Opportunities and challenges for managing nitrogen losses from pasture based dairy farms

Dawn Dalley

DairyNZ

14 March 2024

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Acknowledgement

South Gippsland Sentinel Times
https://www.sgst.com.au › emergency-services › extent-...

Extent of Mirboo North's devastation still hitting home, they ...

14 Feb 2024 — "With Mirboo North the worst hit South **Gippsland** Shire town during Tuesday's storm event, council staff were on site all night as were emergency ...

Australian Broadcasting Corporation
https://www.abc.net.au › news › south-gippsland-storm-...

South Gippsland residents start clean-up after 'terrifying ...

14 Feb 2024 — Hail bucketed the region and strong winds savaged townships and bushland, destroying houses and tearing down trees. Man in glasses in front of ...

South Gippsland Sentinel Times
https://www.sgst.com.au › emergency-services › mirbo...

Mirboo North in ruins as deadly storm leaves trail of ...

15 Feb 2024 — Residents impacted estimate the width of the '**tornado** like storm' was no more than 500 metres wide, it's path clearly visible in Mirboo North ...

Presentation Outline

- Context – national and regional requirements for NZ farmers to meet
  - Water quality
  - Greenhouse gas emissions
  - Animal welfare
- Wintering options
- Nitrogen cycle recap
- Current and recent N research to support farmers
- Extension initiatives
- Final words

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New Zealand Context

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Drivers for change

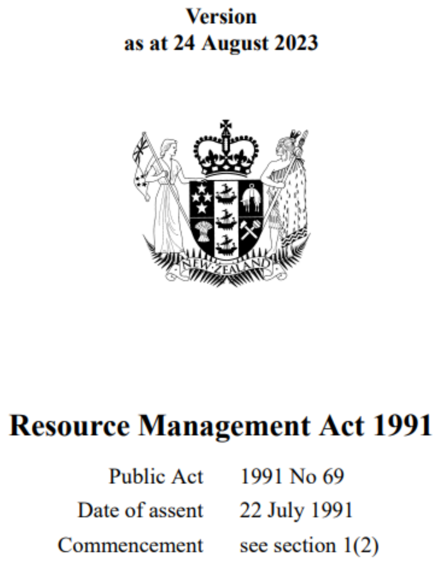
Water Quality – National and Regional Regulation

- Resource Management Act
- National Policy Statement – Fresh Water Management
- National Environmental Standards
- Fresh water farm plans

Greenhouse Gas Emissions

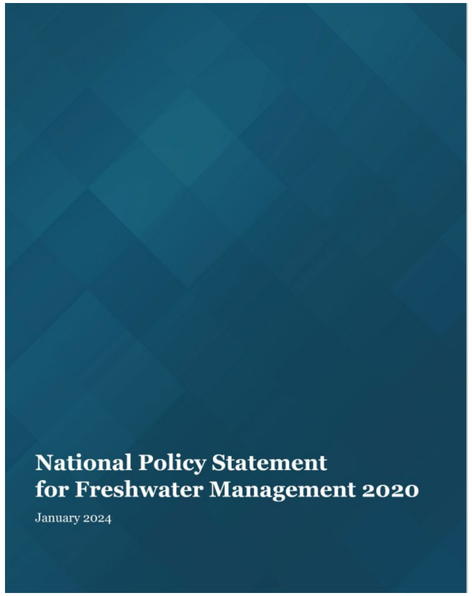
- Government commitments to the Paris Agreement
- Milk company supply conditions
- Bank lending conditions

Dairy cattle code of practice


Version
as at 24 August 2023

Resource Management Act 1991

Public Act	1991 No 69
Date of assent	22 July 1991
Commencement	see section 1(2)



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Some wintering systems in NZ are under pressure to change.

What options are out there??

Which system?

- Level of control required
- Farm system the farm is operating
- Location – catchment, soil type, topography, rainfall
- Consenting requirements
- Skills of the team
- Resources available
  - Labour, land, infrastructure, finances

Grass wintering

- Traditional North Island wintering
- Long rotation on milking platform, break feeding pasture with silage
- Suits free draining soils and regions with good winter pasture growth
- No diet transitioning required
- Lower risk

Requires
- Good pasture management skills
- Contingency for dry autumn/low pasture accumulation
- Reliable supply of silage
- Good soils and climate

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Forage crops

- Regions with low winter growth rates and/or heavy soils
- High yields (brassica’s 12-18 T DM/ha, fodder beet (20-35 T DM/ha)
- High quality feed
- Minimises area required for wintering

<u>Requires</u>

- Contingency for crop failure/poor yields
- Transition plan on and off crop
- Plan for dealing with cows that don’t adapt
- Provision of adequate supplement for crop type

<u>Concerns</u>

- Public perception, cows in mud
- Environmental impact – sediment, P and N losses, soil structural damage

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Baleage wintering

- Alternative to crops on heavy soils – loophole in the wintering rules
- Diet predominantly baleage fed in ring feeders
- Range of implementation strategies
  - 70 to 100 baleage bales per hectare
  - Varying pre-graze pasture mass
- Level of post winter regrassing dependent on soil type, weather and implementation regime
- No transitioning required

<u>Requires</u>

- Reliable source of good quality baleage
- Ability to recycle baleage wrap
- Lots of bale feeders

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Hay bale wintering

- Originated from the US as part of some regenerative farming systems
  3500-4000 kg DM/ha pasture pre-grazing cover
- Hay bales set out in a grid formation at approx. 30 bales/ha (approx. 18-20 metres apart)
- No ring feeders
- Hay provides soil armour
- Seed in hay germinates post winter
- No transitioning required

<u>Requires</u>

- Significantly more land than crops
- Good quality hay

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Off paddock infrastructure

- Range of options: covered and uncovered
  - Freestall barn
  - Composting barn
  - Herd Home®
  - Wintering/fed pad
- High capital cost
  - Square metres per cow
  - Effluent consenting
  - Roof
- Good for nitrate leaching, not so good for GHG (pollution swapping)
- Management challenges can compromise animal welfare outcomes

Good management paddock wintering

Buffer areas

Critical source areas (CSA's)

- Areas that accumulate water and nutrients during rainfall.
- Leave uncultivated in grass where possible
- Do not graze through the CSA

Waterway buffers

- Minimum 5m and stock excluded
- As slope increases, so should buffer distances

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Reducing stock movements

Portable troughs

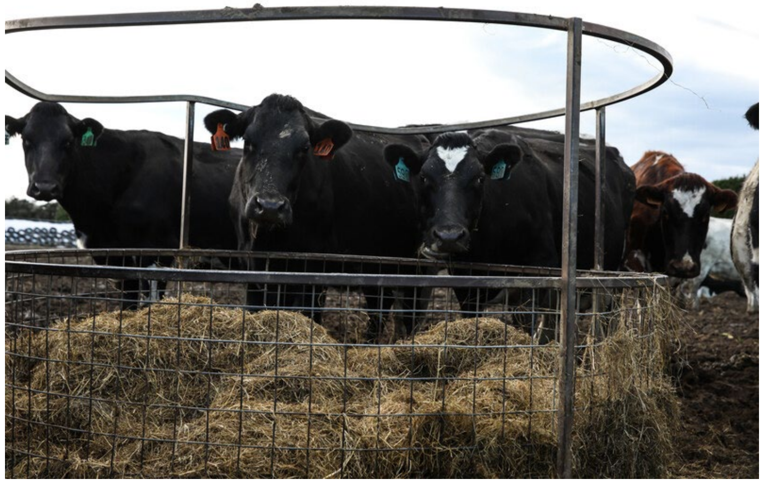
- Use a portable troughs to give animals easy access to fresh clean water.
- Place at the side of the break for ease of shifting.

Backfencing

- Shift back fence regularly to reduce movement of animals and damage to soils.

Baleage

- Place bales away from waterways and CSAs. Use bale rings to improve utilisation.



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Contingency plans for adverse weather?

- Budgeting 10% extra feed
- Increasing area available
  - New break or behind the back fence
- Saving drier, lower risk paddocks on the farm with shelter
- Saving sheltered areas within a paddock for grazing later
- Yards/laneways with rubber matting for short periods
- Rolling out straw
- Feed-pads/stand-off pads
- Tree blocks (safe!)
- Alternative grass paddocks
- Grass strips in crop paddocks

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Wet weather breakout zone considerations

- Identifying and not spraying out and cultivating
- Management prior to winter
- Ease of access
  - Contractors to harvest pasture, spray crop etc
  - Animals during grazing
- Location in paddock
  - Avoid lower lying areas of the paddock or CSA's
  - Drier, more sheltered areas

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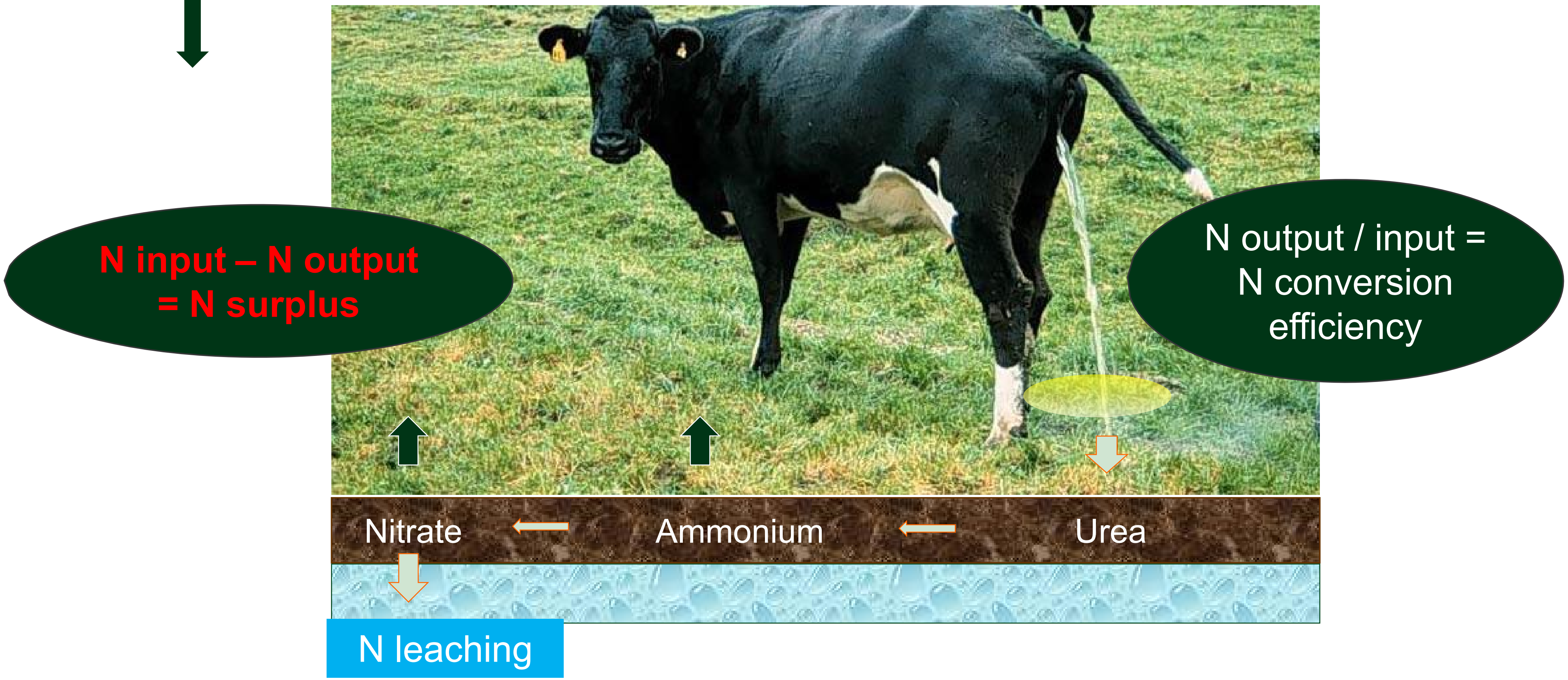
Nitrogen cycle recap

The nitrogen cycle

Inputs:
N fertiliser
Supplements
N fixation

Outputs:
milk, meat, crop



Nitrogen surplus is a good proxy for N leaching risk

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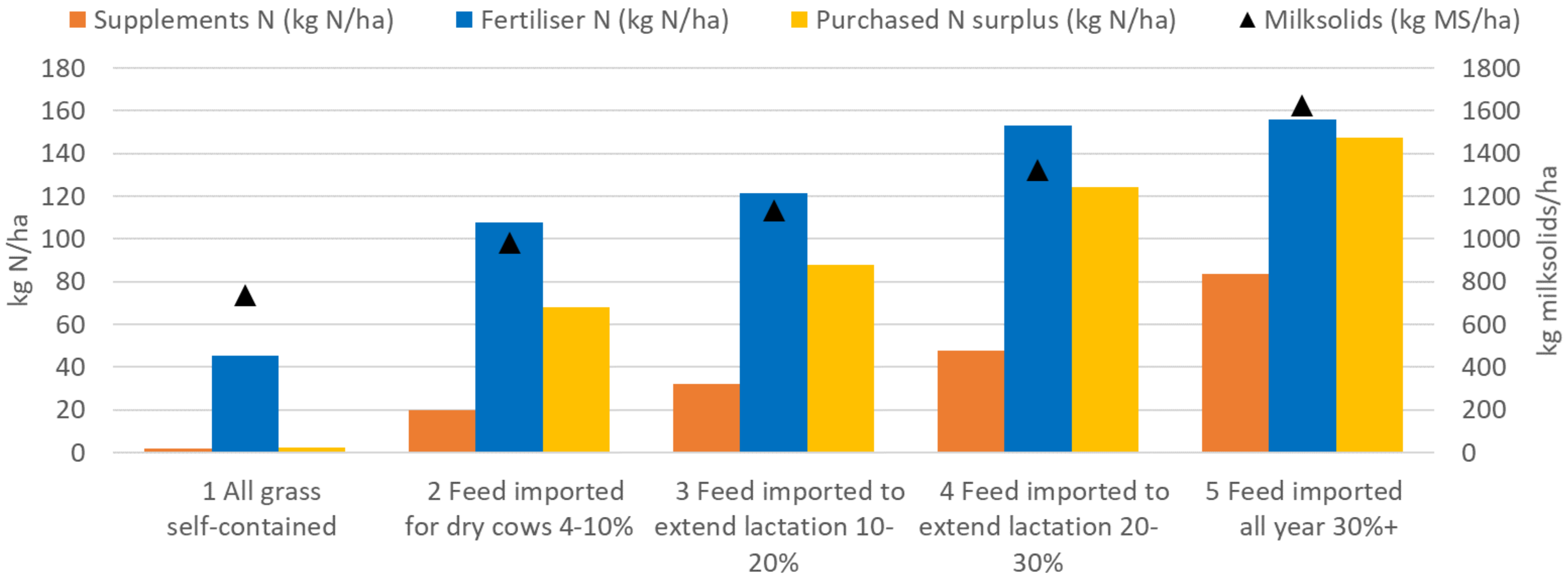
Generally, N surplus increases with increasing farm intensity

BUT large variation between farms within system → improvements possible



Pinxterhuis et al. 2019 (Technical Series April)

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Proposed mitigations

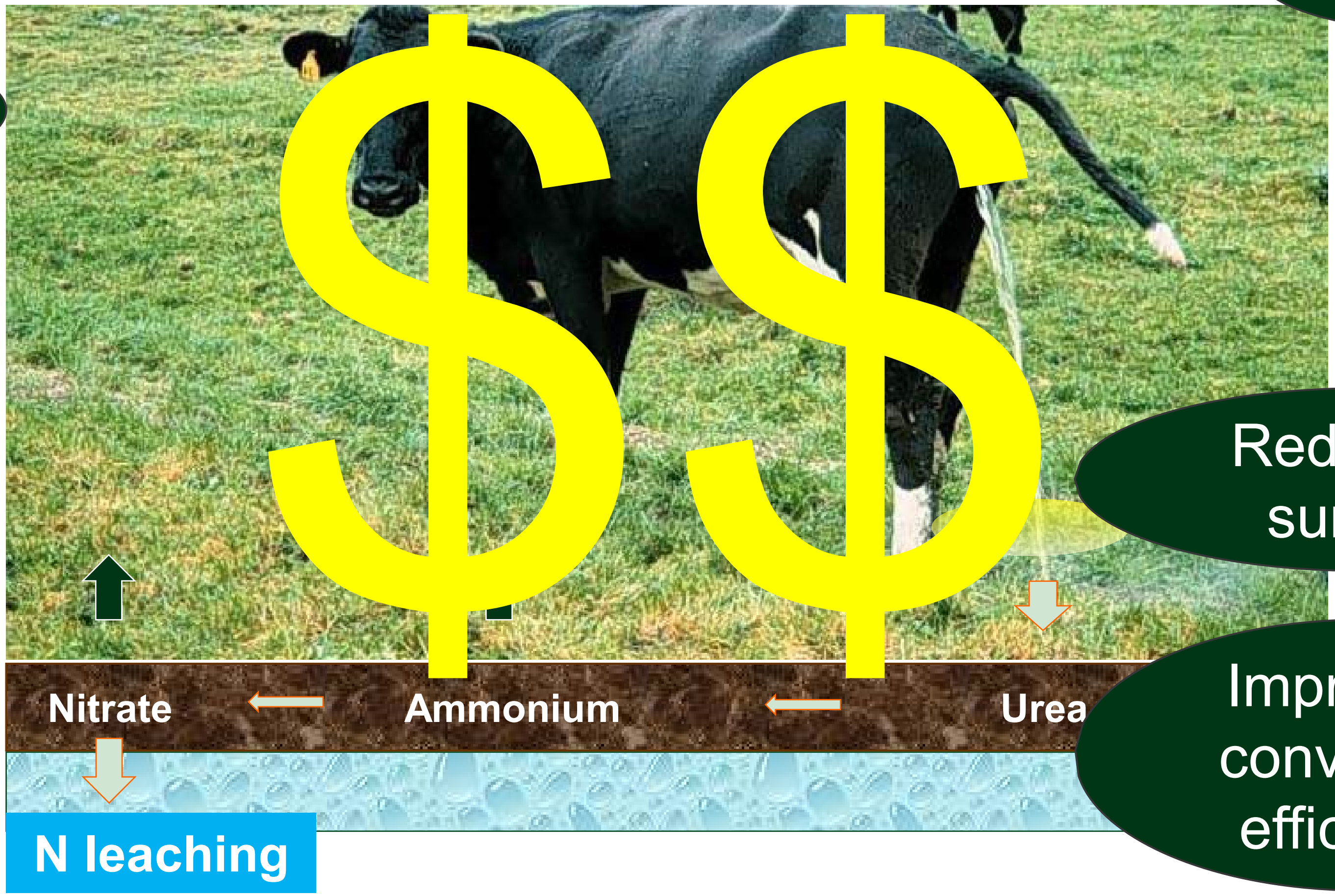
Research challenge is to break the link between environmental impact and production intensity

Inputs:
N fertiliser
Supplements
N fixation

Outputs:
milk, meat, crop

Reduce

Increase



Reduce N surplus

Improve N conversion efficiency

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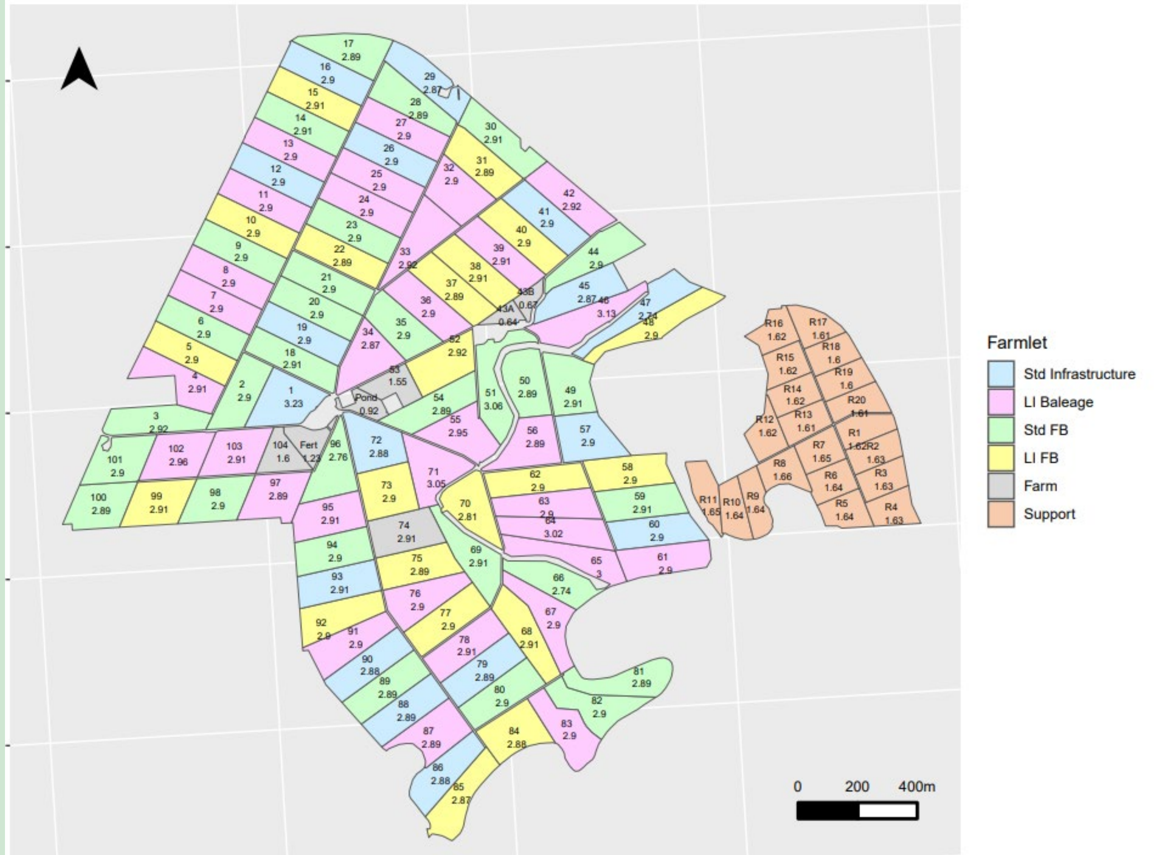
N loss mitigation research: Improving water quality



Farm Systems Research

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Previous systems research provided solid basis: Pastoral 21 and Forages for Reduced Nitrate Leaching

Reduced N inputs

N efficient pasture species
Less N fertiliser
Low-N supplementary feed

High cow production

High BW cows
Lower stocking rate
More pasture per cow

N efficient wintering

Stand-off in autumn and winter
Low-N crops
Catch crops

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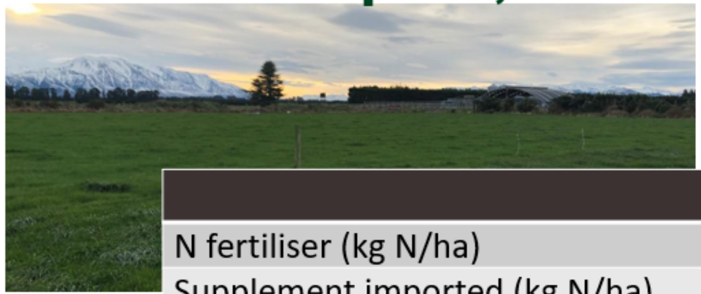
Pastoral 21 (2011-2015) – Canterbury reduce inputs, increase efficiency

Canterbury	"High input"	LUDF	"Low input"
Stocking rate (cows/ha)	5.0	3.9	3.5
N fertiliser (kg N/ha)	**Up to 400**	313	**Up to 150**
Grain feeding (kg/cow)	Up to 800	0	Up to 100
Average production (kg MS/ha)	2,241	1,821	1,700 (-24%)
Average operating profit ($/ha)	4,205	4,395	4,300 (+2%)
Average N leached (kg N/ha)	46	39	32 (-30%)

Pastoral 21 (2011-2015) – Waikato

Waikato	Current	Future
Stocking rate (cows/ha)	3.2	2.6
Cow genetic merit (BW)	156	225
Replacement rate (%)	22	18
N fertiliser (kg N/ha)	**Up to 150**	**Up to 50**
Grain feeding (kg/cow)	0	max 400
Standoff – urine collected	No	Yes
Effluent applied (% of farm) (kg N/ha)	23 9	50 19
Average production (kg MS/ha)	1,201	1,151 (-4%)
Average operating profit ($/ha)	2,086	1,807 (-15%)
Average N leached (kg N/ha)	54	31 (-43%)

Backtrack dairy (2015/16 – 2018/19) – reduced inputs, increased efficiency



	Waiora	Whakapono
N fertiliser (kg N/ha)	**138**	**99**
Supplement imported (kg N/ha)	49	47
Product out (kg N/ha)	99	101
Purchased N Surplus (kg N/ha)	88	45
N leaching (kg N/ha)	42	38
Production (MS/ha grazed)	1,546	1,597
Pasture eaten (t DM/ha)	16.5	17.2

Low N Systems

Stacking of options for transformational impact - improved urine patch genetics, nitrogen excess management and mitigation technologies

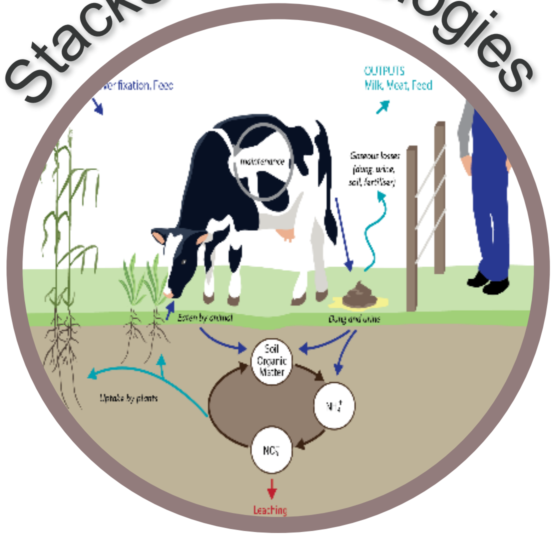
New genetics

Animals with improved urine patch characteristics, phenotyping

Nitrogen optimisation

Developing tools to help manage N excess

Stacked technologies



Modelling, measuring and demonstrating transformational reductions

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Fonterra
Dairy for life

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CRV
BETTER COWS › BETTER LIFE

Northland Agricultural Research Farm

- Current Farm
  - Kikuyu & ryegrass pastures, up to **190 kg** N/ha, 3.1 cows/ha
- Alternative Pastures Farm
  - Fescue & cocksfoot pastures, up to **190 kg** N/ha, 3.1 cows/ha
- Low Emissions Farm
  - Kikuyu & ryegrass pastures, **no nitrogen** applied, 2.3 cows/ha

Northland Dairy NDDT Development Trust

Dairy Trust Taranaki

Gibson Farm

- Current: 3.1 Friesian cows/ha, **190 kg** N/ha and 700 kg DM/cow imported feed.
- Step Change: 2.5 cows/ha, **75 kg** N/ha and 300 kg DM/cow imported feed

Waimate West Demonstration Farm

- Farmlet 1 Current system based on perennial ryegrass, 3.5 Jerseys/ha
- Farmlet 2 Diverse Pasture farmlet, 3.5 Jerseys/ha

Kavanagh Farm

- Net carbon zero farmlet

Dairy Trust
TARANAKI

N loss mitigation research: Improving water quality

Winter fodder beet vs kale; reduced system intensity

Southern Dairy Hub

Farm management interventions to deliver a 30% reduction in nitrate leaching

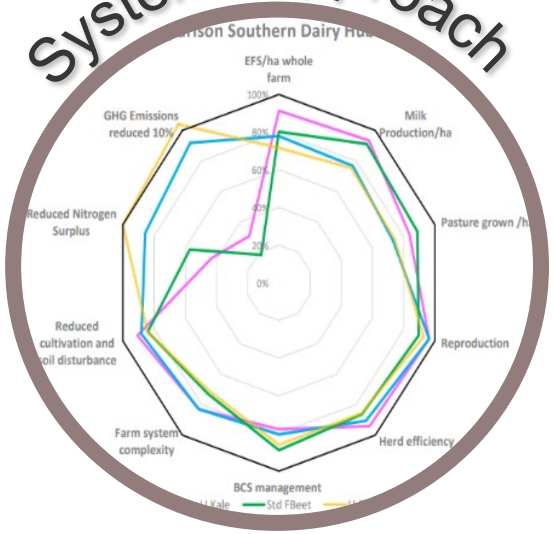
Purchased N

Less N fertilizer, less imported feed, fewer cows

Winter crop

Kale or fodder beet for wintering; fodder beet for shoulder feeding

Systems approach



Four-year farm systems comparison at scale

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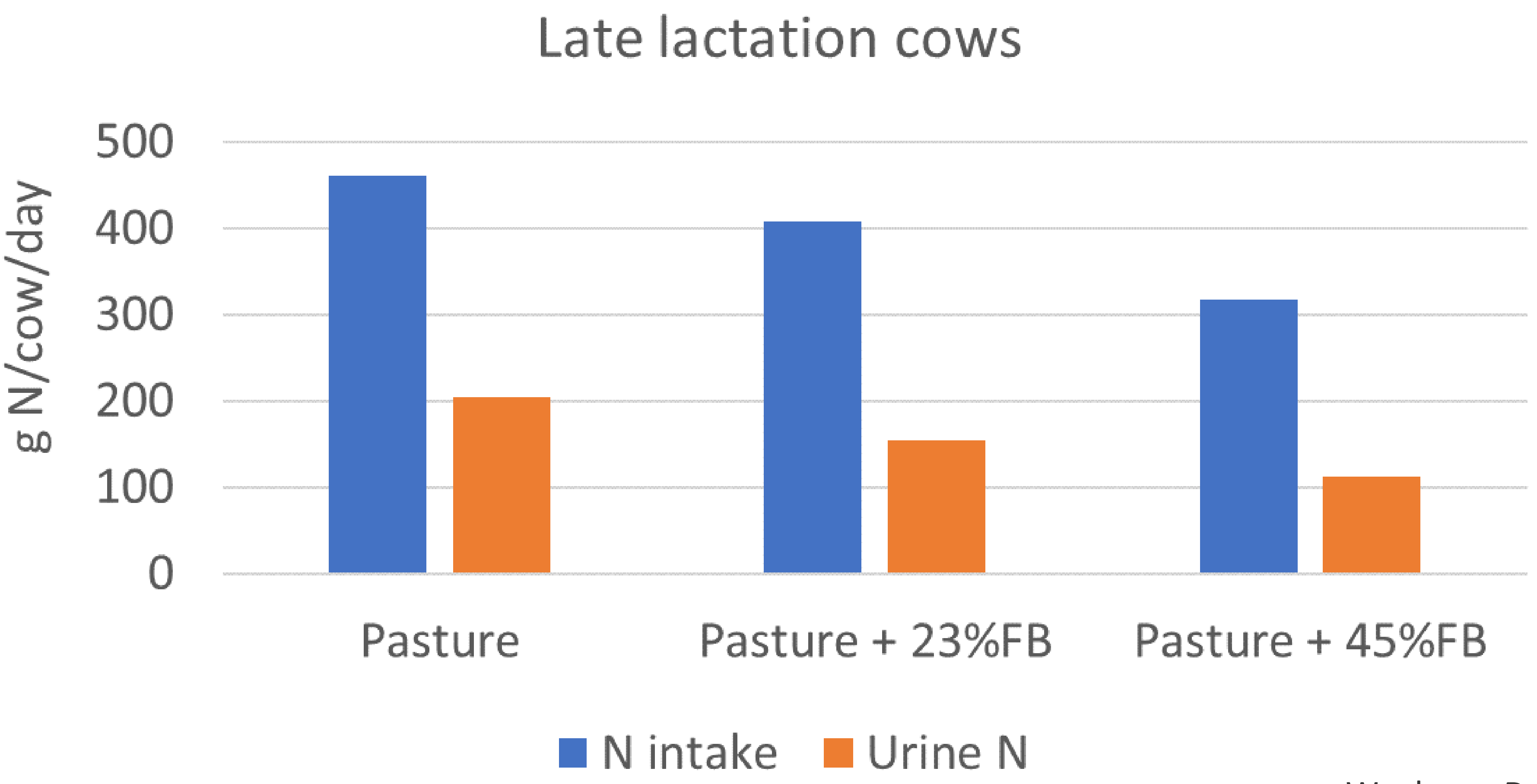
Fodder beet is a low-N feed, that reduces N intake and urinary N excretion

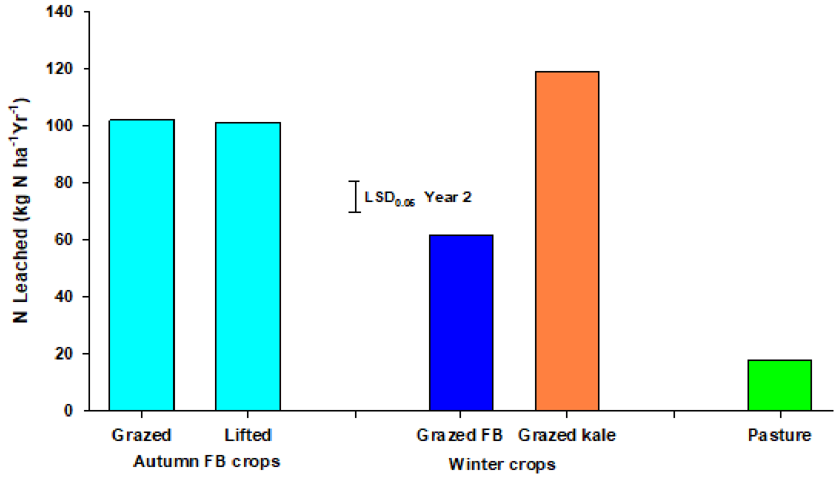


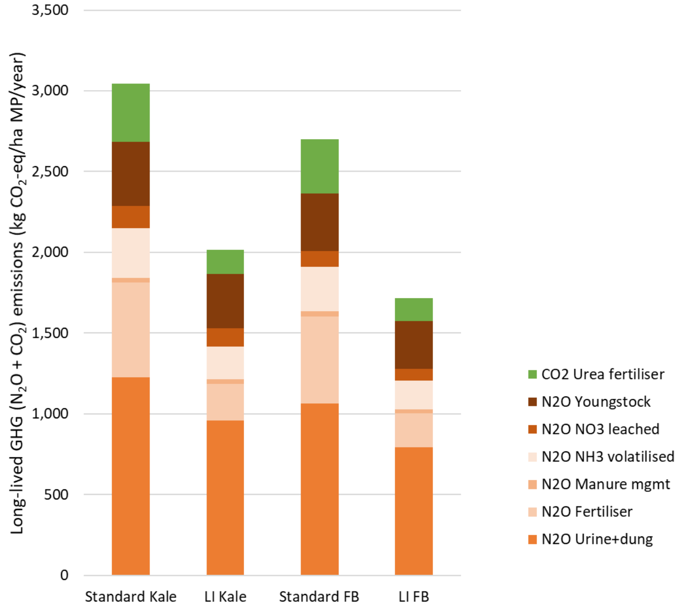
Waghorn, Dalley et al. 2018

Ministry of Business, Innovation & Employment · DairyNZ · agresearch · FAR · Landcare Research Manaaki Whenua · Plant & Food Research · Lincoln University

Fodder beet systems have environmental opportunities

- Reduced winter nitrate leaching both per ha (55 vs 106 kg N/ha) & per cow wintered (2.0 vs 5.6 kg/cow)
- Fodder beet systems at SDH had a lower methane footprint (9%) and lower long-lived gas footprint (13%) than the kale systems
- Reduced nitrous oxide emissions
  - 39% lower than from cows grazing kale
- Reduced methane emissions
  - 18% lower than from cows grazing kale





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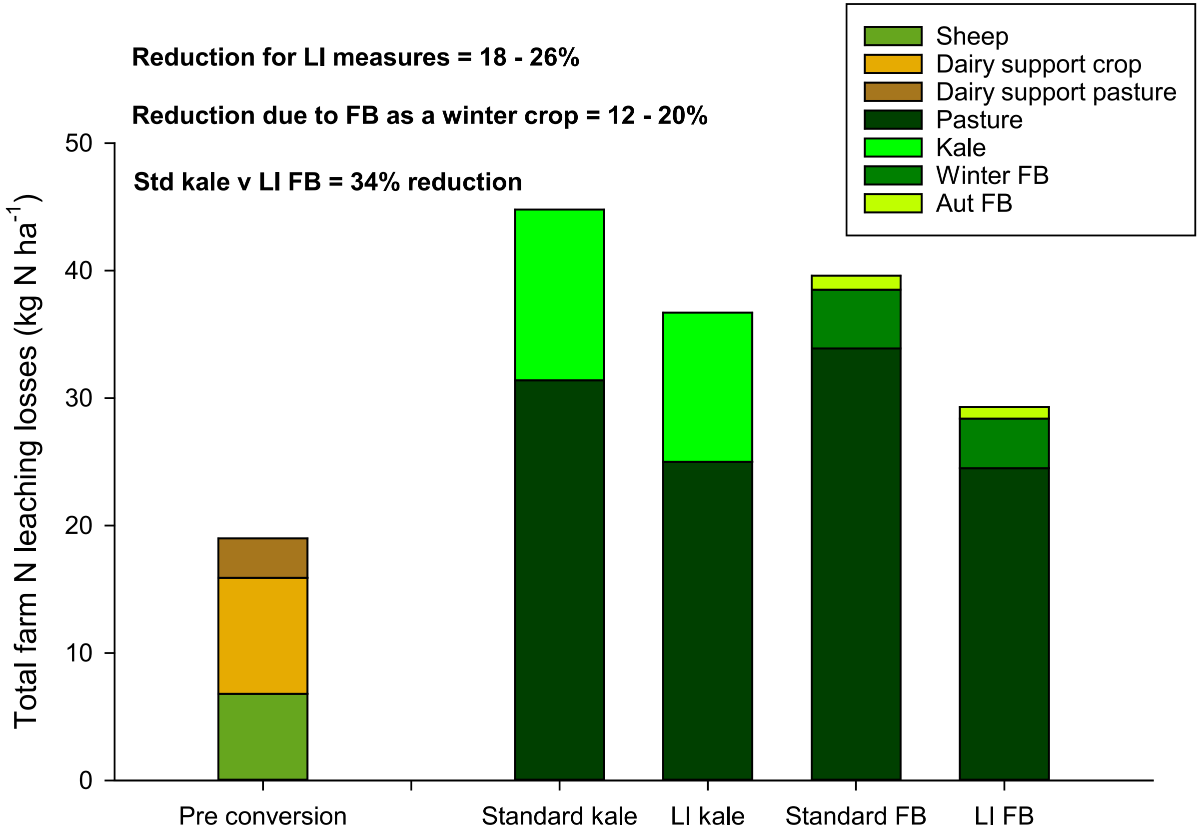
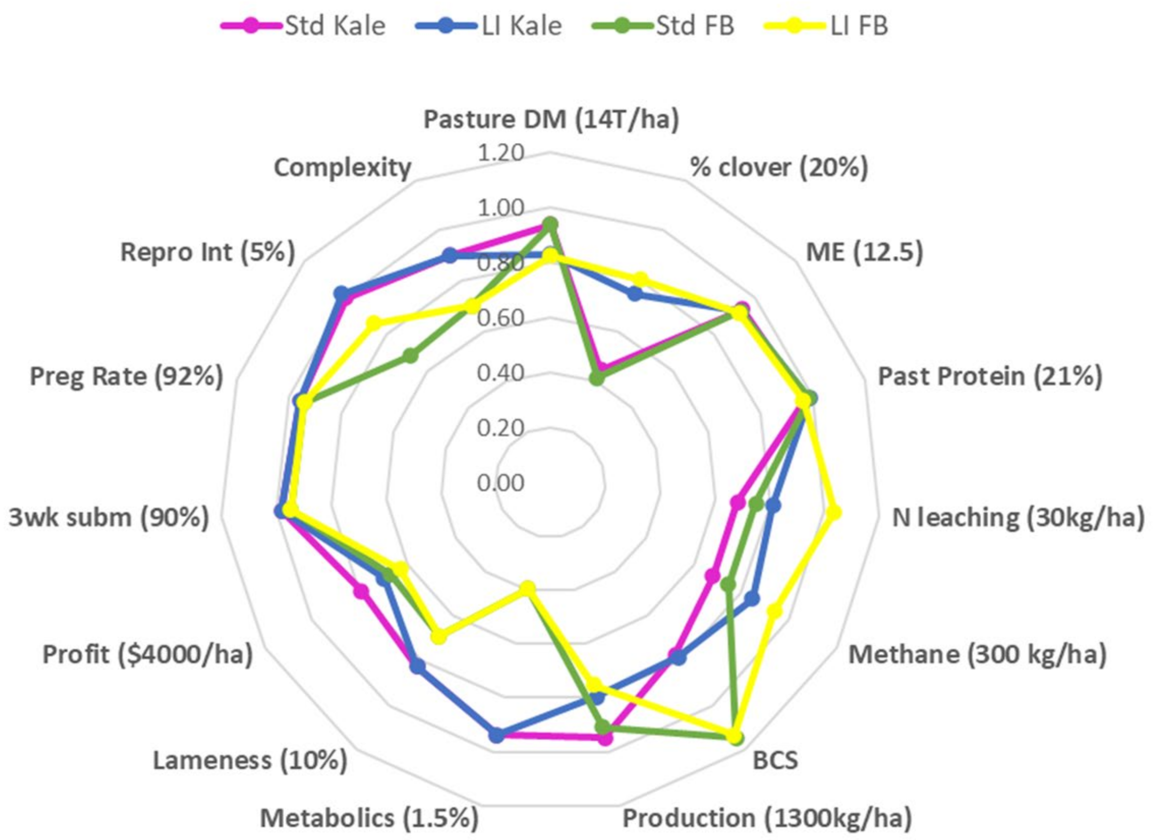
Lower system intensity reduced leaching losses in Southland but not as profitable





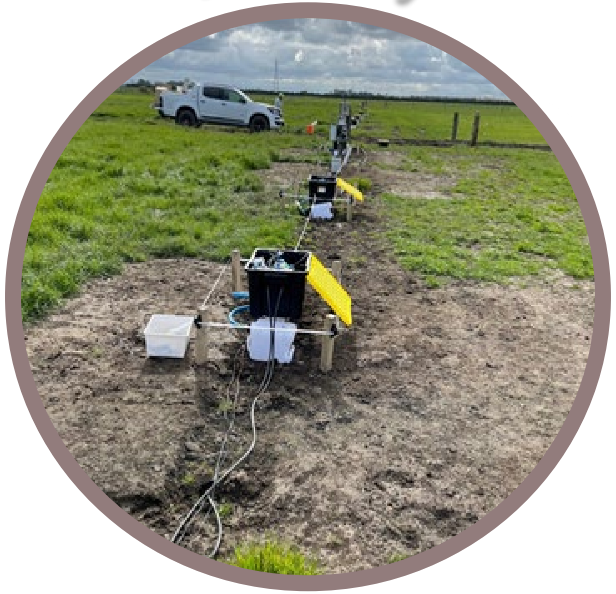
N loss mitigation research: Improving water quality

Alternative pasture species

Plantain potency and practice

Providing confidence in a low cost, high impact mitigation for nitrate leaching

Efficacy



Leaching measured at scale
and on different soils

Safety and integrity

Risk and potential benefits to milk,
meat, and animal health and welfare

Adoptability

Solutions for management and
regulation; demonstration of adoption
and impact; cultivar evaluation

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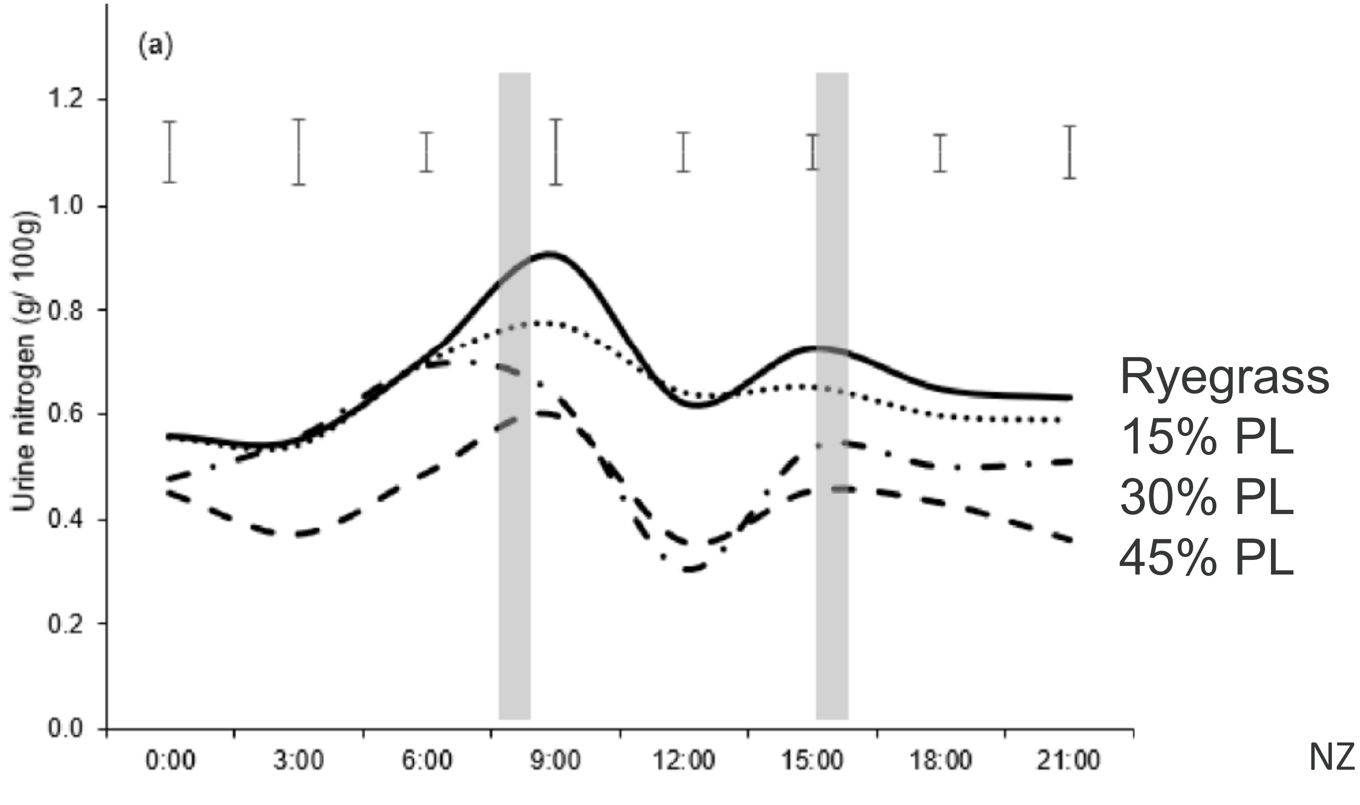
PGG Wrightson Seeds

Plantain reduces urine N concentration

Leads to significant reduction in leaching from urine patch



NZ studies used the plantain cultivar Tonic and Agritonic (currently in Ecotain)

Minnée et al. 2020

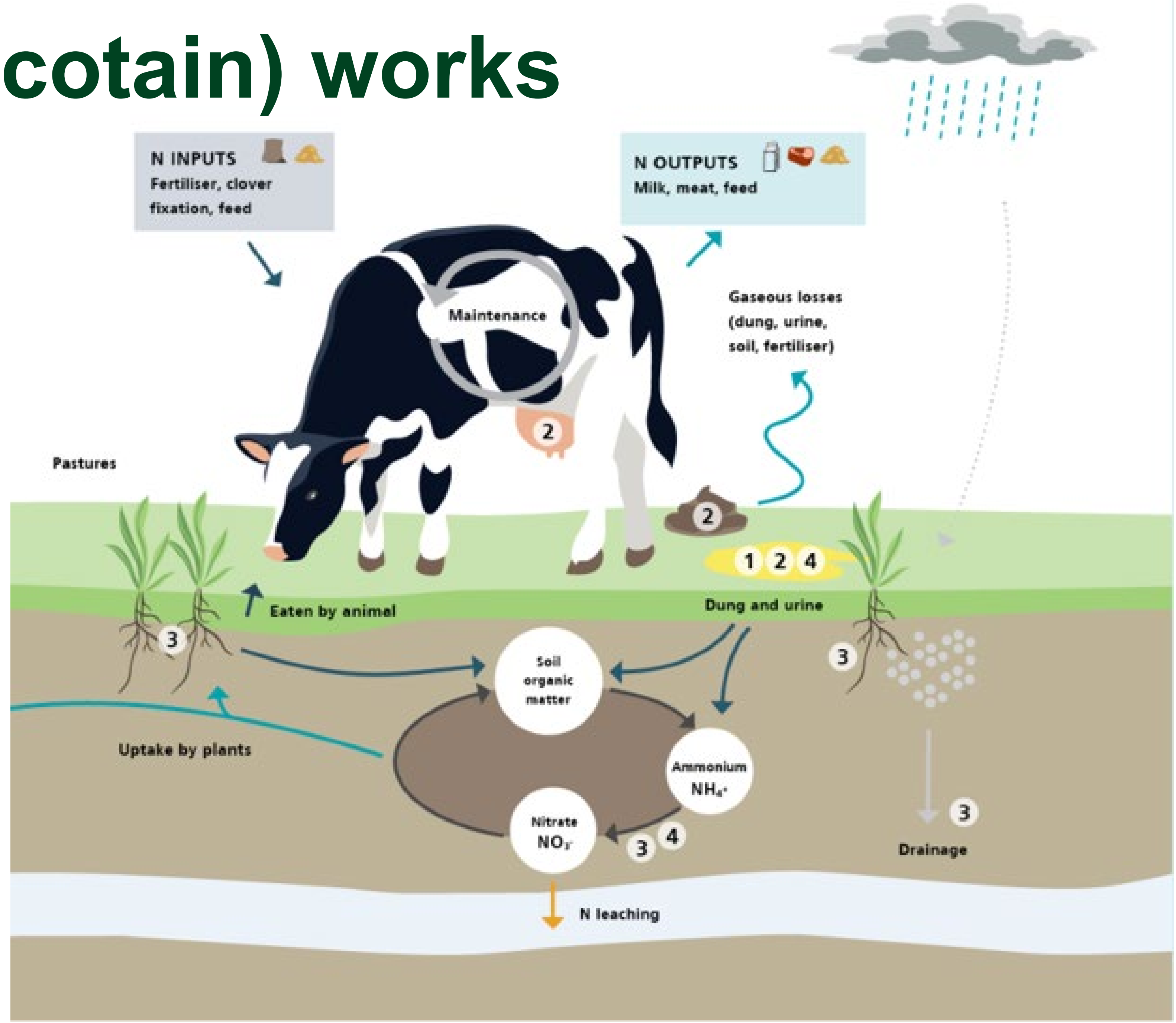
How plantain (ecotain) works

1. Dilution effect
Higher urination frequency & volume (lower DM%)

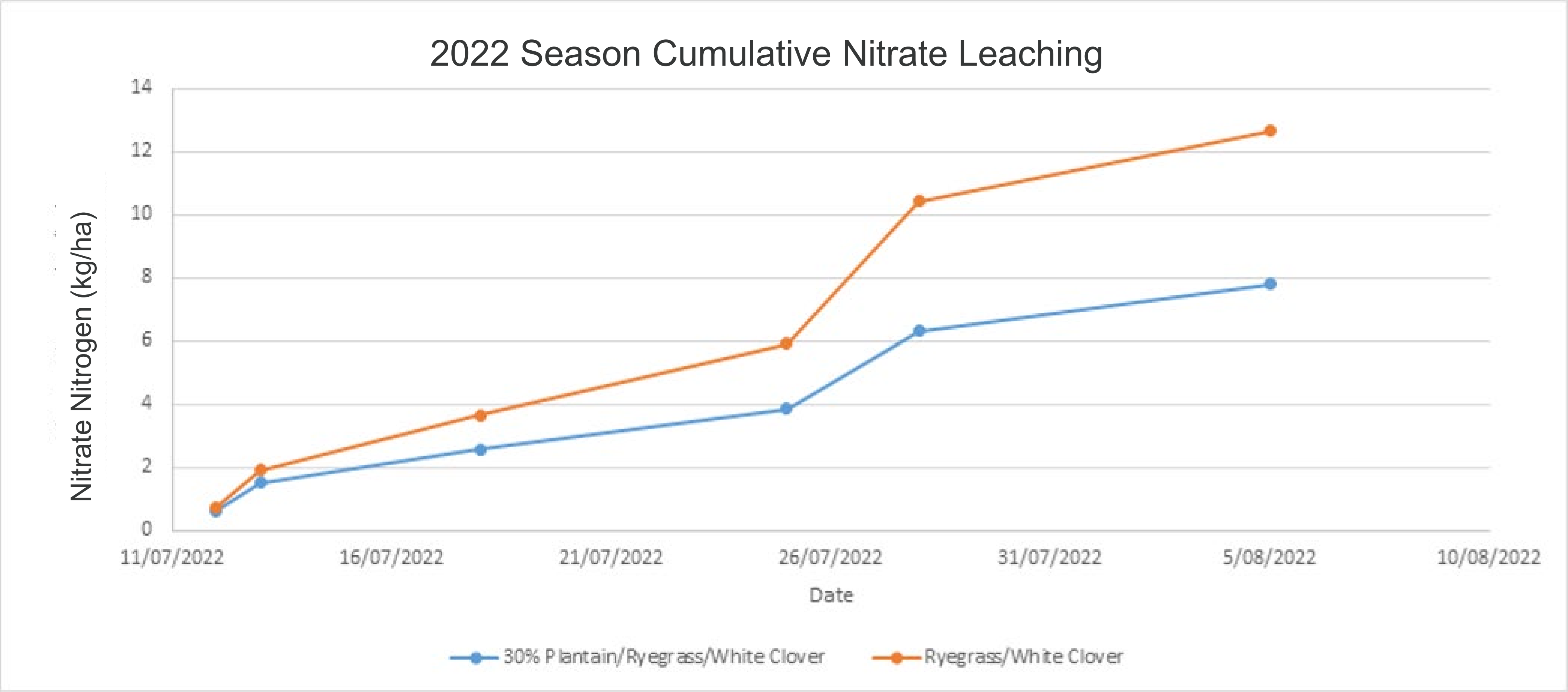
2. Partitioning effect
More N partitioned to dung vs. urine

3. Direct N retention effect
Secondary compounds in plantain roots slow down conversion of urine-urea N to nitrate

4. Indirect N retention effect
Secondary compounds in urine slow down conversion of urine-urea N to nitrate



Plantain (cv. Agritonic) at LURDF



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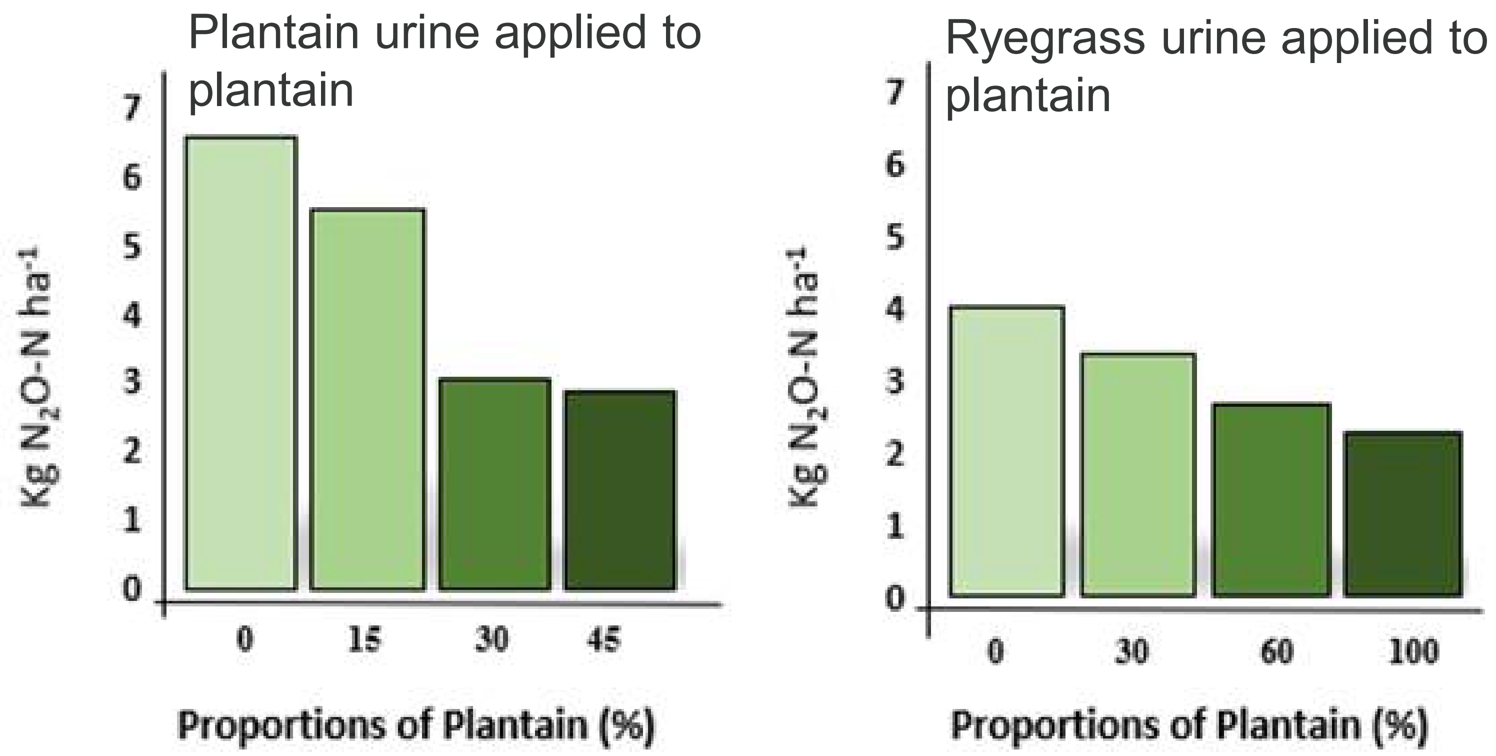
Nitrous oxide emissions

Data from AgResearch



Data from Massey

39% reduction in N_2O from 30% plantain

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N loss mitigation research: Improving water quality

Catch crops following winter crop grazing

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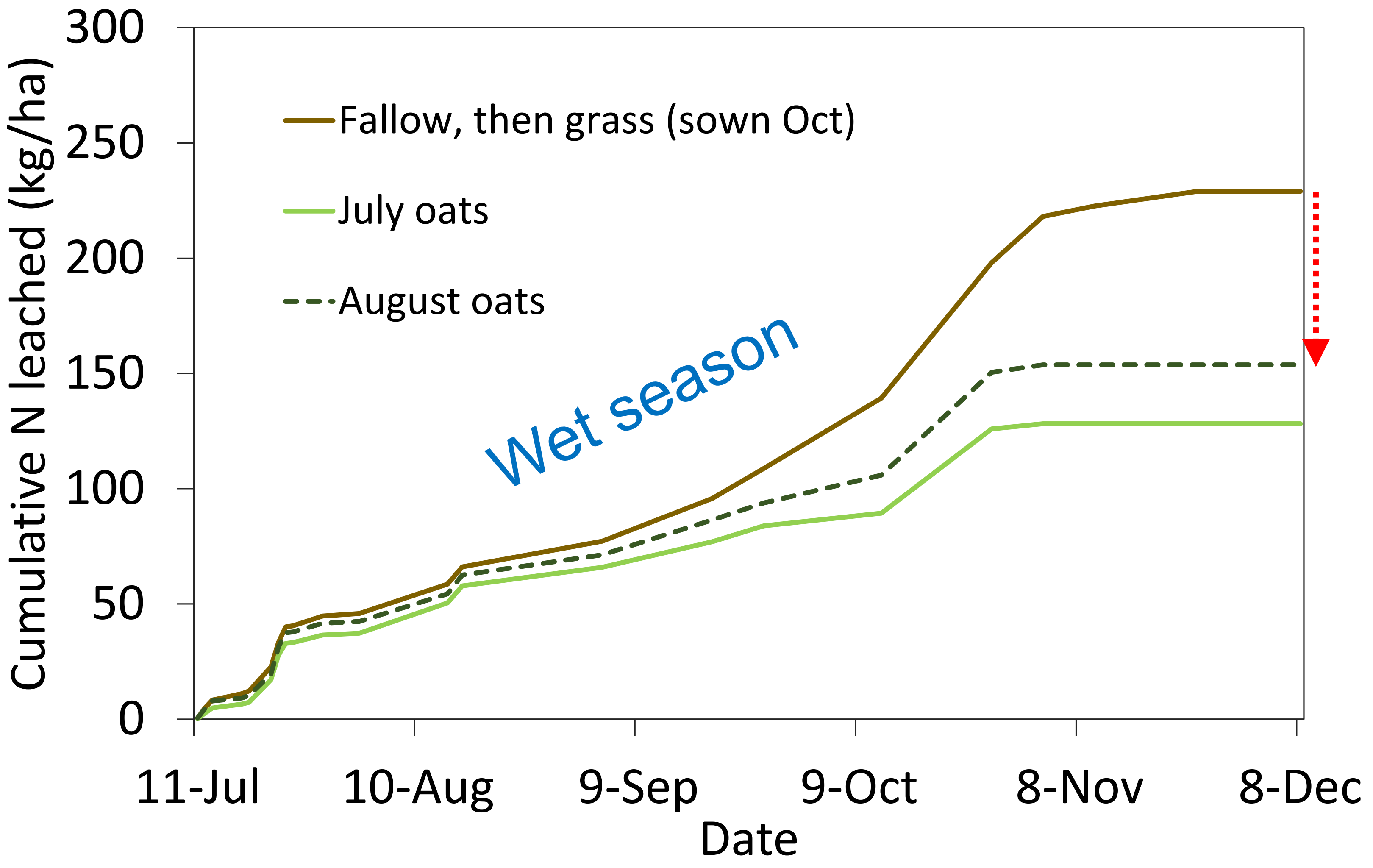
Catch crops can reduce leaching by up to 50%



Urine patch losses

Canterbury trial

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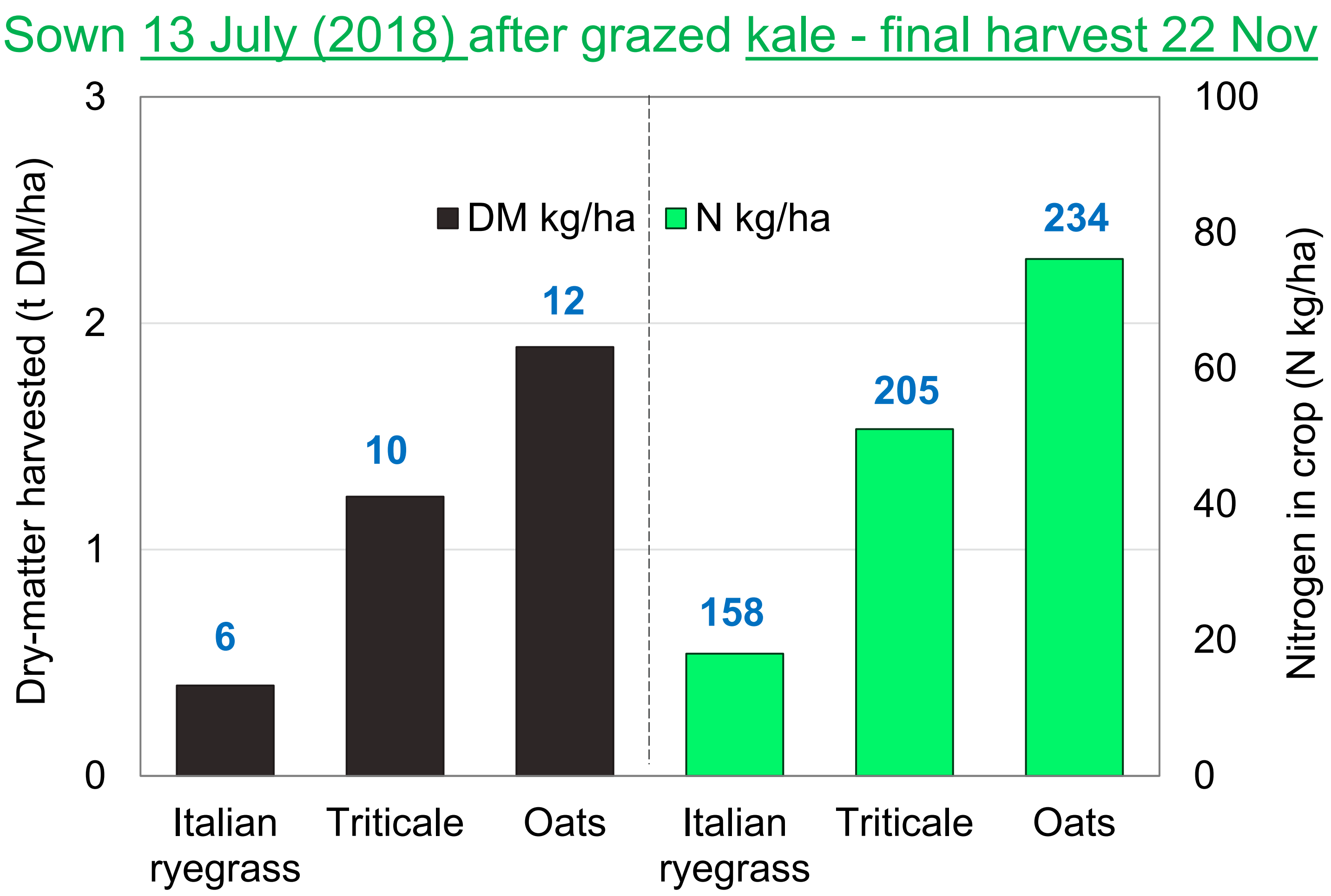
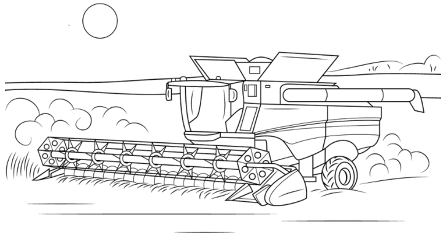
2. Select winter-active species

Cereals perform better than ryegrass



1st sampling 10 Oct



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N loss mitigation research: Improving water quality

Edge of field (EoF) nitrate mitigations

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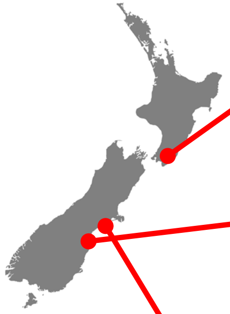
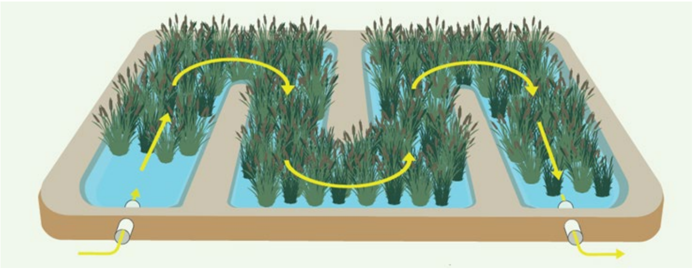
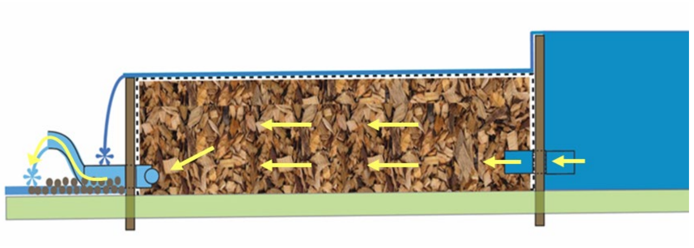
3 EoF case studies



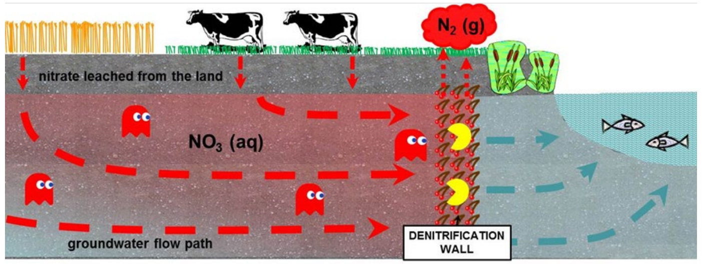
constructed wetland



denitrification bed



denitrification wall



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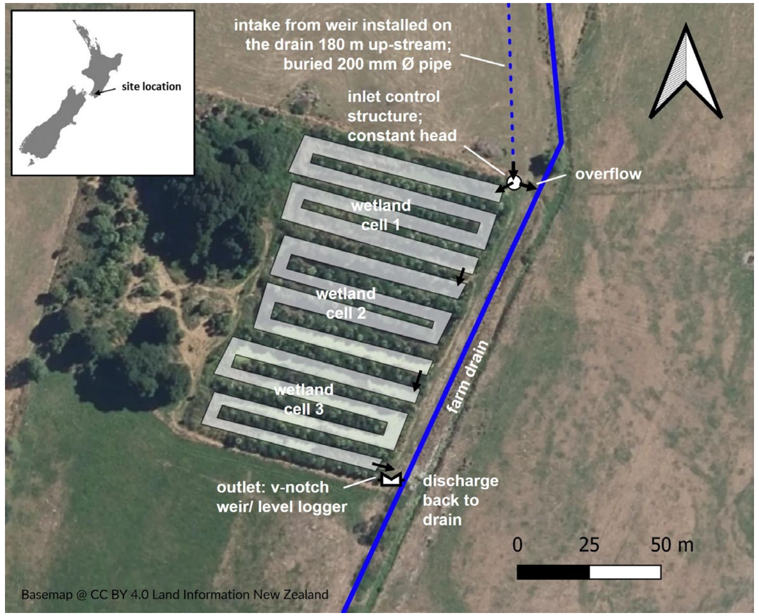
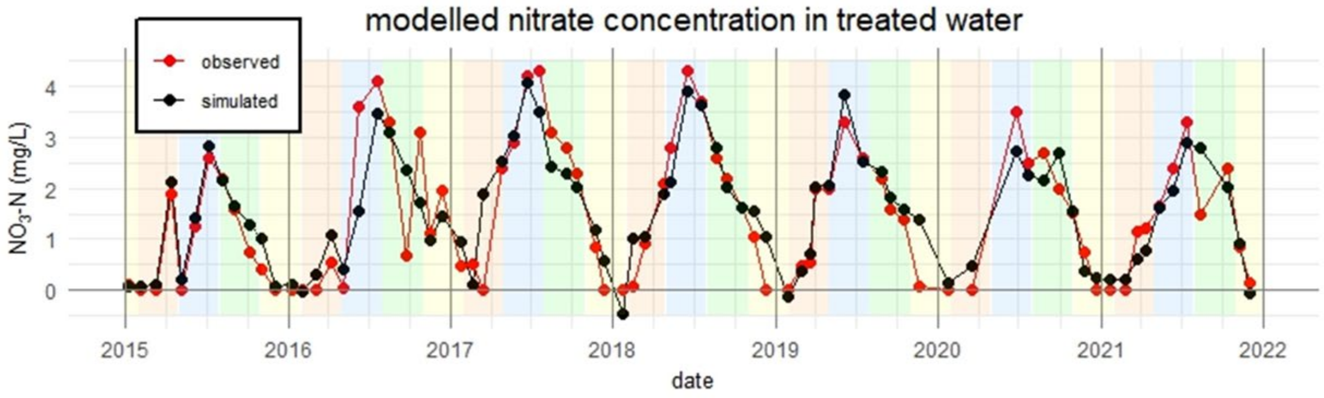
Analysing wetland performance

Evidence to underpin performance expectations





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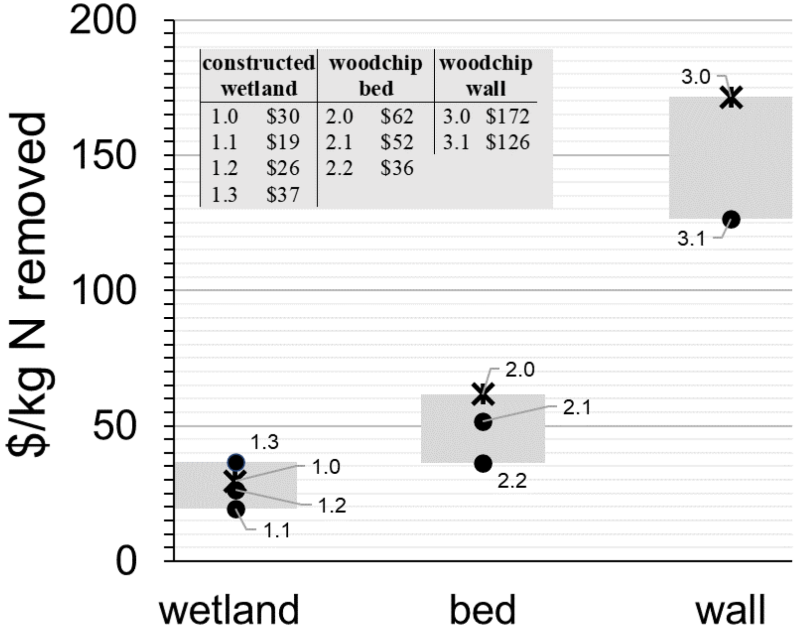
Cost-effectiveness of N-removal



Resource consents and compliance costs:

- Differ between regions.
- Added \$3.5k - \$6k (13 - 26%) to annualised cost of the mitigations examined.
- Are a significant cost burden to the cost-effectiveness of edge-of-field N-mitigation practices and present a barrier to uptake.

How are we helping farmers and what are the opportunities?

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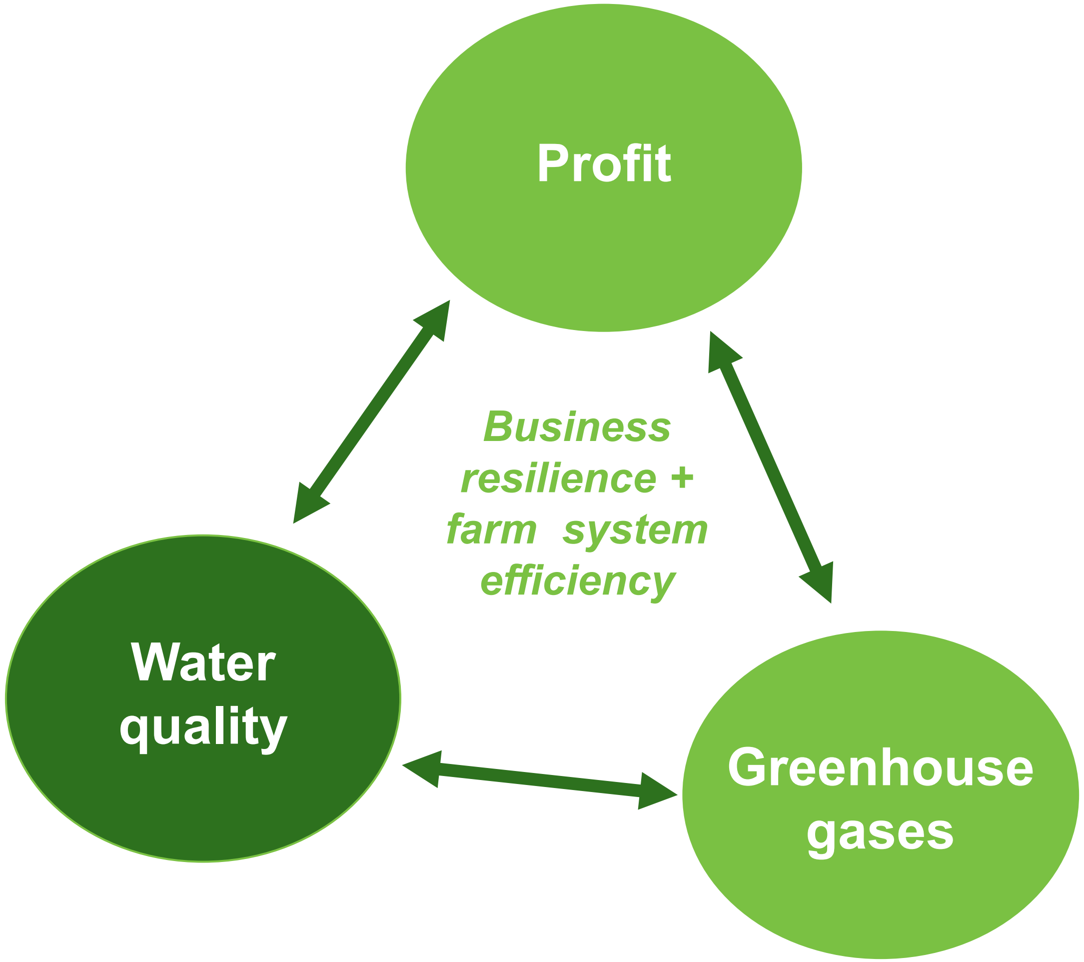
Project Step Change

- Integrated approach focussed on farm system efficiency
- Supporting on-farm solutions implemented by individual farmers considering economic and environmental footprint implications
- Delivered by a multidisciplinary team



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Advocating for fair regulation

- Submitting on proposed plan changes
- Providing evidence in the environment court
- Ongoing research

Promoting an evidence-based approach to regulation

IN THE ENVIRONMENT COURT
I MUA I TE KOOTI TAIAO O AOTEAROA

UNDER	of the Resource Management Act 1991
IN THE MATTER	of appeals under Clause 14 of the First Schedule of the Act
BETWEEN	**TRANSPOWER NEW ZEALAND LIMITED** (ENV-2018-CHC-26)
	FONTERRA CO-OPERATIVE GROUP LIMITED (ENV-2018-CHC-27)
	HORTICULTURE NEW ZEALAND (ENV-2018-CHC-28)
	ARATIATIA LIVESTOCK LIMITED (ENV-2018-CHC-29)

SUMMARY OF EVIDENCE OF DAWN ELLEN DALLEY FOR DAIRYNZ LTD AND FONTERRA COOPERATIVE GROUP LTD

4 February 2024

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Final Comments

Concluding remarks

- The tension between farm profit, environmental footprint, animal welfare and customer expectations has driven component and systems research in New Zealand for the last 15 years
- Change is inevitable, and the Australian dairy sector is unlikely to be immune
- Opportunity exists now for you to understand and address your environmental footprint

What does the future look like for your farm and what changes can you make now to control your destiny?


Ngā mihi nui
Thank you
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