Stacked mitigations for Edendale - Potential for N & Profit

Case study farmers:

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Funding partners

Ministry for Primary Industries
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In partnership with the Low N Systems programme

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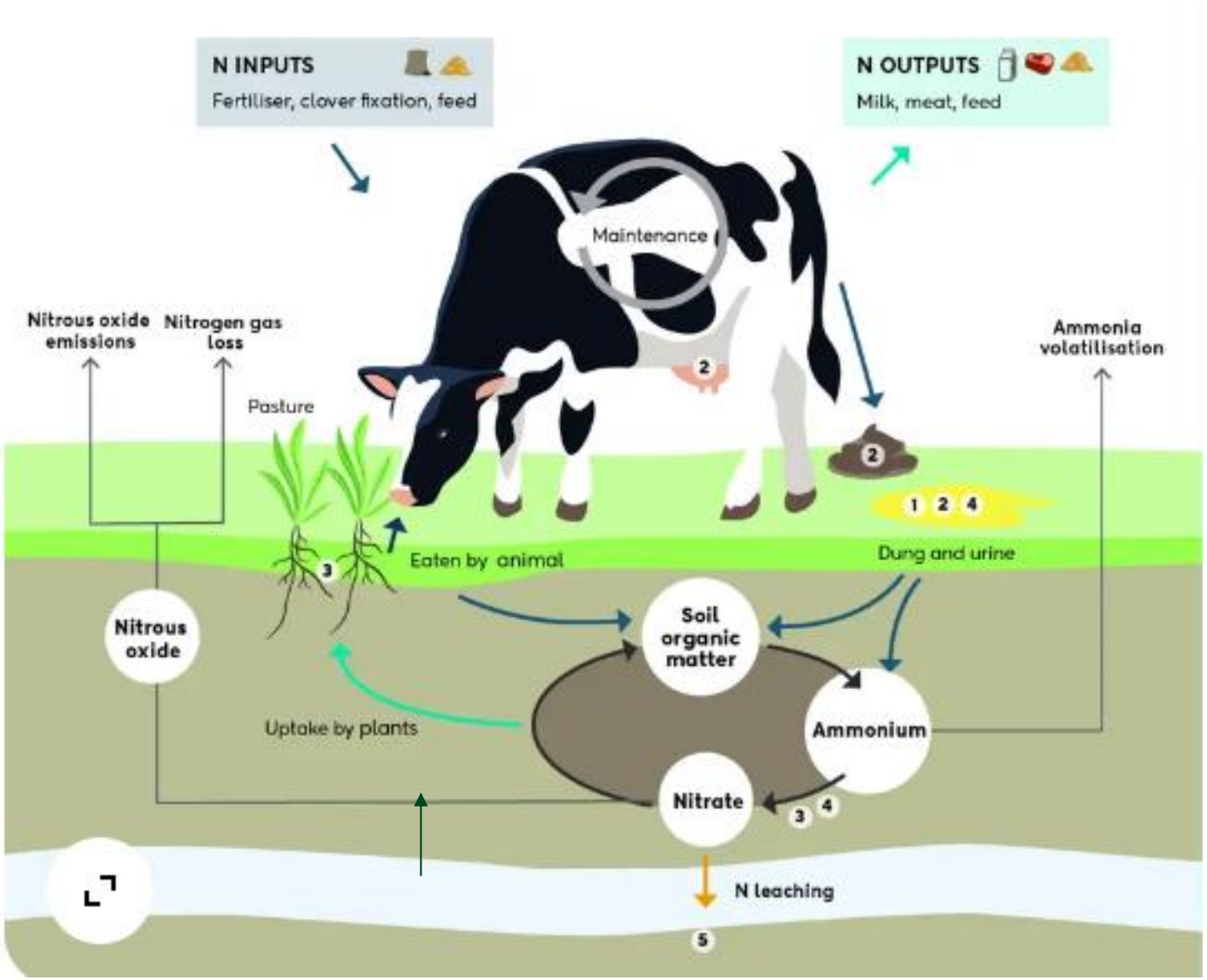
What we'll cover

- Understanding mitigation options for N leaching
- N loss and profit impacts from stacking mitigations on 5 Edendale farms
- Update on plantain research – paddock walk on Raemac

A huge thanks to the **Edendale Aquifer Group** project partners

Mitigations for N leaching & N_2O emissions



Lower N intake and inputs

- Reduce fertiliser
  - Clover: 0.4kg N/1kg reduction in N fert
- Reduce supplement
- Lower N supplement; lower N forage
- Earlier culling; Dry cows off early
- Retire land

Urinary N mitigations

- Plantain – reduced N/day and dilution through increased urine volume. 6% reduction leaching per 10% plantain
- Dilution through salt (not in Overseer)

Fertiliser and effluent practices

- Smaller, more timely N applications. Avoid late autumn/winter.
- Stand-off facilities/barns
- Larger effluent area

Reduce drainage and increase N uptake

- Manage irrigation
- Increase winter growth – Italian ryegrass (not in Overseer)
- Follow winter crops with catch crops
- Plantain

Solutions in the soil

- Reduce cultivation (disturbing organic matter)
- Plantain – reduced nitrification rate
- Wetlands

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Low N Systems – testing a mitigation stack in Lincoln, Canterbury

Canterbury scenario	Current Baseline	1. Reduce SR & Fert 80kg N/ha	2. Italian ryegrass	3. Plantain	4. Pasture wintering
N loss (kg/ha)	37	28	29	22	18
Farmgate N Surplus (kg N/ha)	261	205	206	203	205
Operating profit ($/ha)	4676	4465	4587	4491	4328
N loss % change (relative to baseline)	0%	-23%	-20%	-41%	-50%
GHG % change (relative to baseline)	0%	-9%	-9%	-10%	-11%
Operating profit % change (relative to baseline)	0%	-5%	-2%	-4%	-7%

- Preliminary results from year 1 similar to pre-trial modelling, supported by 50% reduction in N leaching on milking platform using ceramic suction cup measurements

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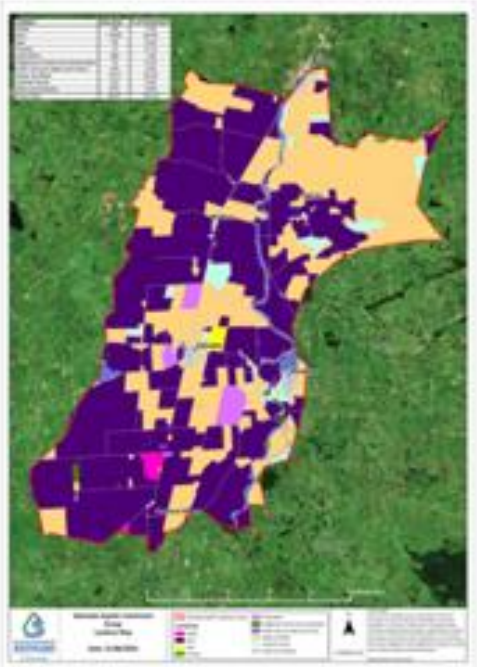
Modelling a stack for Edendale - approach

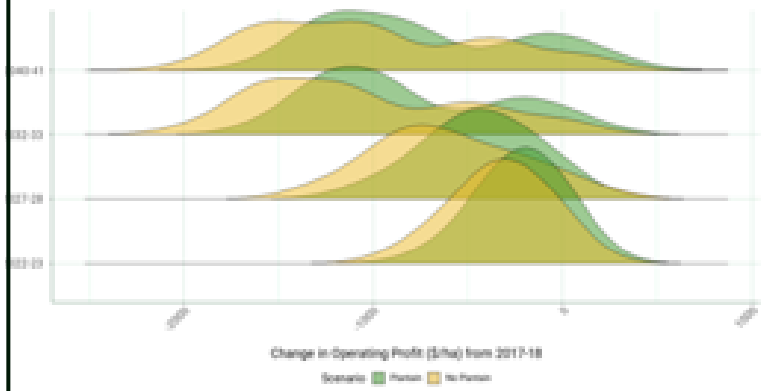


Catchment typologies

FARMAX

Overseer

Farm scale modelling
– 5 farms



Catchment scale economic and environmental modelling

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Summary of modelling results

Average of 5 Edendale farms

Mitigation	Description	N leaching change per step	OP change per step	Cumulative change from baseline
Baseline	2022.23			
Step 1	GMP: Lower CP supplement	0%	3%	
Step 4	GMP: reduce N fert by 10%	-4%	0%	-3% N leaching & +4% OP
Step 6	GMP: No N applied in winter	0%	0%	
Step 8	GMP: Direct drilling kale and swedes	-1%	-1%	
Step 9	Plantain 10% of pasture DM	-7%	0%	-17% N leaching & -1% OP
Step 10	Plantain 20% of pasture DM	-7%	-2%	
Step 11	Baleage wintering	-5%	-7%	-22% N leaching & -8% OP
Step 12	Retire 2.5 ha unproductive land	0%	1%	
Step 13	Retire 1 ha of milking platform	0%	0%	
Step 14	Reduce imported supplement by 25%	-4%	-7%	
Step 15	Limit fert to 100 kg N/ha	-7%	-1%	
Step 16	Limit fert to 50 kg N/ha	-3%	-5%	
Step 17	Reduce imported supplement by 50%	-1%	2%	-30% N leaching & -16% OP
Step 18	Stand-off pad	-16%	-14%	
Step 19	Zero N fert	-7%	-9%	-43% N leaching & -34% OP
Step 20	Wetland	-4%	-2%	

Low-hanging fruit

Exploring large N leaching reductions

More detail in handout

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Modelling wintering barns

- As an alternative to a stand-off pad, a freestall barn was modelled
- All cows now wintering on the platform
- This was step 19, after deintensification

Gleneden		Lowburn		Raemac		Richburn		Rimoo	
N leaching change	OP change	N leaching change	OP change	N leaching change	OP change	N leaching change	OP change	N leaching change	OP change
-2%	-41%	-7%	-50%	Already have a barn		-7%	-47%	0%	-34%

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Raemac Farm

Tim and Justine McRae – Owner / operators

155 ha milking platform, 84 ha support block

Peak cows milked	475	(3.1 cows / ha)
Cows wintered	500	
Young stock	Grazed off	
516 ms / cow	1581 ms / ha	
129 Kg N / ha	Purchases supplement 4.6 t / ha	
Current infrastructure	barn	

Unique features

- Integrated runoff
- Tulips
- Plantain trial farm

Modelling a stack - Raemac

Stack mitigation	Description	N leaching			Operating Profit	
		kg/ha	% change from baseline	% change this step	% change from baseline	% change this step
Baseline	2022.23	38				
Step 1	GMP: Lower CP feed	38	0%	0%	2%	2%
Step 4	GMP: reduce N fert by 10%	38	1%	1%	6%	4%
Step 6	GMP: shift winter N fert	38	1%	0%	7%	0%
Step 8	GMP: direct drill swedes	38	1%	0%	6%	0%
Step 9	Plantain 10% of pasture DM	36	-5%	-6%	6%	0%
Step 10	Plantain 20% of pasture DM	33	-11%	-6%	4%	-2%
Step 11	Baleage wintering youngstock	33	-11%	0%	-1%	-5%
Step 12	Retire 2.5 ha of unproductive land	33	-11%	0%	0%	1%
Step 14	Reduce imported supplement by 25%	33	-12%	-2%	-6%	-6%
Step 15	Limit fert to 100 kg N/ha	31	-18%	-6%	-5%	1%
Step 16	Limit fert to 50 kg N/ha	30	-20%	-3%	-11%	-7%
Step 17	Reduce imported supplement by 50%	30	-21%	-1%	-10%	2%
Step 19	Zero N fert	28	-24%	-5%	-21%	-12%
Step 20	Wetland of 0.27 ha	27	-26%	-2%	-23%	-3%

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Rimoo Farm

Nicola and Richard Abbott – Owner / operators

151 ha milking platform

Peak cows milked	422	(2.8 cows / ha)
Cows wintered	Wintered off	
Young stock	Grazed off	
485 ms / cow	1356 ms / ha	
85 Kg N / ha	Purchases supplement 0.1 t / ha	
Current infrastructure	None	

Unique features

- Rolling contour
- Tile drained

Modelling a stack - Rimoo

Stack mitigation	Description		N leaching		Operating Profit	
		kg/ha	% change from baseline	% change this step	% change from baseline	% change this step
Baseline	2022.23	34				
Step 4	GMP: reduce N fert by 10%	32	-7%	-7%	-2%	-2%
Step 9	Plantain 10% of pasture DM	29	-13%	-7%	-2%	0%
Step 10	Plantain 20% of pasture DM	27	-20%	-7%	-3%	-1%
Step 11	Baleage wintering	26	-23%	-4%	-8%	-5%
Step 12	Retire 1 ha of unproductive land	26	-23%	0%	-8%	0%
Step 14	Reduce imported supplement by 25%	26	-24%	-2%	-8%	-1%
Step 16	Limit fert to 50 kg N/ha	24	-30%	-8%	-13%	-5%
Step 17	Reduce imported supplement by 50%	23	-32%	-2%	-16%	-4%
Step 18	Stand-off pad	18	-46%	-21%	-27%	-13%
Step 19	Zero N fert	17	-51%	-10%	-44%	-24%

Richburn

Fortuna – Manager

161 ha milking platform

Peak cows milked	433 (2.8 cows / ha)
Cows wintered	Wintered off
Young stock	Grazed off
512 ms / cow	1411 ms / ha
152 Kg N / ha	Purchases supplement 1.9 t / ha
Current infrastructure	Redpath – 300 cows but used for less

Modelling a stack - Richburn

Stack mitigation	Description		N leaching		Operating Profit	
		kg/ha	% change from baseline	% change this step	% change from baseline	% change this step
Baseline	2022.23	34				
Step 1	GMP: Replace high CP feeds	34	0%	0%	1%	1%
Step 4	GMP: reduce N fert by 10%	31	-9%	-8%	-1%	-2%
Step 9	Plantain 10% of pasture DM	29	-15%	-7%	-2%	0%
Step 10	Plantain 20% of pasture DM	27	-21%	-7%	-3%	-1%
Step 11	Baleage wintering	24	-28%	-9%	-9%	-7%
Step 14	Reduce imported supplement by 25%	23	-33%	-6%	-18%	-10%
Step 15	Limit fert to 100 kg N/ha	21	-38%	-8%	-20%	-2%
Step 16	Limit fert to 50 kg N/ha	21	-38%	-1%	-29%	-12%
Step 17	Reduce imported supplement by 50%	21	-39%	0%	-24%	8%
Step 18	Stand-off pad	17	-50%	-19%	-31%	-10%
Step 19	Zero N fert	16	-54%	-6%	-40%	-13%

Gleneden

Fortuna – Contract milker

495 ha effective

Peak cows milked	1309 (2.9 cows / ha)
Cows wintered	Wintered off
Young stock	Grazed off
371 ms / cow	982 ms / ha
94 Kg N / ha	Purchases supplement 1.7 t / ha
Current infrastructure	small barn used for some cows

Modelling a stack - Gleneden

Stack mitigation	Description		N leaching		Operating Profit	
		kg/ha	% change from baseline	% change this step	% change from baseline	% change this step
Baseline	2022.23	31				
Step 1	GMP: Lower CP supplement	31	0%	0%	5%	5%
Step 4	GMP: reduce N fert by 10%	30	-4%	-4%	5%	0%
Step 5	GMP: Increase use of Red Path	29	-6%	-2%	4%	-1%
Step 6	GMP: No N applied in winter	29	-6%	-1%	4%	0%
Step 8	GMP: Direct drilling kale and swedes	29	-7%	-1%	1%	-2%
Step 9	Plantain 10% of pasture DM	27	-14%	-7%	1%	0%
Step 10	Plantain 20% of pasture DM	25	-20%	-7%	-3%	-3%
Step 11	Baleage wintering	23	-26%	-8%	-14%	-13%
Step 14	Reduce imported supplement by 25%	22	-28%	-3%	-20%	-6%
Step 16	Limit fert to 50 kg N/ha	22	-30%	-2%	-19%	0%
Step 17	Reduce imported supplement by 50%	21	-33%	-4%	-22%	-3%
Step 18	Stand-off pad	18	-41%	-12%	-35%	-18%
Step 19	Zero N fert	18	-43%	-5%	-34%	3%

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Lowburn Farm

Jon and Birgit Pemberton – Owner / operators

2 properties Lowburn (owned) Menzies (leased)
365 ha milking platform

Peak cows milked	1068 (2.9 cows / ha)
Cows wintered	Wintered off
Young stock	Grazed off
480 ms / cow	1404 ms / ha
69 Kg N / ha	Purchases supplement 3.9 t / ha
Current infrastructure	1 feedpad for 800 cows at Menzies

Unique features

- Terrace – wetland opportunity
- Next to Mataura River – floodable (2/3 of Menzies floodable)

Modelling a stack – Lowburn

Stack mitigation	Description		N leaching		Operating Profit	
		kg/ha	% change from baseline	% change this step	% change from baseline	% change this step
Baseline	2022.23	31				
Step 4	GMP: reduce N fert by 10%	30	-2%	-2%	-1%	-1%
Step 6	GMP: Shift winter N application	30	-3%	0%	0%	1%
Step 9	Plantain 10% of pasture DM	28	-9%	-7%	0%	0%
Step 10	Plantain 20% of pasture DM	26	-16%	-8%	-2%	-1%
Step 13	Retire 1 ha of milking platform	26	-16%	0%	-2%	0%
Step 14	Reduce imported supplement by 25%	23	-24%	-9%	-13%	-12%
Step 16	Limit fert to 50 kg N/ha	23	-25%	-2%	-13%	0%
Step 17	Reduce imported supplement by 50%	23	-24%	1%	-8%	5%
Step 18	Stand-off pad	20	-34%	-13%	-24%	-17%
Step 19	Zero N fert	18	-41%	-11%	-30%	-7%
Step 20	Wetland	17	-46%	-7%	-31%	-2%

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Modelling key messages

Plantain and lowering N fertiliser inputs are the low hanging fruit

To consider next: Baleage wintering, standoff, deintensifying.

Consider wetlands in the right place

Barns can have a place but require a tailored system.

Fonterra Edendale farm overview

March 2025

Edendale site overview

Fonterra Edendale site overview

- Site capacity to process 16.4 million litres of milk each day – August to June

- Wastewater is unclean water originating from:
  - factory and tanker wash bay, both milk components and cleaning chemicals
  - rinsing and cleaning of equipment and silos, spillages, product losses and renewal of cleaning solutions.
  - contaminated stormwater can also be transferred to wastewater when it is outside its permitted conditions.

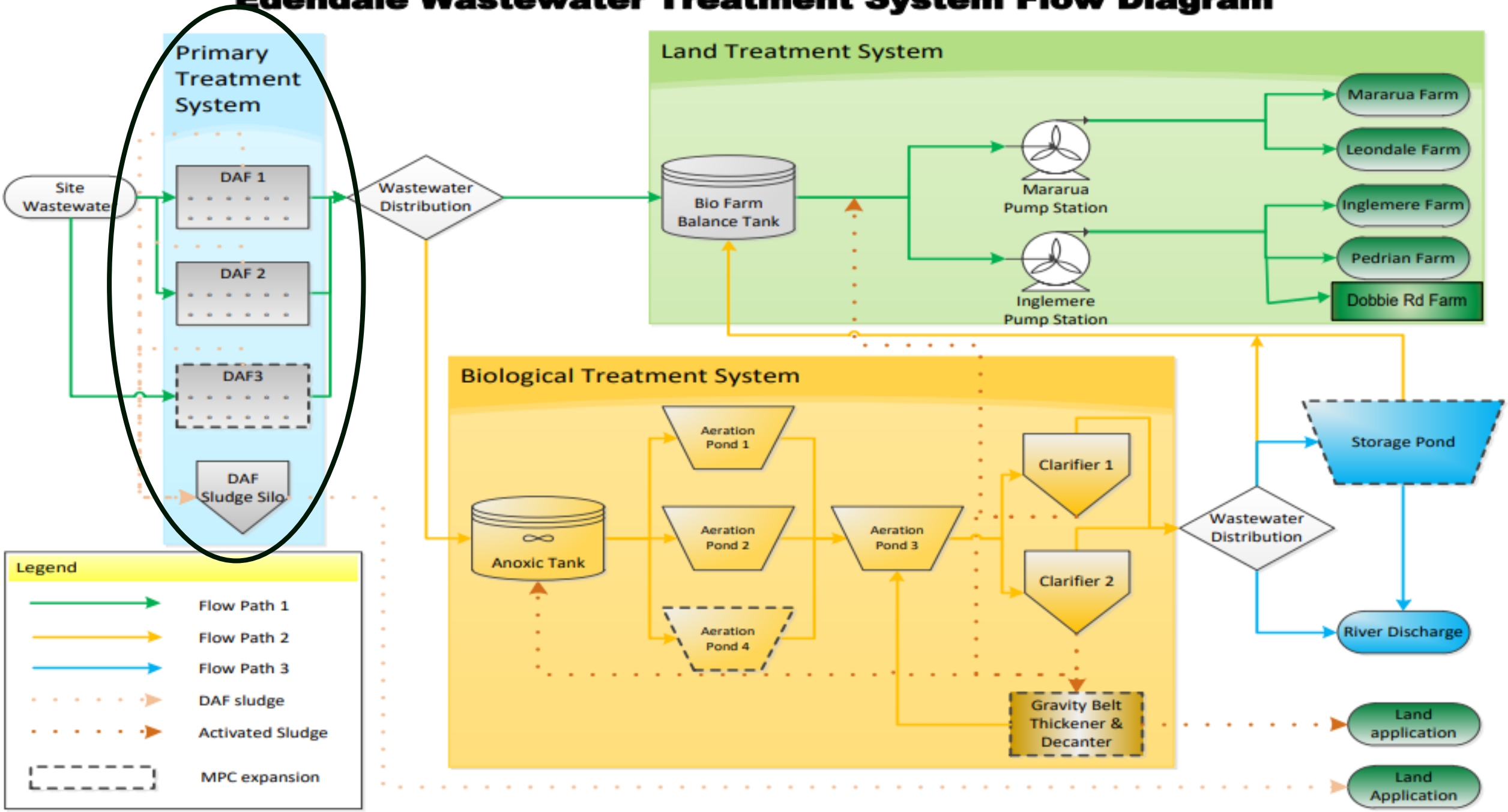
- Peak wastewater volumes October-November – upto12 million litres per day

- Irrigated to land or discharged to the Mataura River after treatment.

- Irrigation takes place on the Fonterra farms,
  - 8km radius of the Fonterra Edendale Factory.
  - 790Ha of irrigated land and 89Ha of non-irrigated land.

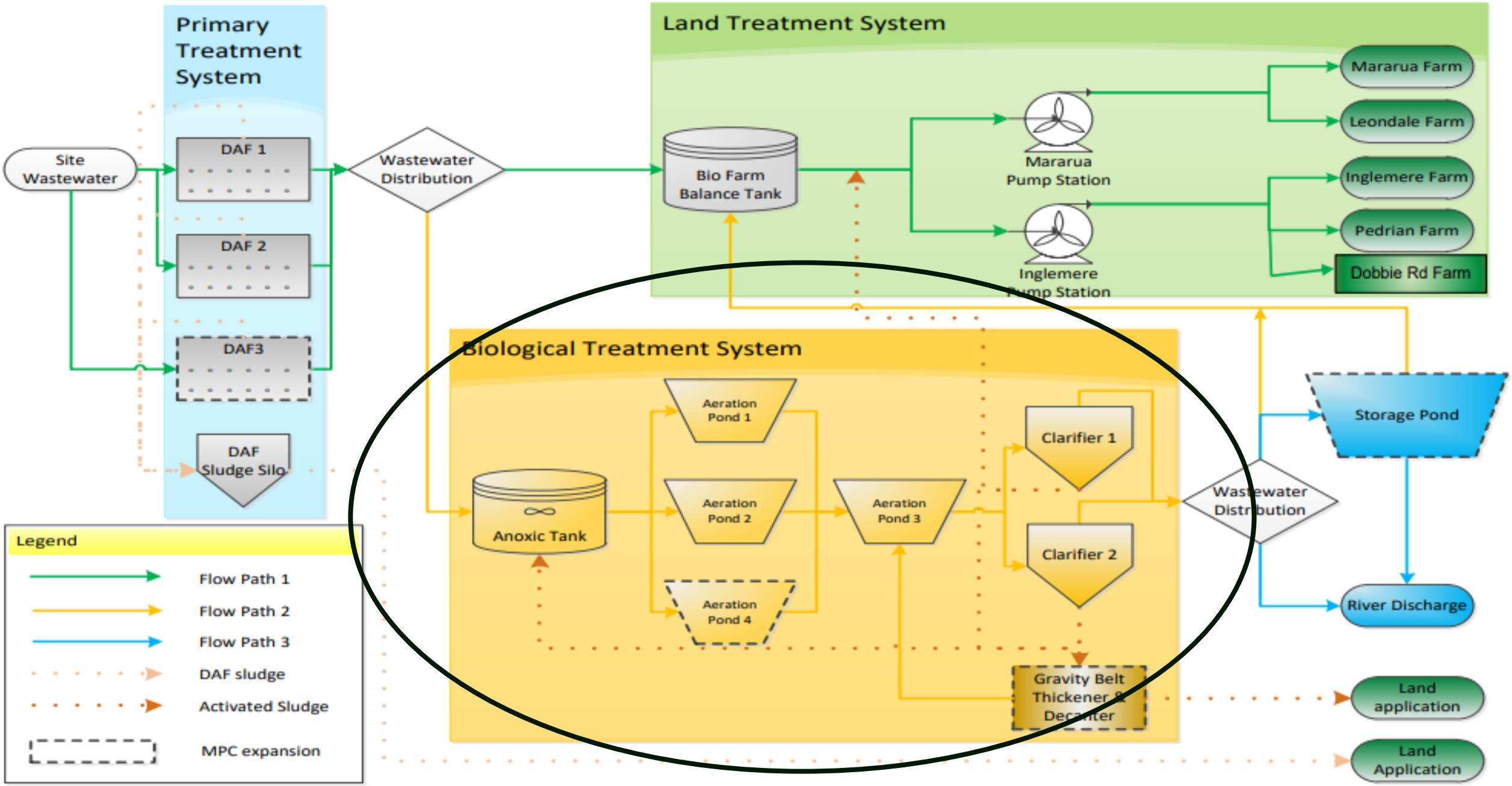
Wastewater treatment

Edendale Wastewater Treatment System Flow Diagram



Primary treatment (DAF)

Edendale Wastewater Treatment System Flow Diagram



Anoxic tank

Aeration ponds

Clarifiers

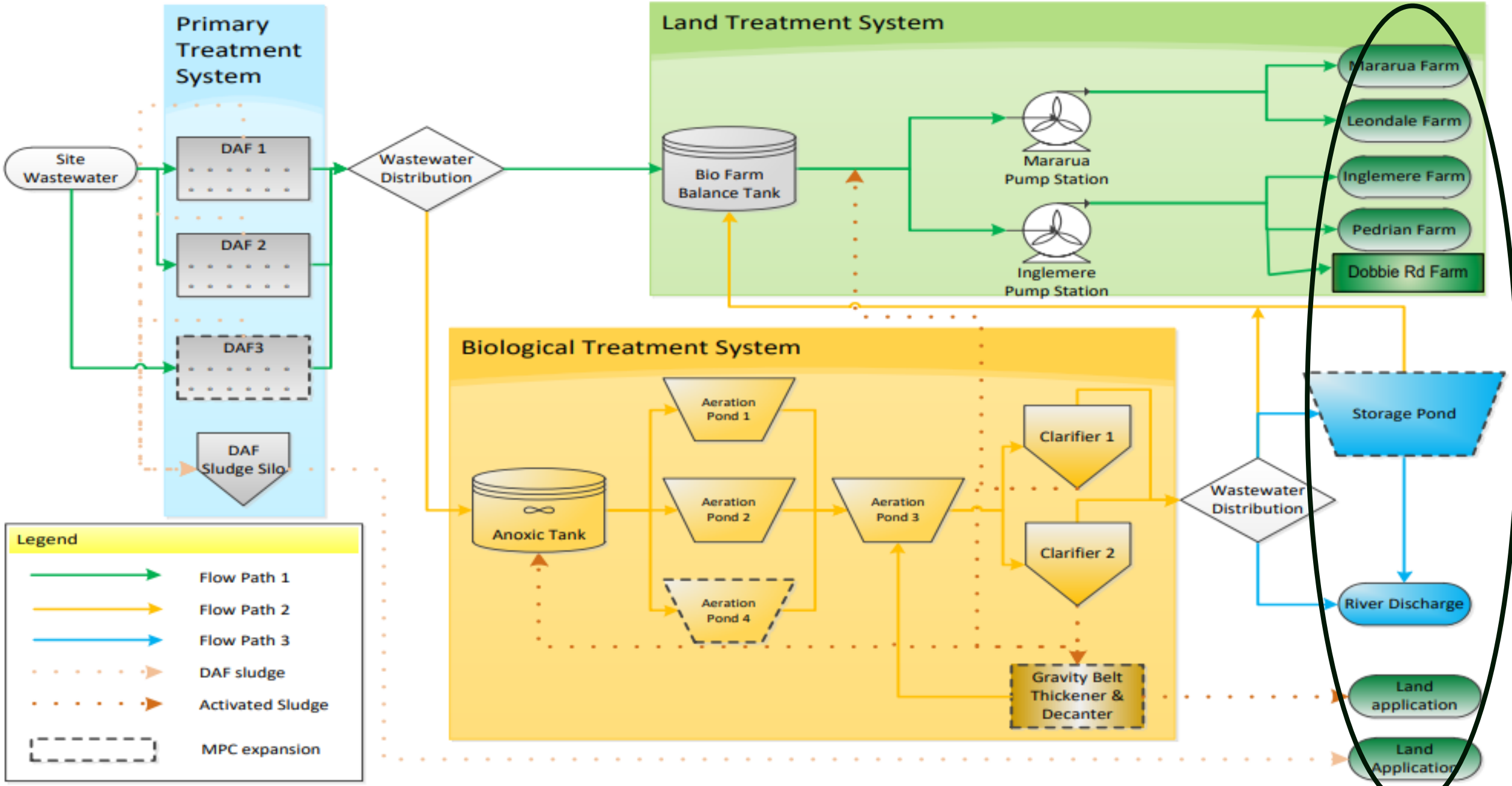
Secondary treatment (Biological)

Treated storage pond

Acts as a buffer if there is too much wastewater to discharge river or irrigation

Mitigates risk from severe weather or soil conditions

Edendale Wastewater Treatment System Flow Diagram



Irrigation to land

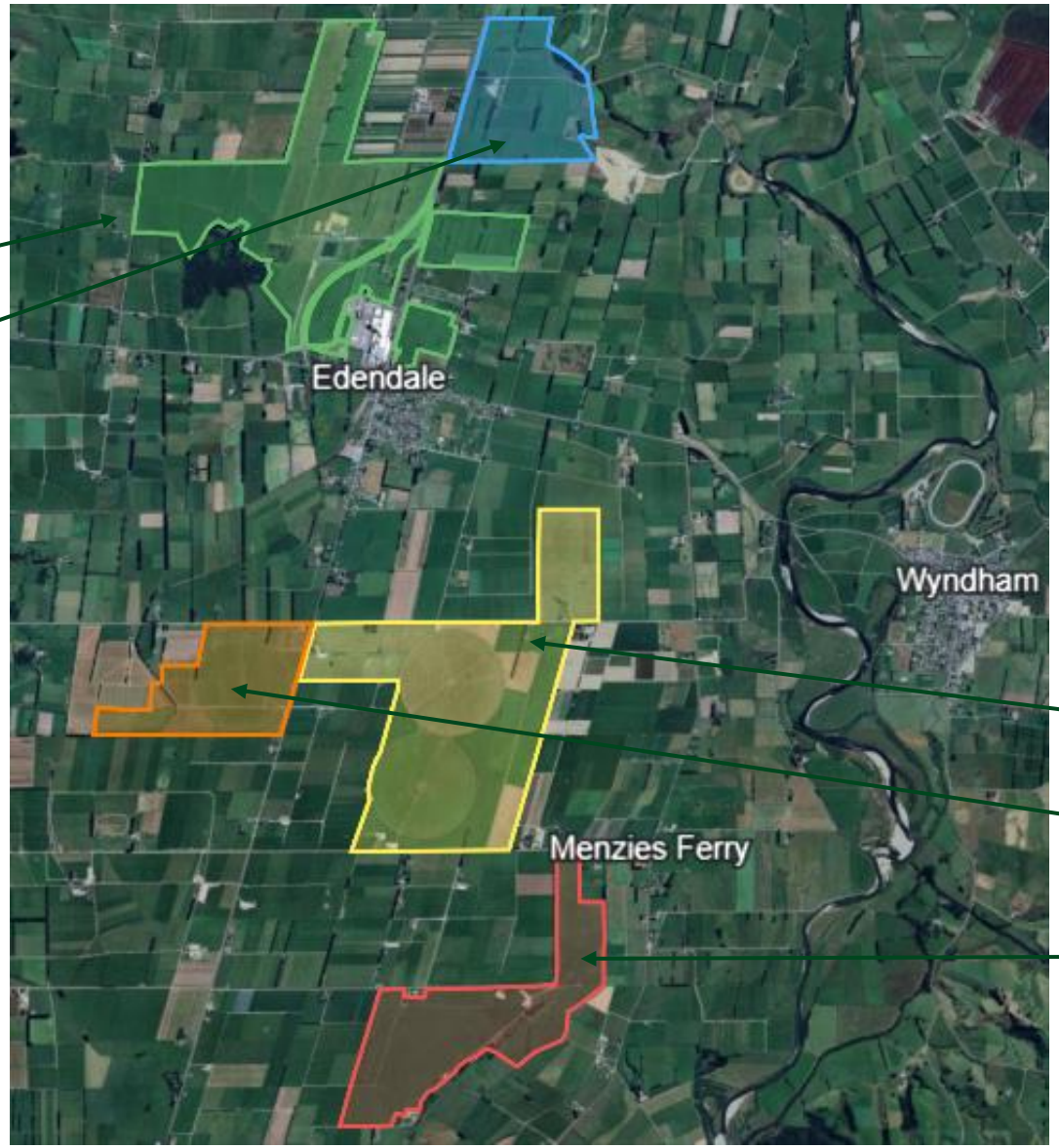
- The treated wastewater that is discharged from the Wastewater Treatment Plant is irrigated to
  - Mararua, 188 ha; in-ground irrigation
  - Leondale, 147 ha; in-ground irrigation
  - Inglemere, 192 ha; 2x450m centre pivots = 133ha (66.5ha per pivot); in-ground irrigation = 184 ha.
  - Pedrian 106 ha; 380m centre pivot = 50.2ha; in-ground sprinklers = 25.5ha
  - Dobbie Rd Farms 120.1 ha; pivot irrigator = 69.2 ha; in-ground irrigation = 44.9 ha

- Pumped to the Mataura River if resource consent conditions are met.

North farms

Mararua

Leondale



South farms

Inglemere

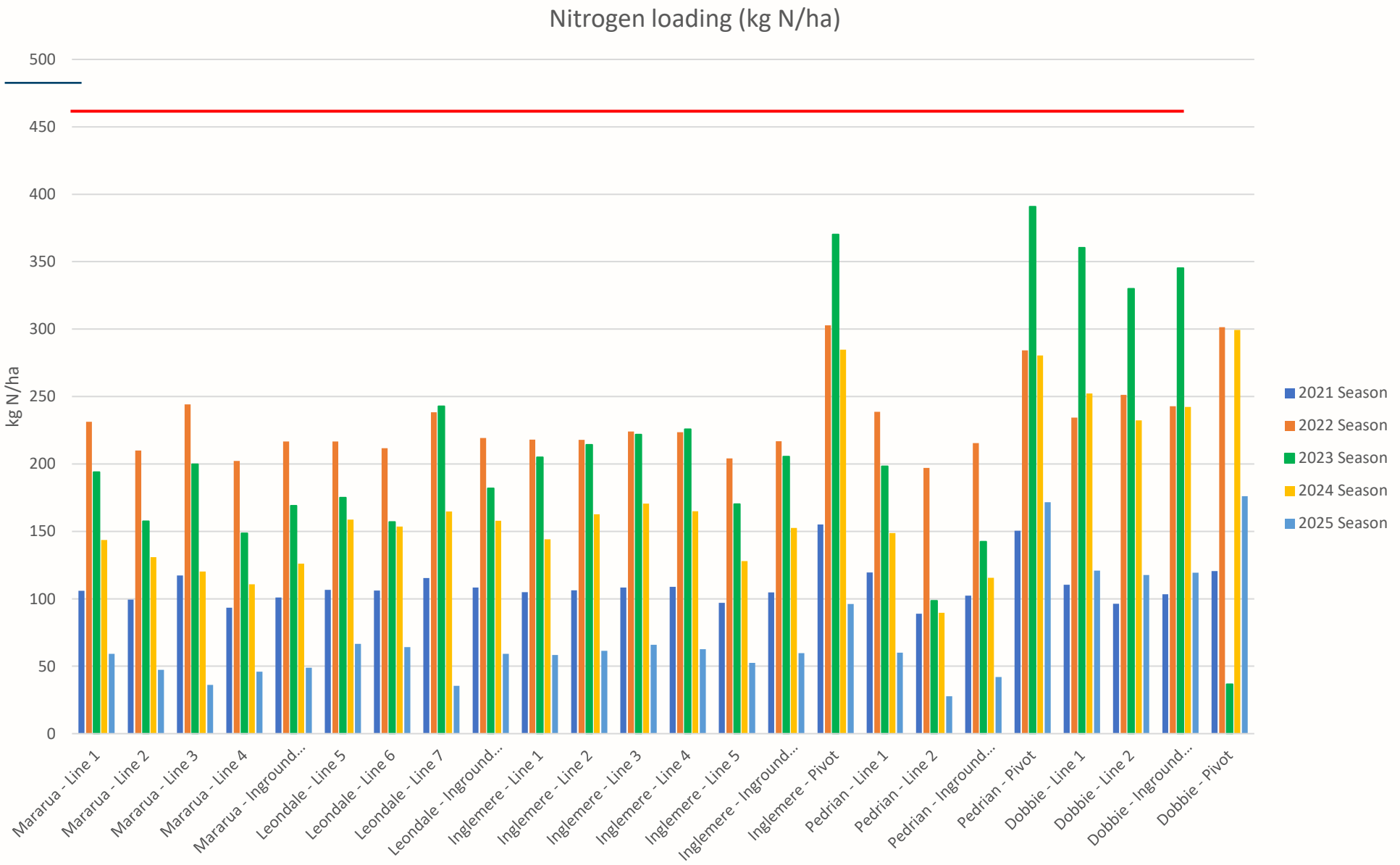
Pedrian

Dobbie

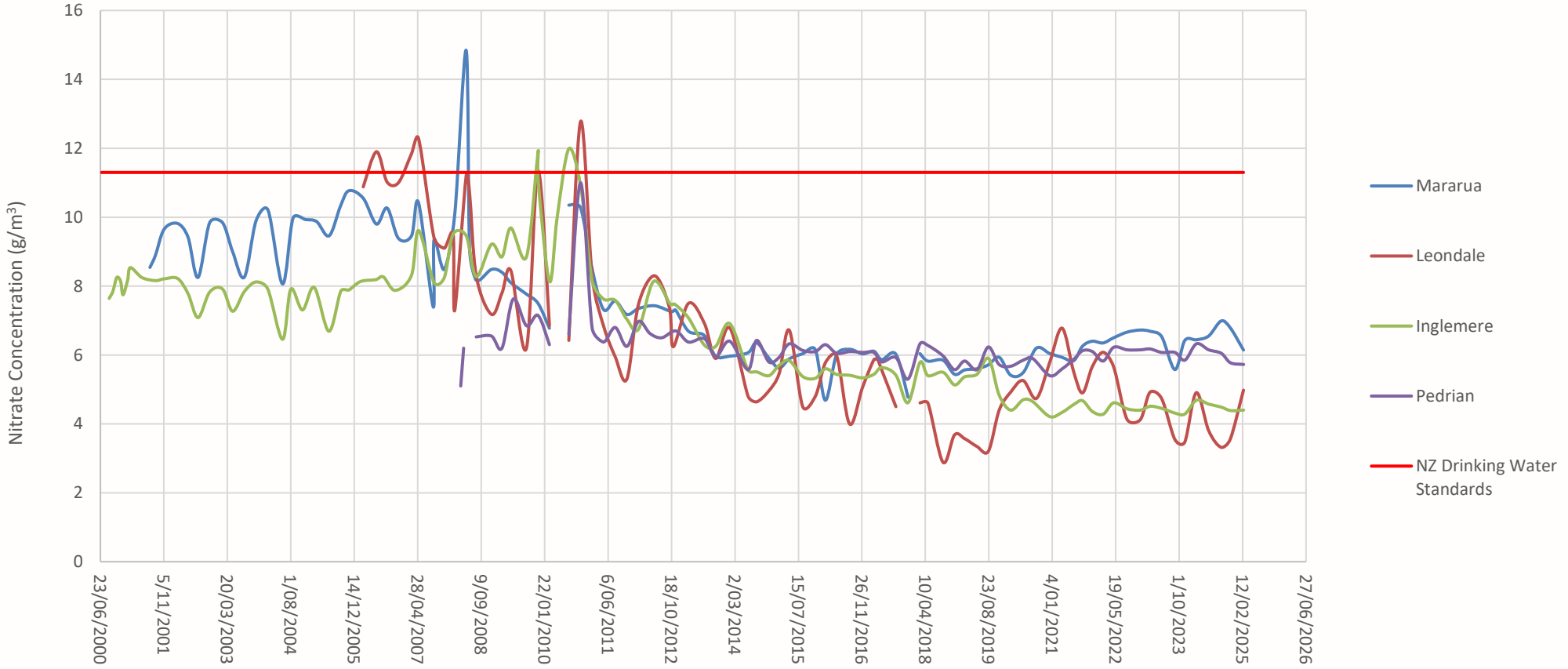
Irrigation to land monitoring

- Daily, weekly, monthly irrigation samples
- Monthly lysimeter leaching sampling
- Bi-Monthly soil chem sampling
- Quarterly bore monitoring (26 Bores across 5 farms)
- Quarterly creek monitoring (Oteramika and Ives streams)

Irrigation loading – annual limit of 450kg/ha (Last 5 years)



Nitrates in groundwater (Last 25 years)



Modelling key messages

Plantain and lowering N fertiliser inputs are the low hanging fruit

To consider next: Baleage wintering, standoff, deintensifying.

Consider wetlands in the right place

Barns can have a place but require a tailored system.

Edendale Aquifer Group

Understanding Nitrogen | Foundation Project

Understanding the movement, interactions, and monitoring of nutrients, particularly nitrogen, through the Edendale Catchment

If you want to stay up to date with our progress, check out our Facebook Page and join our email list

Edendale Aquifer Group - Short feedback form

Plantain and lowering N fertiliser – low hanging fruit

- Reduce N fert 10% + earlier culling gives
  - small-moderate gains with minimal or positive profit impact
- Other GMP steps
  - give small gains with minimum profit impact
- Plantain 10%
  - 7% N reduction and <1% OP
  - Incorporate new pastures @ 3kg/ha
- Plantain 20%
  - 14 % N reduction (further 7% reduction) and -1% to -4% OP
  - Broadcast 6kg/ha prill coat + regrassing (approx. x 10 cost of 10% plantain)

Plantain and lowering N fertilizer inputs are the low hanging fruit

To consider : baleage wintering, standoff, deintensifying.

- Baleage wintering variable impact (0-9%), moderate-high cost
- Limit fert to 100kg/ha moderate impact, low cost
- Reduced imported supplement low-moderate impact, moderate to high cost
- Reduce fert to 50kg/ha low-moderate impact, low-high cost
- Standoff pad big impact, big cost

Landscape and system change options

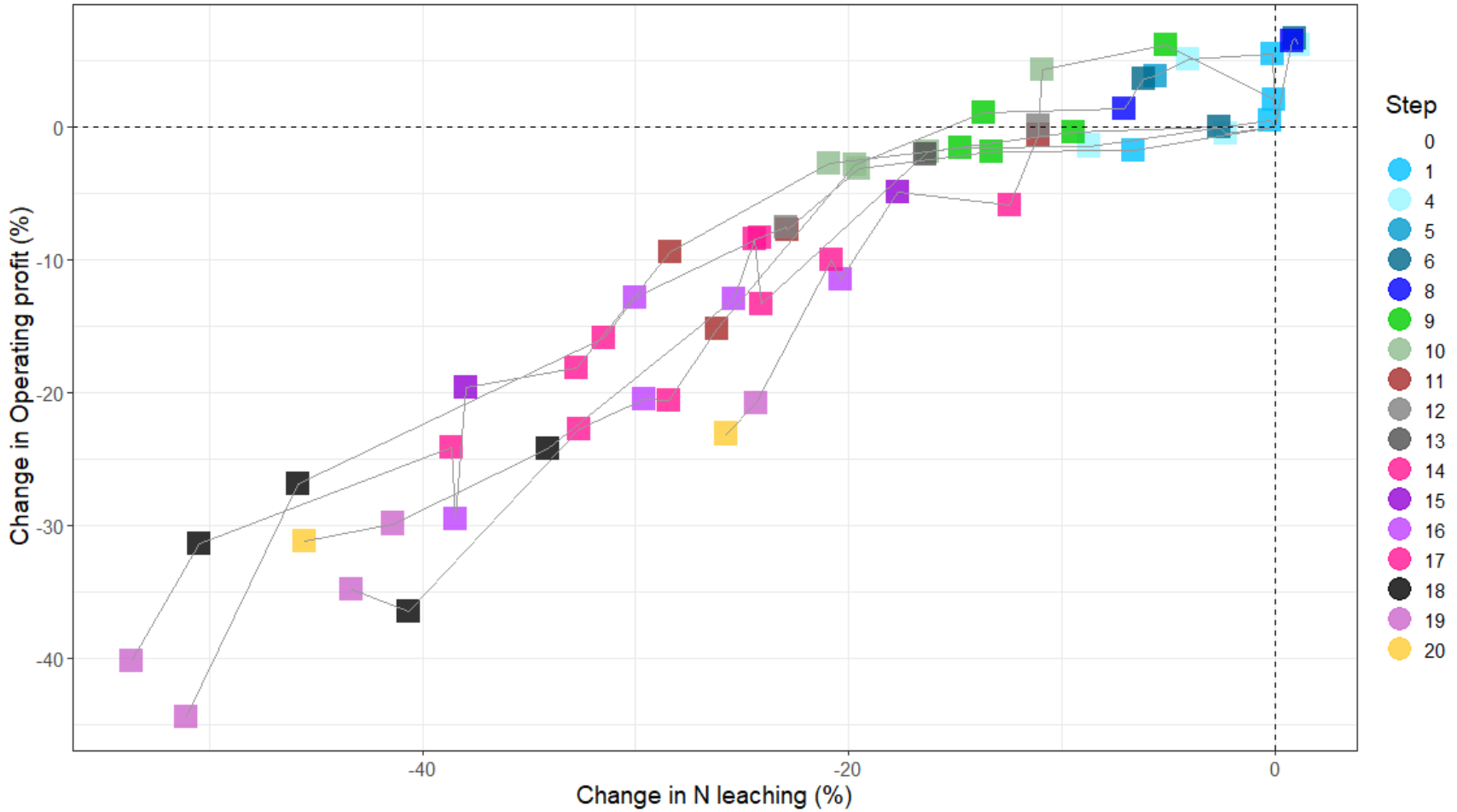
- Consider wetlands in the right place
  - Wetland moderate impact, low-moderate cost

- Barns - require a tailored system
  - Profitability challenging in low intensity system
  - If currently wintering off may not be an environmental mitigation
  - Managing nutrients becomes key

Modelling Detail

5 case study farms

Change in profit and leaching from Edendale stack for 5 farms



GMP

Plantain

Baleage wintering

Land retirement

Deintensification

Stand off Pad

Wetland

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Modelling the stack for 5 farms – cumulative result

Mitigation	Description	Gleneden N leaching change	Gleneden OP change	Lowburn N leaching change	Lowburn OP change	Raemac N leaching change	Raemac OP change	Richburn N leaching change	Richburn OP change	Rimoo N leaching change	Rimoo OP change
Baseline	2022.23										
Step 1	GMP: Lower CP supplement	0%	5%			0%	2%	0%	1%		
Step 4	GMP: reduce N fert by 10%	-4%	5%	-2%	-1%	1%	6%	-9%	-1%	-7%	-2%
Step 6	GMP: No N applied in winter	-6%	4%	-3%	0%	1%	7%				
Step 8	GMP: Direct drilling kale and swedes	-7%	1%			1%	6%				
Step 9	Plantain 10% of pasture DM	-14%	1%	-9%	0%	-5%	6%	-15%	-2%	-13%	-2%
Step 10	Plantain 20% of pasture DM	-20%	-2%	-16%	-2%	-11%	4%	-21%	-3%	-20%	-3%
Step 11	Baleage wintering	-26%	-14%			-11%	-1%	-28%	-9%	-23%	-8%
Step 12	Retire 2.5 ha unprod land					-11%	0%			-23%	-8%
Step 13	Retire 1 ha of MP			-16%	-2%						
Step 14	Reduce imported supplement by 25%	-28%	-20%	-24%	-13%	-12%	-6%	-33%	-18%	-24%	-8%
Step 15	Limit fert to 100 kg N/ha					-18%	-5%	-38%	-20%		
Step 16	Limit fert to 50 kg N/ha	-30%	-19%	-25%	-13%	-20%	-11%	-38%	-29%	-30%	-13%
Step 17	Reduce imported supplement by 50%	-33%	-22%	-24%	-8%	-21%	-10%	-39%	-24%	-32%	-16%
Step 18	Stand-off pad	-41%	-35%	-34%	-24%			-50%	-31%	-46%	-27%
Step 19	Zero N fert	-43%	-34%	-41%	-30%	-24%	-21%	-54%	-40%	-51%	-44%
Step 20	Wetland			-46%	-31%	-26%	-23%				

Modelling the stack for 5 farms – per mitigation

Mitigation	Description	Gleneden N leaching change	Gleneden OP change	Lowburn N leaching change	Lowburn OP change	Raemac N leaching change	Raemac OP change	Richburn N leaching change	Richburn OP change	Rimoo N leaching change	Rimoo OP change
Baseline	2022.23										
Step 1	GMP: Lower CP supplement	0%	5%			0%	2%	0%	1%		
Step 4	GMP: reduce N fert by 10%	-4%	5%	-2%	-1%	1%	6%	-9%	-1%	-7%	-2%
Step 6	GMP: No N applied in winter	-6%	4%	-3%	0%	1%	7%				
Step 8	GMP: Direct drilling kale and swedes	-7%	1%			1%	6%				
Step 9	Plantain 10% of pasture DM	-14%	1%	-9%	0%	-5%	6%	-15%	-2%	-13%	-2%
Step 10	Plantain 20% of pasture DM	-20%	-2%	-16%	-2%	-11%	4%	-21%	-3%	-20%	-3%
Step 11	Baleage wintering	-26%	-14%			-11%	-1%	-28%	-9%	-23%	-8%
Step 12	Retire 2.5 ha unproductive land					-11%	0%			-23%	-8%
Step 13	Retire 1 ha of milking platform			-16%	-2%						
Step 14	Reduce imported supplement by 25%	-28%	-20%	-24%	-13%	-12%	-6%	-33%	-18%	-24%	-8%
Step 15	Limit fert to 100 kg N/ha					-18%	-5%	-38%	-20%		
Step 16	Limit fert to 50 kg N/ha	-30%	-19%	-25%	-13%	-20%	-11%	-38%	-29%	-30%	-13%
Step 17	Reduce imported supplement by 50%	-33%	-22%	-24%	-8%	-21%	-10%	-39%	-24%	-32%	-16%
Step 18	Stand-off pad	-41%	-35%	-34%	-24%			-50%	-31%	-46%	-27%
Step 19	Zero N fert	-43%	-34%	-41%	-30%	-24%	-21%	-54%	-40%	-51%	-44%
Step 20	Wetland			-46%	-31%	-26%	-23%				

Stack detail

Farm	Richburn	Gleneden	Rimoo	Raemac	Lowburn
1. GMP: Lower CP supplement	Replaced 24 t DM DDG with PKE	Replaced 145 tDM DDG with PKE		Replace DDG with PKE	
4. GMP: reduce N fert by 10%	Remove March N fert. From 156 to 138 units N/ha average. Shift autumn culls earlier.	Removed the 6 units of N in April. Reduced october N to 15 units. Farm average from 97 ot 87 units. Culls now all sent 7 March	Remove April urea (keep March N protect). From 101 to 88 units N/ha average. Shift autumn culls earlier.	Shifted December N-protect and reduced March N. Adjusted supplement feeding (less barley). N fert from 132 to 112 units	Reduce March N, so farm N 66 to 60 units. Send culls earlier in autumn by 10 days.
5. Increase use of Red Path		Redpath barn can hold 250-300 cows comfortably. Increase use for dry cows May through September. Estimate further maintenance costs of $90/cow for 150 cows = $13,500 added to 'other' expense line.			
6. GMP: No N applied in winter		Shifted August N to combine with September (now 32 units). Slightly adjust Aug/Sep PKE feeding		Shifted August N to October. Made more baleage	Combined August N with September (now 28 units). Was able to reduce September supplement feeding a very small amount
8. GMP: Direct drilling kale and swedes		Direct drill kale (no impact on yield) and swedes (assume 10% drop in yield - feed more purchased baleage)		Swedes fed to youngstock switched from conventional cultivation to direct drilling (10% lower yield, lower crop costs, more imported baleage)	

Stack detail continued

Farm	Richburn	Gleneden	Rimoo	Raemac	Lowburn
9. Plantain 10% of pasture DM	Plantain 3 kg/ha @ $21.70/kg seed over the 16 ha that has crop = $1,042 total cost in 'other' expense line	Plantain 3 kg/ha @ $21.70/kg seed over the 40.3ha ha that has crop = $2,263 total cost in 'other' expense line	Plantain 3 kg/ha @ $21.70/kg seed over the 16.8 ha that has crop = $1,094 total cost in 'other' expense line	Plantain modelled as 10% of pasture DM across all blocks. Plantain 3 kg/ha seed @ $21.70 /kg seed over the 30.5 ha that has crop = $1,986 total cost in 'other' expense line	Plantain modelled at 10% of pasture DM. Assume included in regrassing 10% of farm annually 36.5 ha with 3kg of plantian seed @ $21.70/kg = $2,376
10. Plantain 20% of pasture DM	including plantain in regrassing as above (step 9) and also broadcast at 6 kg prill coat/ha @ $11.40/kg for a further 145 ha. Total $10,960 for plantain to 'other' expense line in Farmax.	Plantain modelled at 20% across farm. regrassing as in step 9 plus broadcast 6 kg/ha prill coat @ $11.40 across remaining 458 ha = $31,327 (total $47,090 in 'other' expense line)	including plantain in regrassing as above (step 9) and also broadcast at 6 kg prill coat/ha @ $11.40/kg for a further 134 ha. Added further $9,179 to 'other' expense line in Farmax.	Plantain modelled as 20% of pasture DM across all blocks. Including plantain in regrassing as above (step 9) and also broadcast at 6 kg prill coat/ha @ $11.40/kg for a further 178 ha. Added further $12,175 so now total $14,161 to 'other' expense line	Remaining farm area 328.5 ha spread prill coat seed with fert at rate of 6kg/ha @ $11.40/kg = $22,469
11. Baleage wintering	Remove fodder beet and block out 9 ha (based on 8 m2/c/d) for pasture wintering (all of July through November). Balance feed/BCS gain with 170 tDM imported baelage.	Remove crops and feed dry cows baleage, block out 33 ha (@ 8m2/c/d) for wintering for June through to mid-November. pasture wintering modelled in Overseer as crop block cultivated in June, fallow in September, resown minimum tillage in October.	Remove swedes crop and block out 12 ha (based on 8 m2/c/d) for pasture wintering (all of July through october). Additional 6.2 ha to be regrassed @ $1,177/ha. Balance feed/BCS gain with 80.5 tDM imported baelage.	Youngstock switched from swedes to oats/Moata and baleage	

Stack detail continued

Farm	Richburn	Gleneden	Rimoo	Raemac	Lowburn
12. Retire 2.5 ha unprod land			Add 1ha forestry block. Reduce plantain and fertiliser costs for 1 ha	2.5ha of terraced land. Assume no change in productivity but adjust N fert area	
13. Retire 1 ha of MP					Reduce herd by 2 cows. Reduce plantain and fertiliser costs for 1 ha
14. Reduce imported supplement by 25%	Reduce cow numbers, then reduce imported supplement to 76% of baseline (now 122 PKE, 53 barley, 71 tDM baleage).	Reduce cow numbers, adjust numbers off-farm. Reduce imported supplement to 75% of baseline (now 190 t PKE and 546 t baleage)	Reduce cow numbers, then reduce imported supplement (Remove barley grain and soya hulls, reduce PKE, reduce baleage).	Reduced stocking rate. Reduced imported PKE and barley for in-shed feeding, and imported baleage and silage. Imported feed now 73% of baseline (now 44t pke, 40t barley, 488 tDM silage, 34t DM baleage).	Culling cows early April and then reduced cow numbers. Reduced imported supplement (now 202 tDM silage, 469 tDM each of PKE and Barley)
15. Limit fert to 100 kg N/ha	Remove 28 units in April, reduce October N fert. 138 to 100 units average. Reduce cow numbers and adjust supplement			Removed March application and culled cows earlier	
16. Limit fert to 50 kg N/ha	Remove October and November N fertiliser, reduce December N. Reduce cow numbers, adjust supplement timing	Remove October and November N, farm average 87 to 49 units. Reduce cow numbers, reduce baleage made in November/December. Adjust supplement timings	Remove autumn N except whey, remove November N. Change October ammo 36 to ammo31 and reduce amount. Reduce cow numbers	Removed October application, reduced rates in September and January. Reduced stocking rate	Reduced Menzies N in October and autumn, farm 60 to 50 units. Reduced cow numbers by 2 and adjusting supplement feeding timing

Stack detail continued

Farm	Richburn	Gleneden	Rimoo	Raemac	Lowburn
17. Reduce imported supplement by 50%	Reduce cow numbers, reduce purchased supplement to 54% of baseline level (now 73 PKE, 41, barley, 60 tDM baleage)	Reduce cow numbers, reduce imported supplement to 44% of baseline (now only import 431 t DM baleage)	Reduce cow numbers, then reduce imported supplement (reduce PKE and baleage).	Reduced cow numbers. Imported supplement now at 51% of baseline. In-shed feeding and silage amounts reduced (now 20t pke, 12 t barley, 375 tDm silage, 20 t DM baleage).	Reduce cow numbers and then imported supplement (now 134 t DM silage, 327 tDM each of barley and PKE)
18. Stand-off pad	Standoff 8h/d Autumn and 16h/d winter (note cows away for some of winter). Cost $1,500/cow so annual of $255/cow for 328 cows. Additional effluent amounts to 29 units of N to 90 ha in October and reduce supplement	Add stand off pad for milkers which will be in addition to the redpath barn for dry cows, to hold average of 409 cows over autumn (8h/d) and winter (16h/d). Insufficient baleage to keep more cows on red path - according to Overseer - and I don't want to import more feed. Cost for construciton for maximum of 641 cows ($1500/cow with 7% interest and 25 years depreciation) and bedding for average 409 cows @ $90/cow = total annual cost $142,545 (total cost in 'other' expense line now $189,635). Add N fert of 8 units in November to represent effluent capture.	Standoff 8h/d Autumn and 16h/d winter (note cows away for some of winter). Cost $1,500/cow so annual of $250/cow for 389 cows. Additional effluent amounts to 14 units of N to 118 ha in January and reduce PKE.		Stand off pad for 8h/d autumn and 16h/d winter use, as well as existing feedpad. Construction $1,500/c and annual costs for 7% interest and 25 year depreciation for 992 cows maximum capacity, also bedding for average of 552 cows over autumn and winter, = total $213,630
19. Zero N fert	Reduce cow numbers, adjust timing of supplement feeding	Reduced cow numbers and adjusted timing of supplement feeding	Reduce cow numbers, adjust timing of supplement feeding	Reduced cow numbers and adjusted timing of supplement feeding	Reduce cow numbers, change timing of supplement feed
20. Wetland				Improving duck pond. Achieving 1.8% N leaching reduction for cost of $15k	On 7 ha where1 ha is the retired land from step 13. Cost of $15-20k (used $17.5k) estimated for the earthworks

Plantain

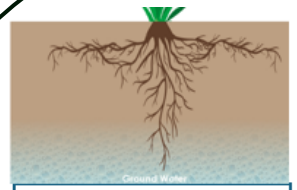
More to come from plantain!

Animal effect

Reduced urinary N from dilution & partitioning

Av. **6%** reduced leaching per 10% plantain (Overseer)

Soil effect



Reduced drainage

Av. **10 mm** less drainage per 10% Ecotain plantain (lysimeters)

Reduced nitrification rate from metabolites in root exudates

Reduced nitrification rate from metabolites in plantain urine

Av. **5.7 kg/ha** reduced N leaching per 10% Ecotain plantain (lysimeters)

Total effect:
Av. **26%** reduction in leaching from av. 17% Ecotain plantain (Lincoln farmlet, 3 yrs)
Av. **26%** reduced leaching from Av. 25% Ecotain plantain (Massey farmlet, 4 yrs)

Total effect

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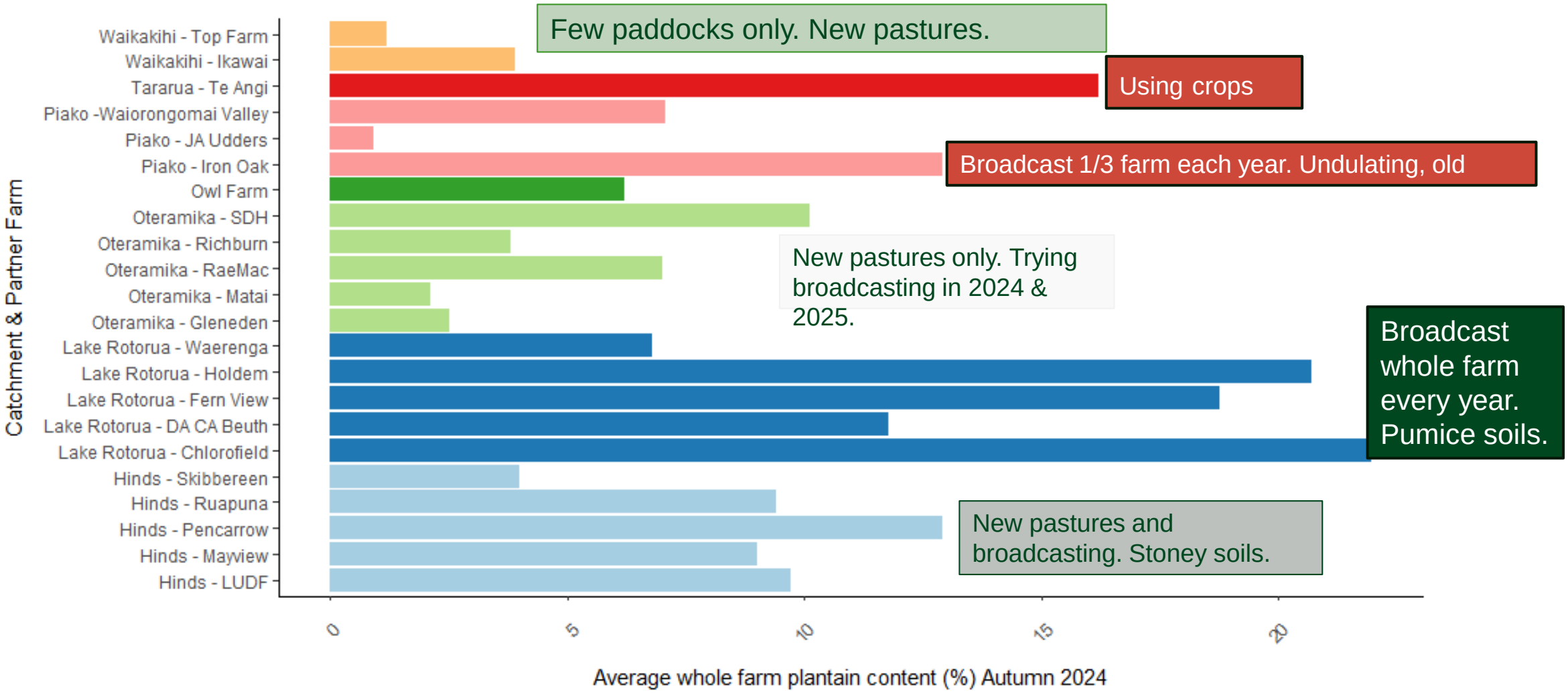
Implementation of plantain on partner farms



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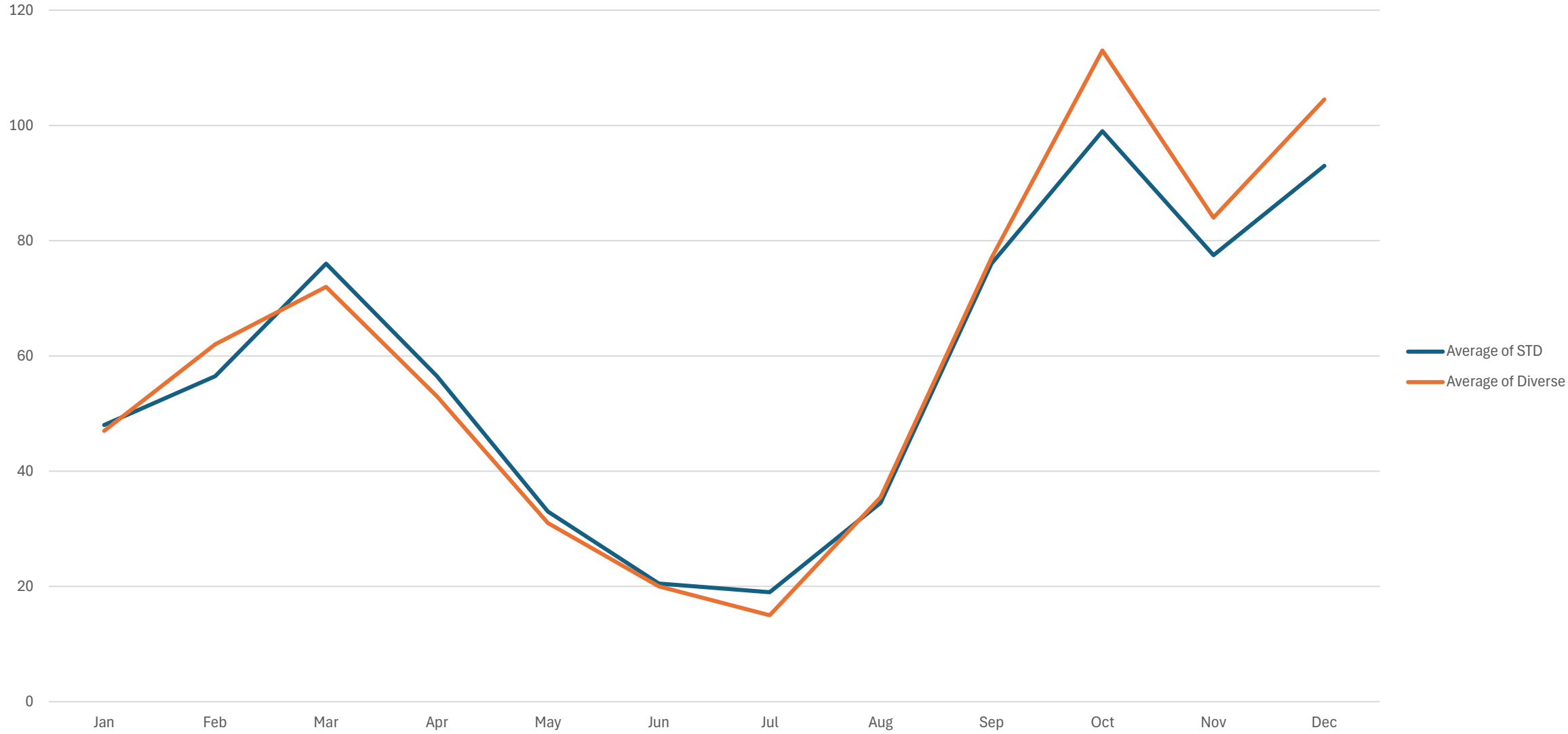
Pasture growth rates ryegrass vs. plantain at Edendale 2022 and 2023



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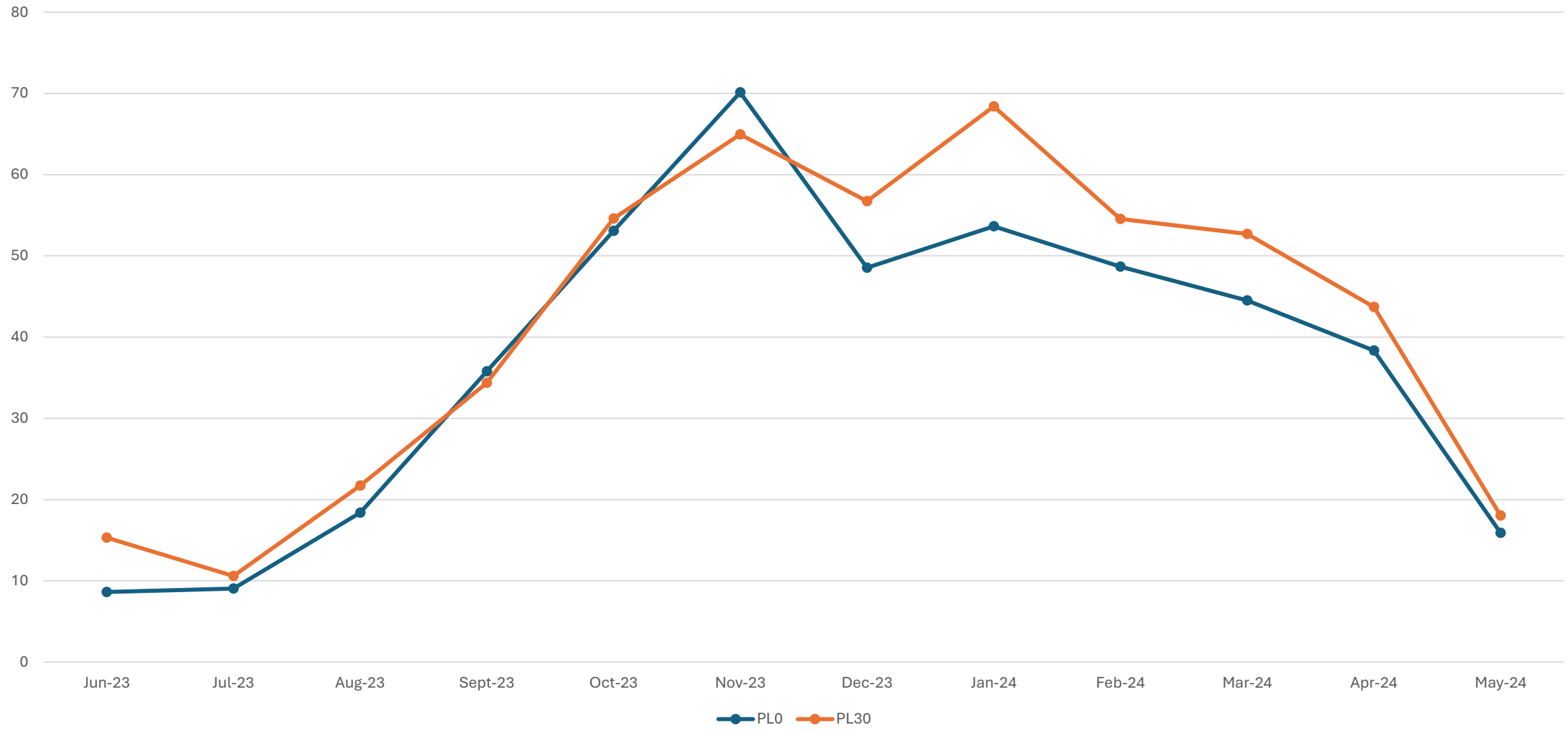
Pasture growth rates ryegrass vs. plantain mixed swards at SDH



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Establishing plantain

- New pastures
  - 3-4kg/ha plantain seed sown with ryegrass and clover = around 30% plantain.
  - Ryegrass seeding rate (20, 16, 8kg/ha) did not reliably change plantain %
  - Sowing at a shallow depth is important.
  - Peak plantain content at 4-6 mths post sowing. Persistence 2-3 years.
  - Control weeds before or stagger sowing ryegrass and plantain/clover
- Broadcasting with fertiliser
  - Successful at 2-5kg bare seed equivalent, double rate for coated seed
  - Spring or autumn
  - Peak plantain content 12 months after broadcasting.
  - Control weeds every 3 years as needed and re-broadcast the following year.
- Trend for higher plantain on lighter soils, sloping country and where companion grass is less competitive.

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Plantain costs (note price may vary with retailers)

ESTABLISHING PLANTAIN IN A NEW PASTURE MIX	kg/ha	$/kg	$/ha
Plantain seed (Superstrike treated)	3	$21.70	**$65**
Reduce tetraploid grass seed rate	-3	$16.50	**-$50**
TOTAL cost per ha			**$16**
BROADCASTING PLANTAIN SEED ACROSS EXISTING PASTURE	**kg/ha**	**$/kg**	**$/ha**
Plantain prill coated seed	8	$11.40	$91
TOTAL cost per ha			**$91**
ANNUAL MAINTENANCE BROADCASTING	**kg/ha**	**$/kg**	**$/ha**
Plantain prill coated seed	4	$11.40	$46
TOTAL cost per ha			**$46**

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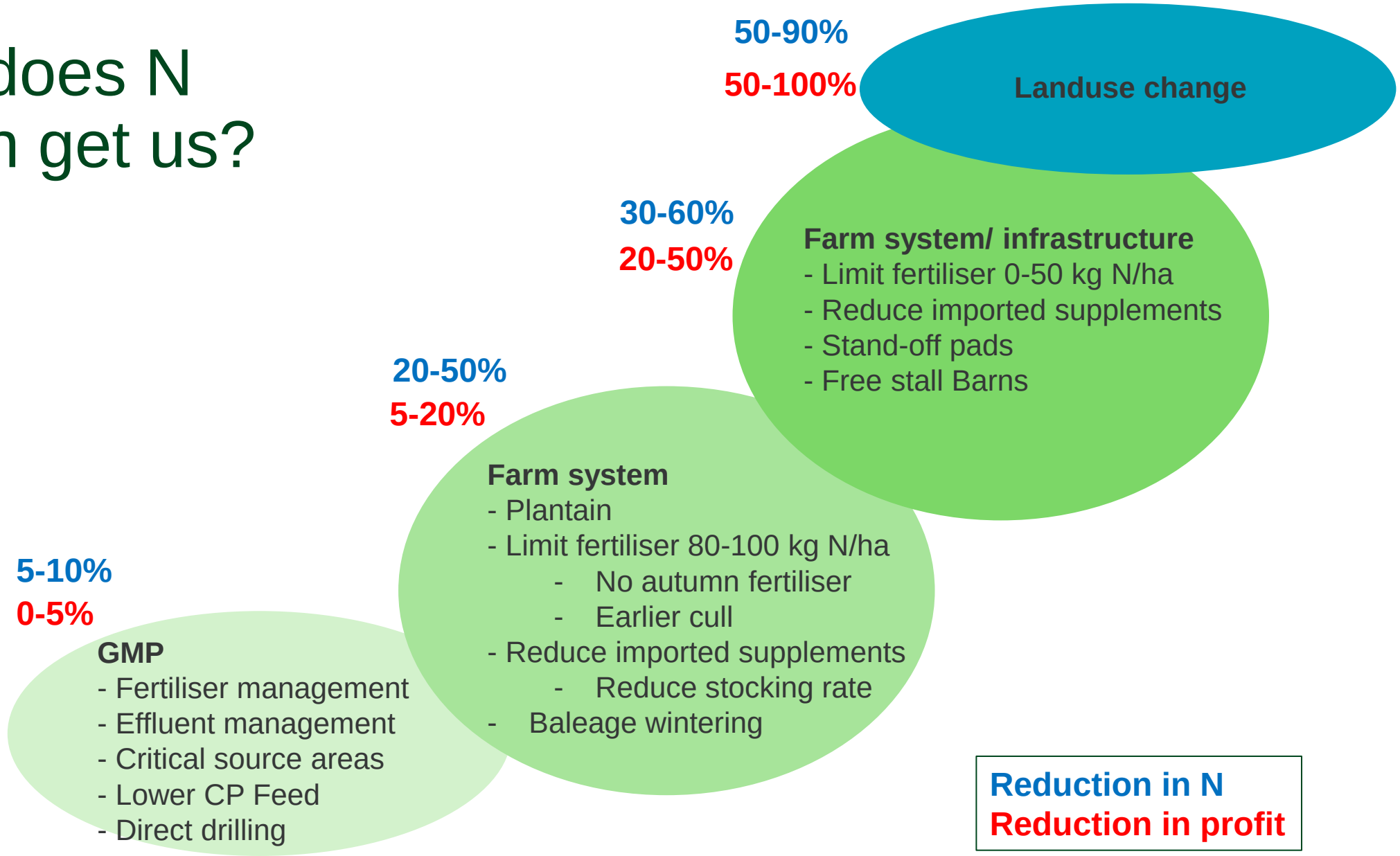
How far does N mitigation get us?



Reduction in N
Reduction in profit