Aligning management practices to sources and pathways of contaminant loss

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Background

Menu of practices for farms to improve water quality in Southland:

Mitigation	GMP examples	Likely Water Quality Benefit				Potential Impact on Farm Business	
		N	P	Sediment	Micro-organisms	Cost	Benefit
Whole Farm Planning	Whole farm business and systems analysis	Whole farm analysis will identify water quality risks. Likely water quality benefits will depend on farm contour, management challenges and practices used to manage risks on farm.				$-$$	$$$
Nutrient Management	Do a whole farm nutrient budget	Likely water quality benefits will depend on the range of practices used to manage nutrients as a result of nutrient budget recommendations.				$	$$
	Keep Olsen P at biological optimum using soil testing	-	L to M (depends on soil P test)			$	$$$
	Use proof of placement for fertiliser and/or farm dairy effluent application	L	M	-	L - M	$$ - $$$	$$$

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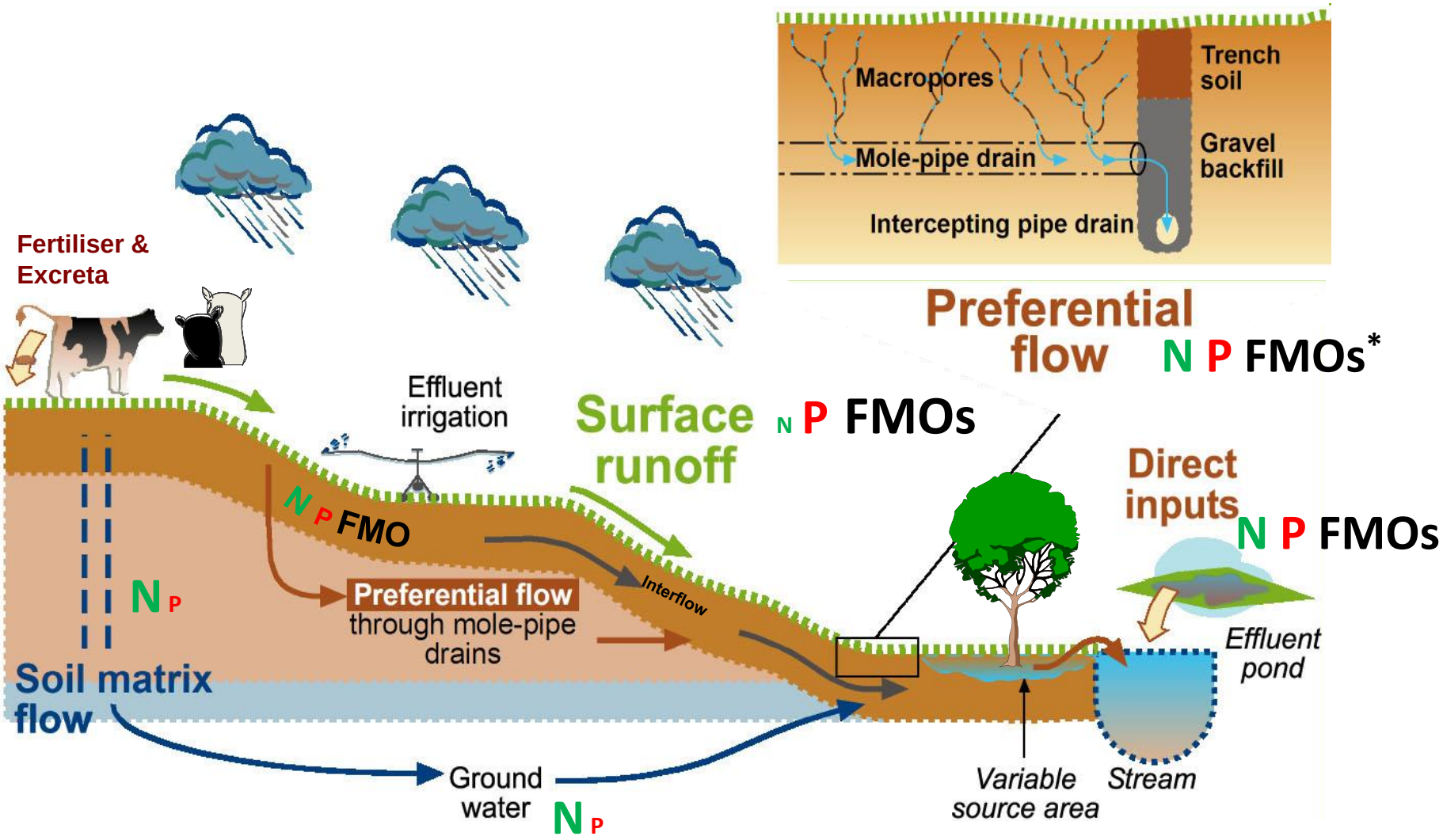
Complexity of sources & pathways
- challenging to identify effective interventions



* *FMOs = faecal microorganisms*

Outline

1. General measures
2. Targeting pathways
3. Uncertainties/gaps

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1. General measures – irrespective of location

- Protect and improve what you've got
  - wetlands, riparian margins
  - infrastructure to keep stock out of waterways

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Tidy-ups

1. General measures – irrespective of location

- Protect and improve what you've got
  - wetlands, riparian margins
  - infrastructure to keep stock out of waterways

- Use the fertility planning tools available
  - soil testing
  - nutrient budgeting
  - appropriate fertiliser forms & placement

- Implement appropriate effluent managements

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Suggested minimum criteria for a land-applied effluent management system

What do farmers need to get right to avoid direct drainage losses?

Soil and landscape feature	Artificial drainage or coarse soil structure	Impeded drainage or low infiltration rate	Sloping land (>7°)	Well drained flat land (<7°)	Other well drained but very stony[X] flat land (<7°)
Application depth (mm)	< SWD*	< SWD	< SWD	< 50% of WHC[#]	≤ 10 mm
Application rate (mm/hr)	N/A	N/A	< soil infiltration rate	N/A	N/A
Storage requirement	Apply only when SWD exists	Apply only when SWD exists	Apply only when SWD exists	24 hours drainage post saturation	24 hours drainage post saturation
Maximum N load	150 kg N/ha/yr	150 kg N/ha/yr	150 kg N/ha/yr	150 kg N/ha/yr	150 kg N/ha/yr

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* SWD = soil water deficit,
[#] WHC = water holding capacity in the top 300 mm of soil,
Very stony[X] = soils with > 35% stone content in the top 100 mm of soil

IMPROVED DAIRY EFFLUENT MGMT

Deferred irrigation: pond storage

Low rate applicators

2. Targeting pathways of contaminant transfer

Key pathways to consider

a. Overland flow
b. Mole-pipe drainage
c. Deep and lateral drainage – P, FMOs
d. Deep drainage - N

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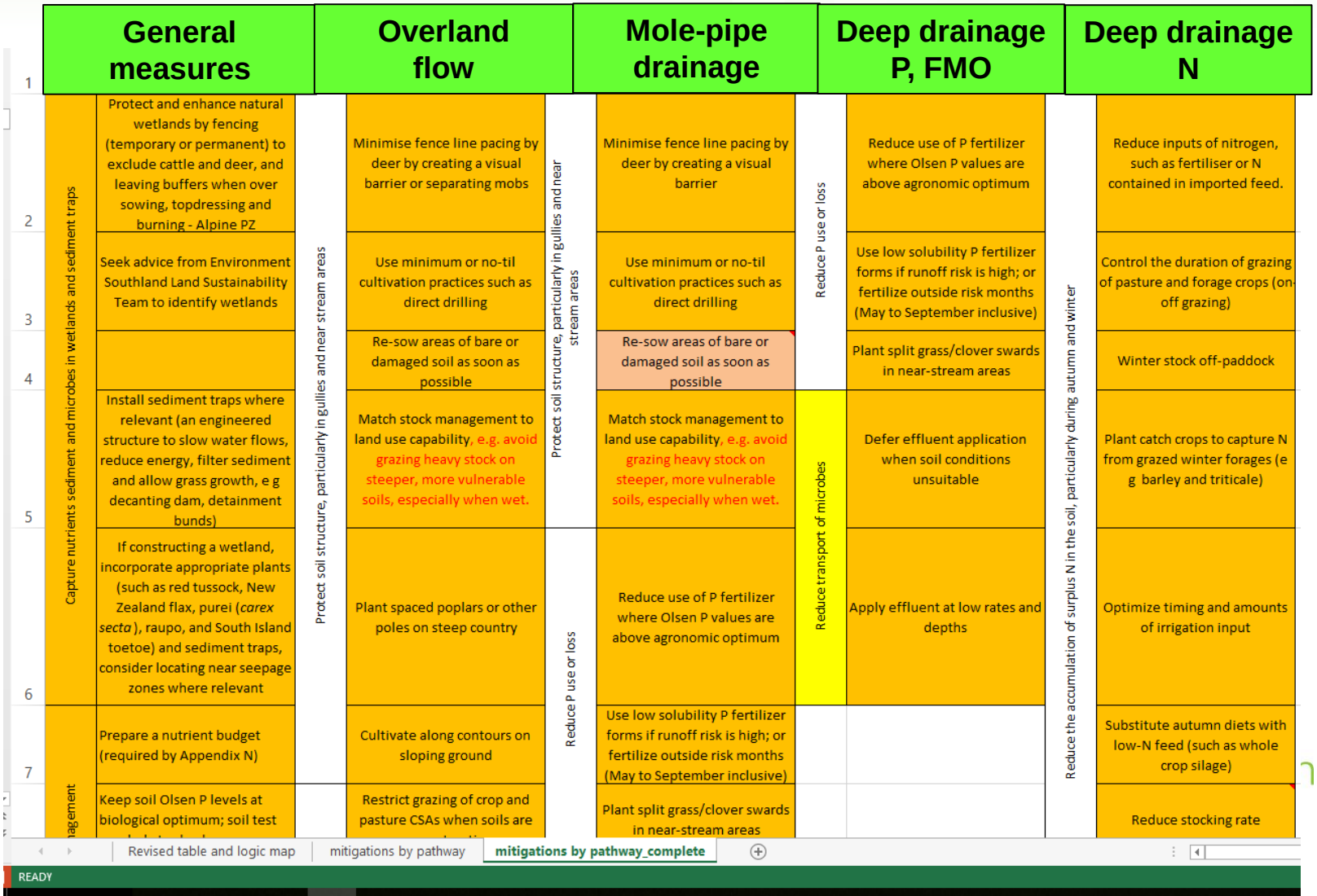
How might it work?



General measures	Overland flow	Mole-pipe drainage	Deep drainage P, FMO	Deep drainage N
Protect and enhance natural wetlands by fencing (temporary or permanent) to exclude cattle and deer, and leaving buffers when over sowing, topdressing and burning - Alpine PZ	Minimise fence line pacing by deer by creating a visual barrier or separating mobs	Minimise fence line pacing by deer by creating a visual barrier	Reduce use of P fertilizer where Olsen P values are above agronomic optimum	Reduce inputs of nitrogen, such as fertiliser or N contained in imported feed.
Seek advice from Environment Southland Land Sustainability Team to identify wetlands	Use minimum or no-til cultivation practices such as direct drilling	Use minimum or no-til cultivation practices such as direct drilling	Use low solubility P fertilizer forms if runoff risk is high; or fertilize outside risk months (May to September inclusive)	Control the duration of grazing of pasture and forage crops (on-off grazing)
	Re-sow areas of bare or damaged soil as soon as possible	Re-sow areas of bare or damaged soil as soon as possible	Plant split grass/clover swards in near-stream areas	Winter stock off-paddock
Install sediment traps where relevant (an engineered structure to slow water flows, reduce energy, filter sediment and allow grass growth, e g decanting dam, detainment bunds)	Match stock management to land use capability, e.g. avoid grazing heavy stock on steeper, more vulnerable soils, especially when wet.	Match stock management to land use capability, e.g. avoid grazing heavy stock on steeper, more vulnerable soils, especially when wet.	Defer effluent application when soil conditions unsuitable	Plant catch crops to capture N from grazed winter forages (e g barley and triticale)
If constructing a wetland, incorporate appropriate plants (such as red tussock, New Zealand flax, purei (*carex secta*), raupo, and South Island toetoe) and sediment traps, consider locating near seepage zones where relevant	Plant spaced poplars or other poles on steep country	Reduce use of P fertilizer where Olsen P values are above agronomic optimum	Apply effluent at low rates and depths	Optimize timing and amounts of irrigation input
Prepare a nutrient budget (required by Appendix N)	Cultivate along contours on sloping ground	Use low solubility P fertilizer forms if runoff risk is high; or fertilize outside risk months (May to September inclusive)		Substitute autumn diets with low-N feed (such as whole crop silage)
Keep soil Olsen P levels at biological optimum; soil test	Restrict grazing of crop and pasture CSAs when soils are	Plant split grass/clover swards in near-stream areas		Reduce stocking rate

Capture nutrients sediment and microbes in wetlands and sediment traps

Protect soil structure, particularly in gullies and near stream areas

Protect soil structure, particularly in gullies and near stream areas

Reduce P use or loss

Reduce P use or loss

Reduce transport of microbes

Reduce the accumulation of surplus N in the soil, particularly during autumn and winter

Revised table and logic map | mitigations by pathway | mitigations by pathway_complete

READY

2a. Overland flow

Key measures to consider

- Protect soil structure, particularly in gullies and near stream areas
  - minimise: deer pacing, tillage, bare ground
  - matching forage & stock mgmt. to land suitability

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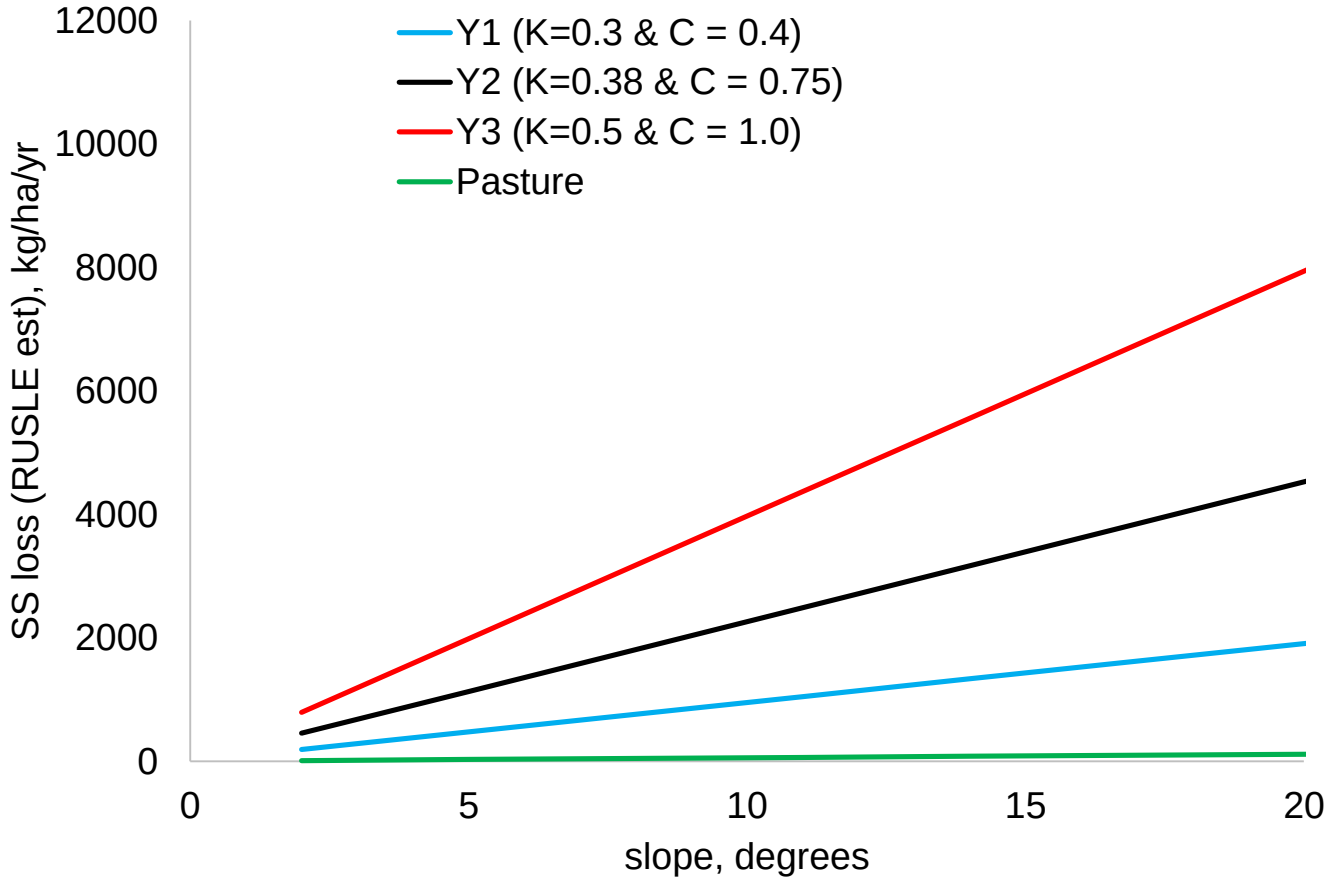
Suitability?

Monaghan et al 2017 NZJAR 60(3): 333-348

Estimating sediment loss using the Revised Universal Soil Loss Equation

The effects of slope and cropping history (expressed via K and C) on sediment losses



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2a. Overland flow

Key measures to consider

- Protect soil structure, particularly in gullies and near stream areas
  - minimise: deer pacing, tillage, bare ground
  - matching stock mgmt. to land use suitability

- Manage critical source areas (CSA)
  - avoid cropping altogether
  - re-site deer wallows
  - low solubility P fert
  - split grass-clover swards
  - strategic grazing (pastures & crop)

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Benefits of CSA protection - crops

- Sediment losses reduced by c.80%
- Phosphorus losses reduced by c. 60 - 70%

2b. Mole-pipe drainage

Key measures to consider

- As for overland flow

  +

- Reduce the accumulation of surplus N in the soil
  - focus on autumn & winter mgmt
  - reduced farm N imports
  - grazing-off; on-off grazing
  - substitute autumn diets with low-N feed

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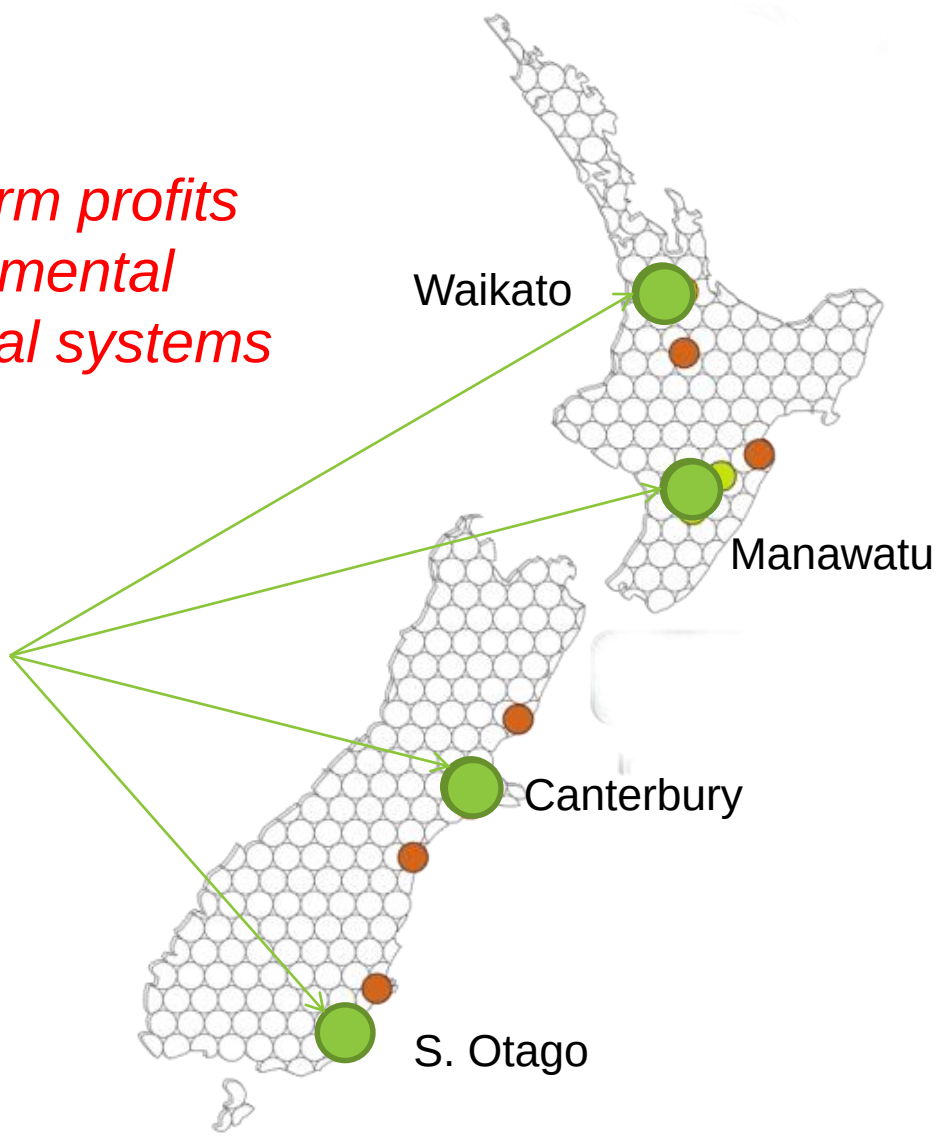
Pastoral 21

Hypothesis: Production and farm profits can be increased, and environmental pollutants decreased in pastoral systems

Projects throughout NZ

Next generation dairy systems



P21: Achievements

Region		Average production	N leached & how estimated		
		kg MS/ha	kg N/ha	% Reduction	Method
Waikato	Current	1193	54		Measured: NO_3-N, porous cups
(4 seasons)	Future	1162	31	43	
Manawatu	Current				Measured: total N in pipe drainage
(3 seasons)	Future			40	
Canterbury	Current[1]				Modelled
(4 seasons)	Future			39	
S Otago	Current				Measured: soil mineral N in autumn
(3 seasons)	Future[2]			22-28	

In all cases comparing an 'improved' system with a 'current' system, typical of the region. Notes:

1. Canterbury - using results from LUDF 2011/12 -2013/14 for comparison
2. South Otago - compared two 'Future systems"
3. South Otago - also 30-40% reduction in P loss; 50-65% reduction in sediment loss

How it was achieved

- **Reduced nitrogen fertiliser inputs**

Excrete less N

Less to deal with!

- **Stood cows off paddock at critical times**

Capture urine N

Less hitting the paddock at the wrong time

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Beukes et al. 2017. Sci. Tot. Env. 599-600

2c. Deep and lateral drainage – P, FMOs

Key measures to consider

- Reduce P sources
  - low solubility P fert
  - split grass-clover swards
- Reduce transport of faecal material
  - Deferred and low rate effluent irrigation

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Split grass-clover to mitigate P loss - pasture

Place clover (with its relatively high P demand) in areas of a catchment unlikely to contribute runoff to the stream.

McDowell 2014 JEQ 43: 2044-2052

2d. Deep and lateral drainage – N

Key measures to consider

- Reduce the accumulation of surplus N in the soil
  - focus on autumn & winter mgmt
  - reduced farm N imports
  - grazing-off; on-off grazing
  - substitute autumn diets with low-N feed
  - wetlands
  - catch crops
  - irrigation scheduling
  - cut-carry?

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Summary

	N	P	Sediment	FMO
Key pathways	Deep drainage	Overland flow	Overland flow	Overland flow
	Mole-pipe dr.	Mole-pipe dr.		
Interventions	Farm N imports	Fertiliser mgmt.	CSA protection	CSA protection
	Off-paddock	CSA protection	Suitable use of land	Off-paddock?
	Wetlands			

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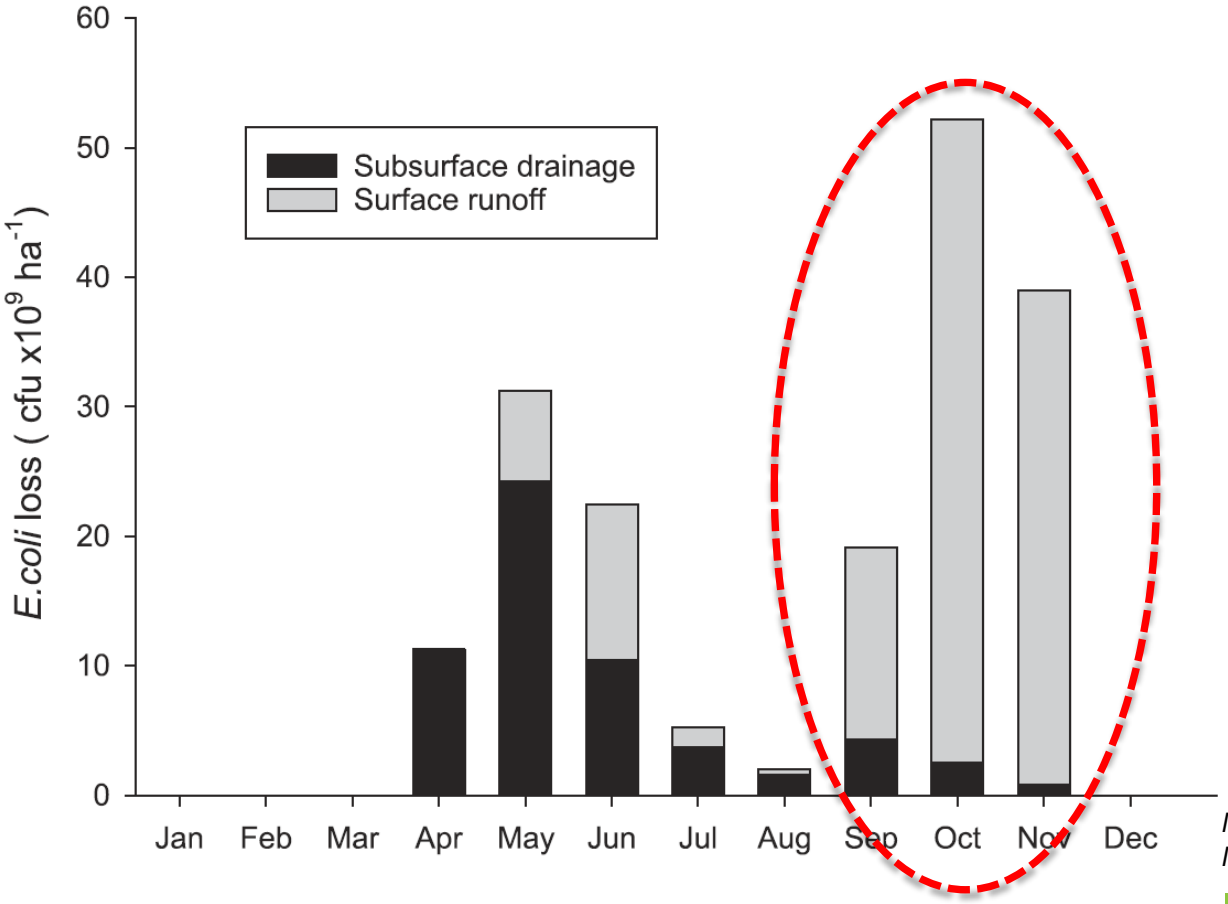
Monthly fluxes of faecal bacteria to water - Tussock Creek study site



Monaghan et al. 2016 AEE
Mean fluxes over 3 years

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Acknowledgements

Pastoral 21 programme

Increasing Profitability. Reducing Footprint.

MBIE

Clean Water, Productive Land programme

Environment Southland

DairyNZ

Fonterra Dairy for life

beef+lamb new zealand

DCANZ DAIRY COMPANIES ASSOCIATION OF NEW ZEALAND

Ministry of Business, Innovation & Employment