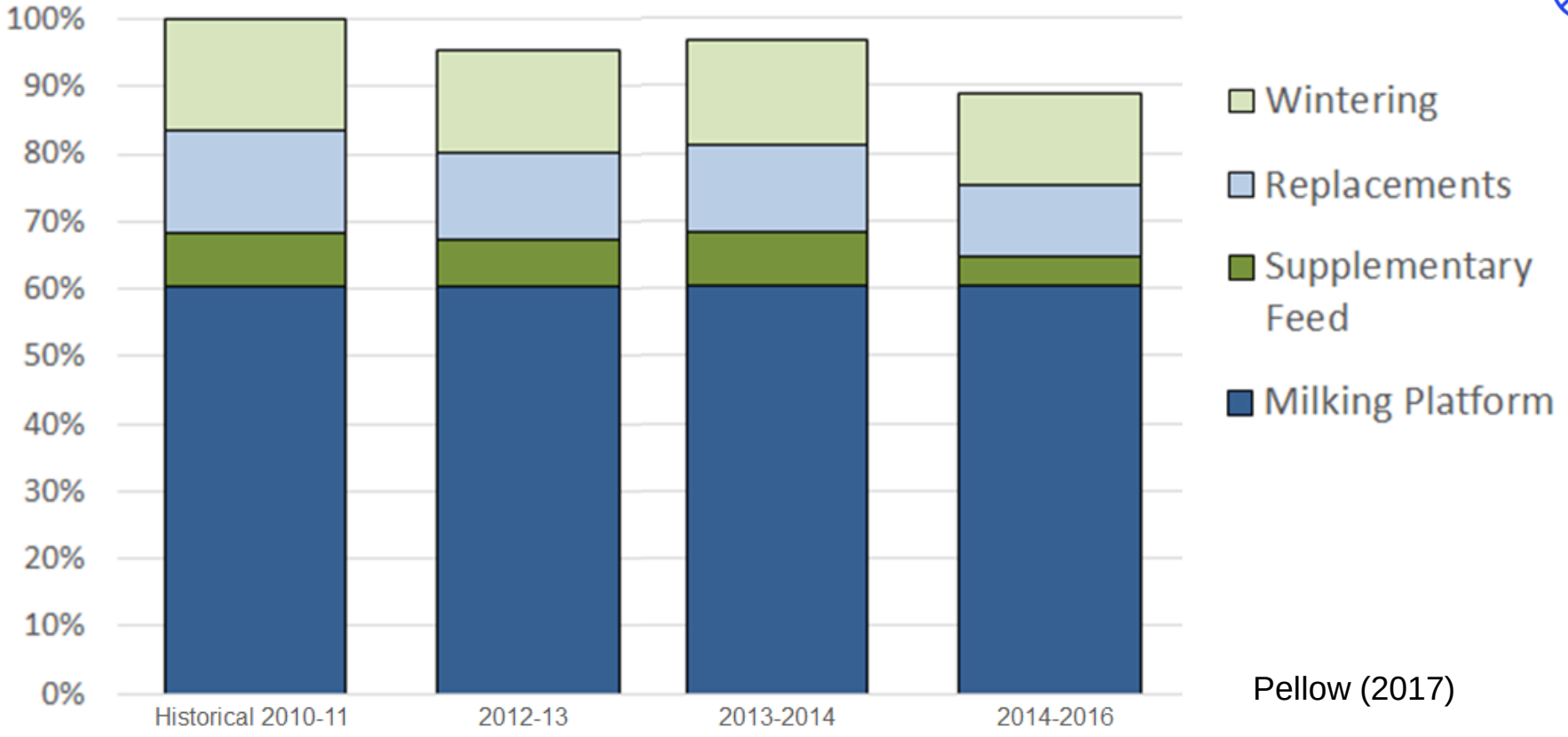


LUDF milk production

	2012/13	2014/15	2015/16	2016/17
Stocking Rate (cows/ha)	3.9	3.5	3.5	3.5
kg milksolids/cow	477	498	522	516
Kg milksolids/ha	1878	1725	1812	1789

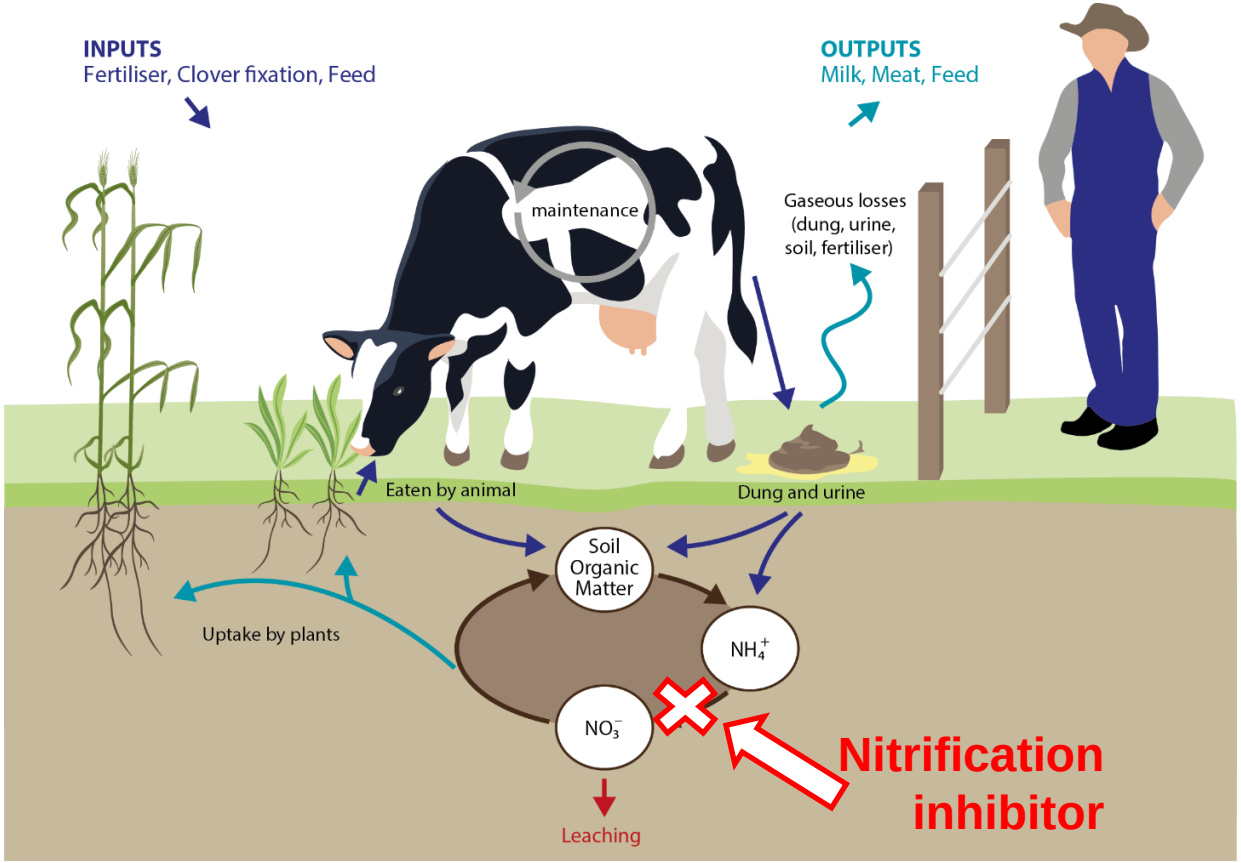
Data from Ron Pellow

Total land use by farm segment – relative to historical LUDF

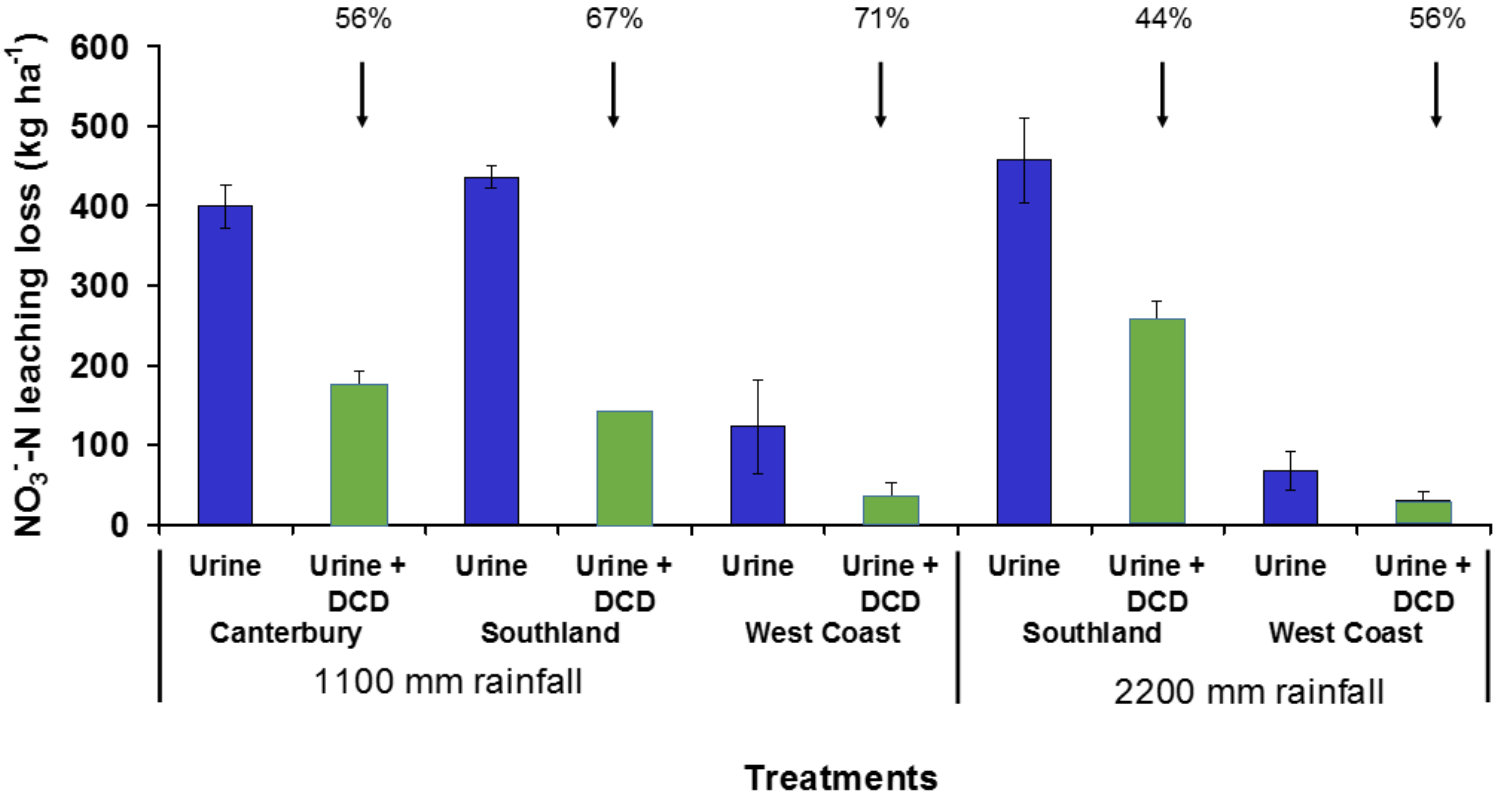


Pellow (2017)

Nitrification inhibitors slow down the production of nitrate and reduce N leaching losses



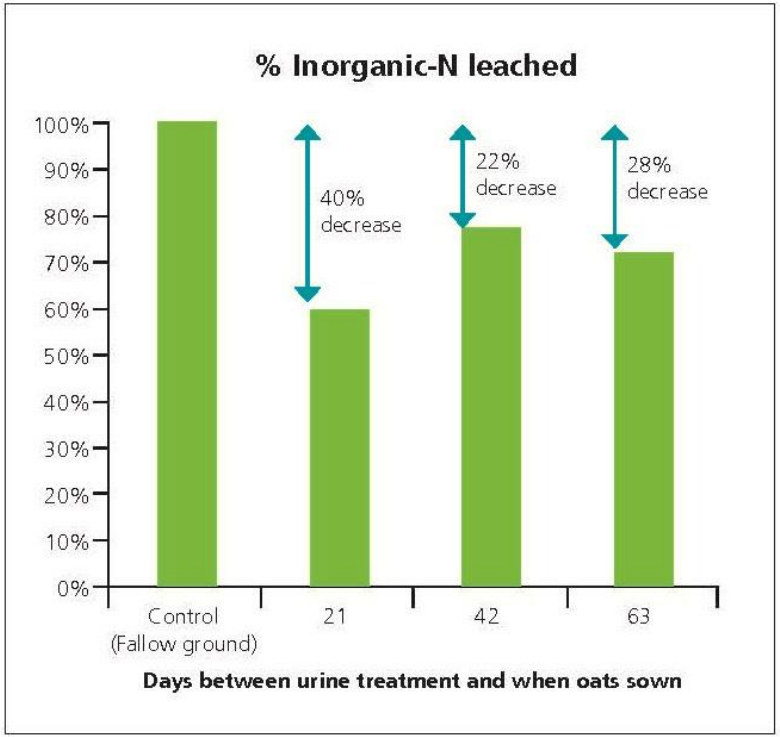
DCD reduced nitrate-N leaching losses in a range of soils and climatic conditions (Di *et al.* 2009)



DCD reduced nitrous oxide emissions in a range of soils and climatic conditions (Di *et al.*, 2009)

Regions and soil	Rainfall	EF3 (%) Urine	EF3 (%) Urine + DCD	% reduction
Canterbury, Lismore	1100 mm	3.0	1.4	53.3
Southland, Mataura	1100 mm	2.0	0.9	55.0
West Coast, Harihari	1100 mm	1.9	0.8	58.0
Canterbury, Lismore	2200 mm	3.9	1.0	74.0
Southland, Mataura	2200 mm	1.5	1.0	33.3
West Coast, Harihari	2200 mm	1.4	0.4	71.4
Average		2.3	0.9	64.0

‘Catch crop’ of oats can reduce nitrate losses from winter forage crops

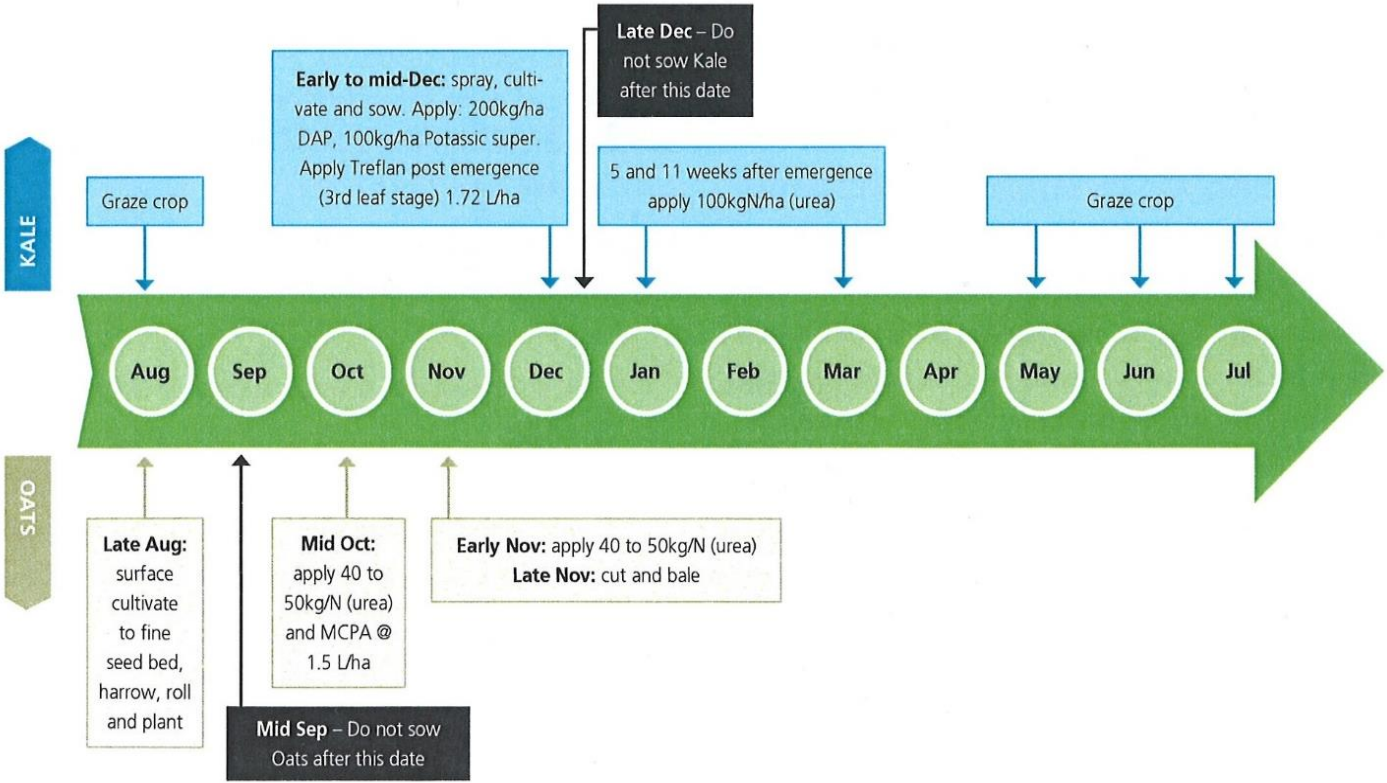


Recent work by Carey *et al.* (2016) has shown 30% reductions in nitrate leaching losses are possible.

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

https://www.dairynz.co.nz/media/3360233/sequence_cropping_kale_and_oats.pdf

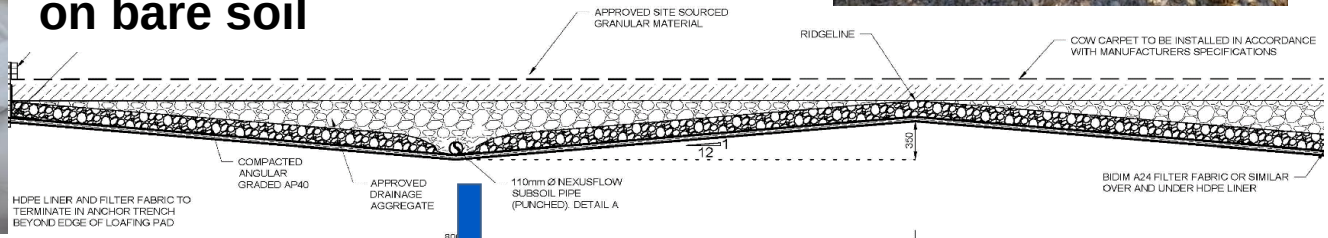
Sequence cropping calendar

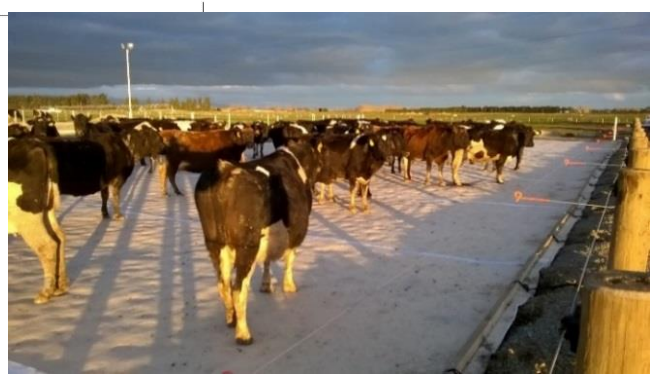


http://www.dairynz.co.nz/media/3360233/sequence_cropping_kale_and_oats.pdf

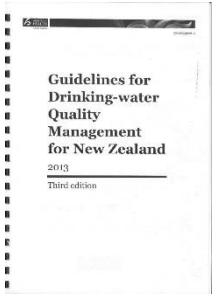
Reducing nitrate leaching using stand off pads

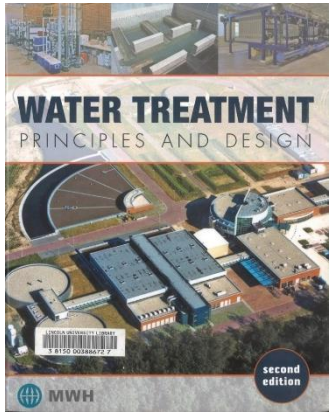
Cows removed from paddock for 16 - 18 hours reduces N loading on bare soil





A New Effluent Treatment System to Reduce Environmental Impacts and Recycle Wash Water





Benefits of ClearTech®

- Reduced water use on farm by recycling water
- Reduced risk of microorganism (*E. coli)* pollution
- Reduced risk of Phosphorus pollution
- Reduced risk of Nitrogen pollution