State of Science

Reducing methane emissions from dairy farms

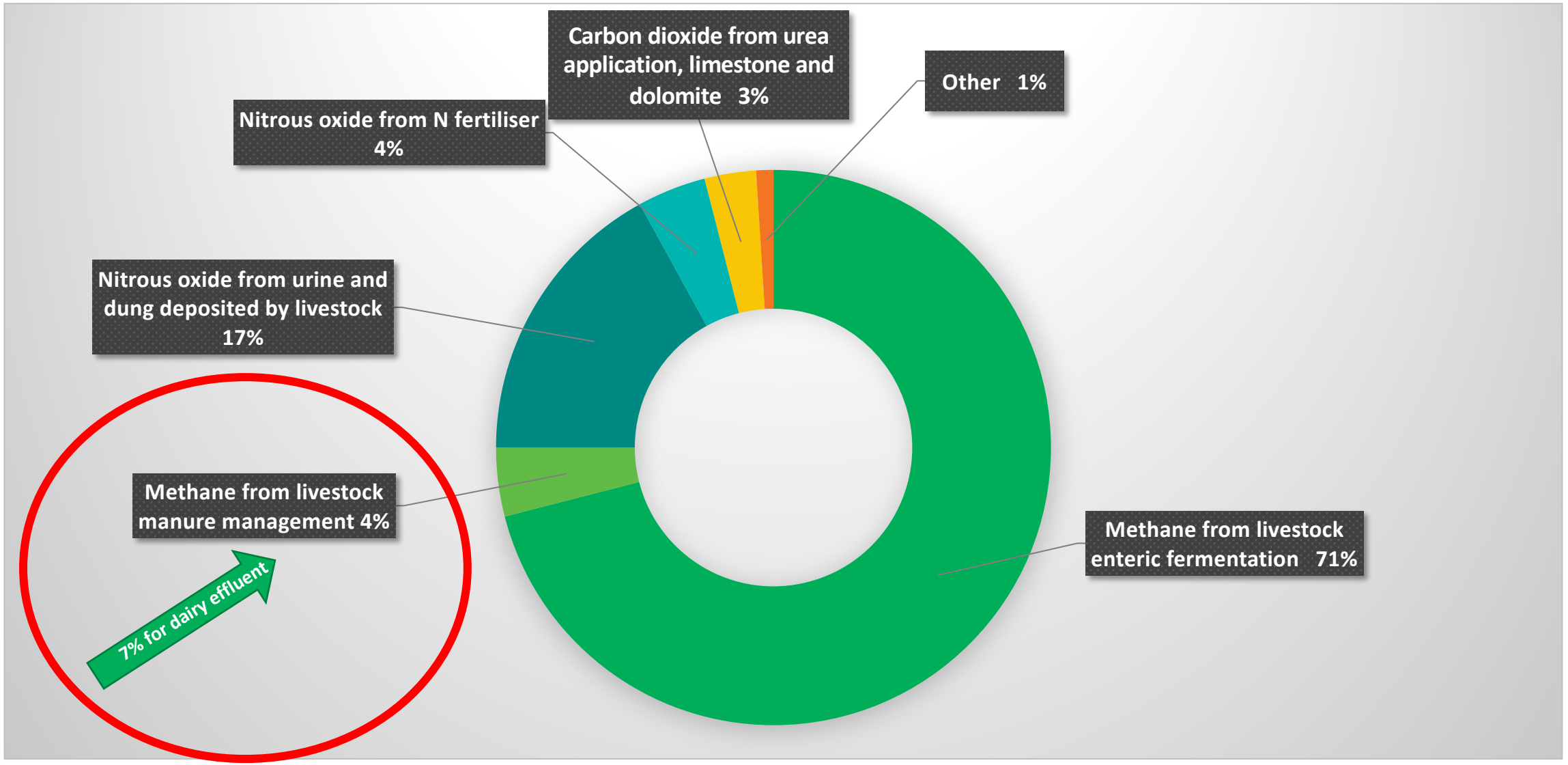
A joint project by:

ravensdown

&

LINCOLN UNIVERSITY
TE WHARE WĀNAKA O AORAKI

Sources of agricultural emissions



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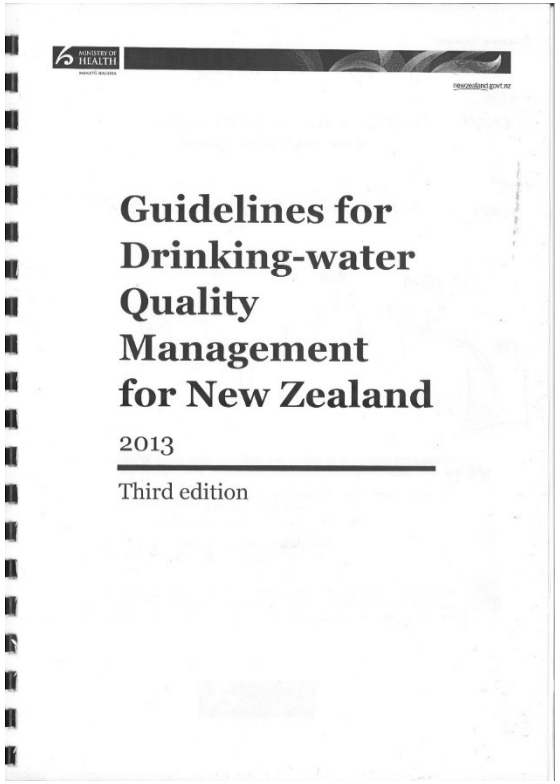
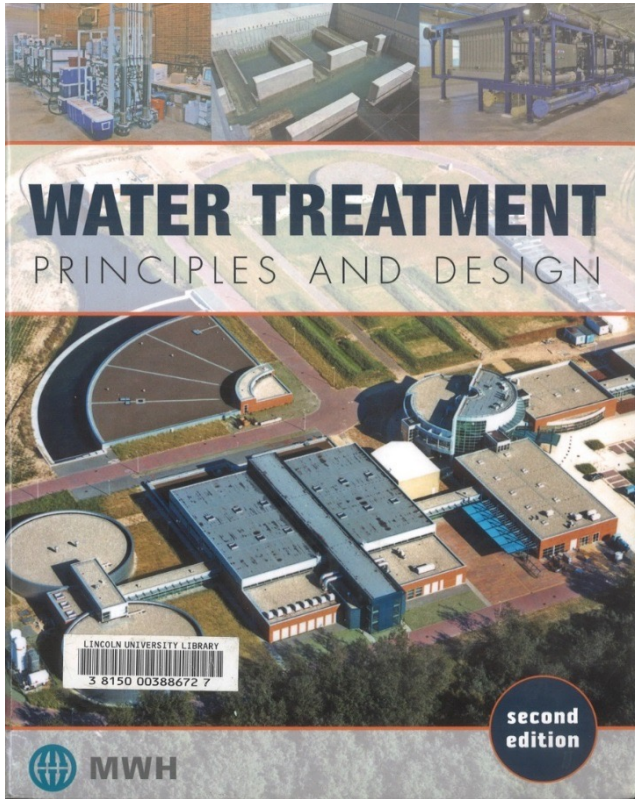
Reducing the risk of farm dairy effluent…

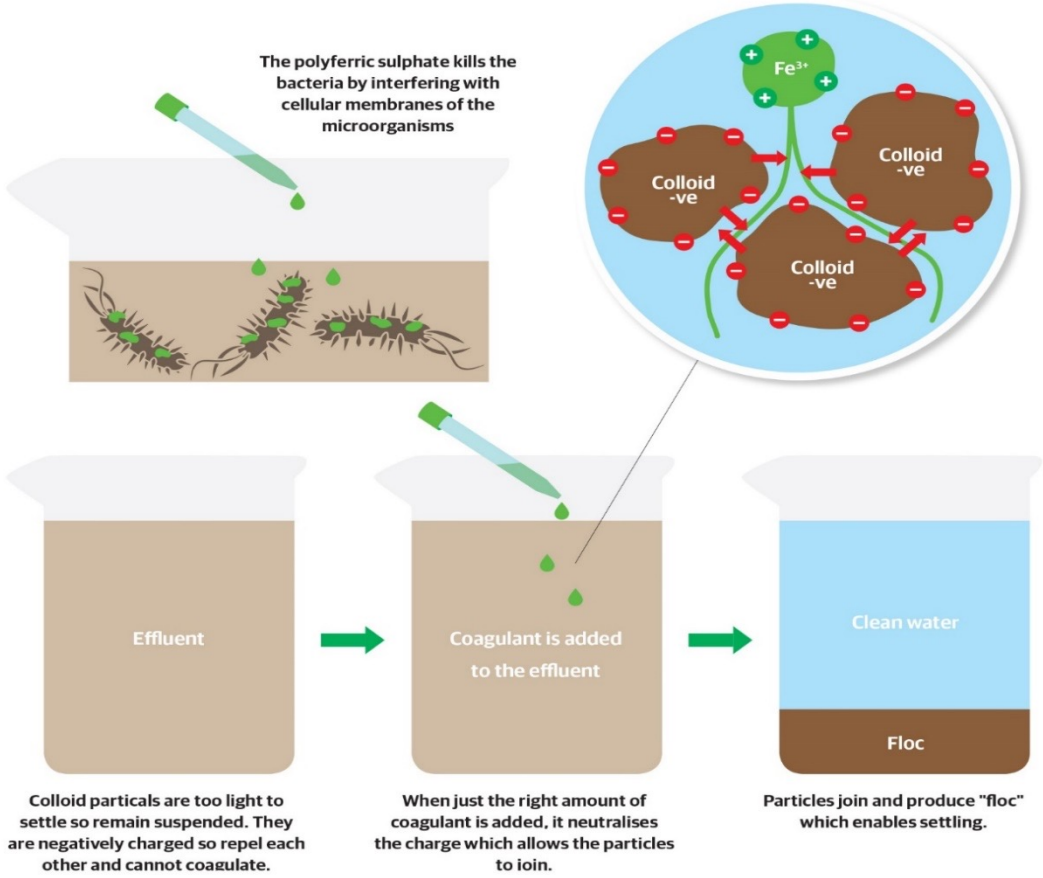
- **LU scientists Professors Keith Cameron and Hong Di developed a new treatment system for farm dairy effluent based on standard engineering processes plus NZ Dept of Health Guidelines for drinking water treatment …**





The effluent treatment works by….

- ClearTech treats farm dairy effluent with a coagulant (polyferric sulphate) which causes ‘flocculation’ and produces:
- (i) ‘clarified water’ that can be recycled to wash the farm yard, and (ii) ‘treated effluent’ that is safer to apply to the land



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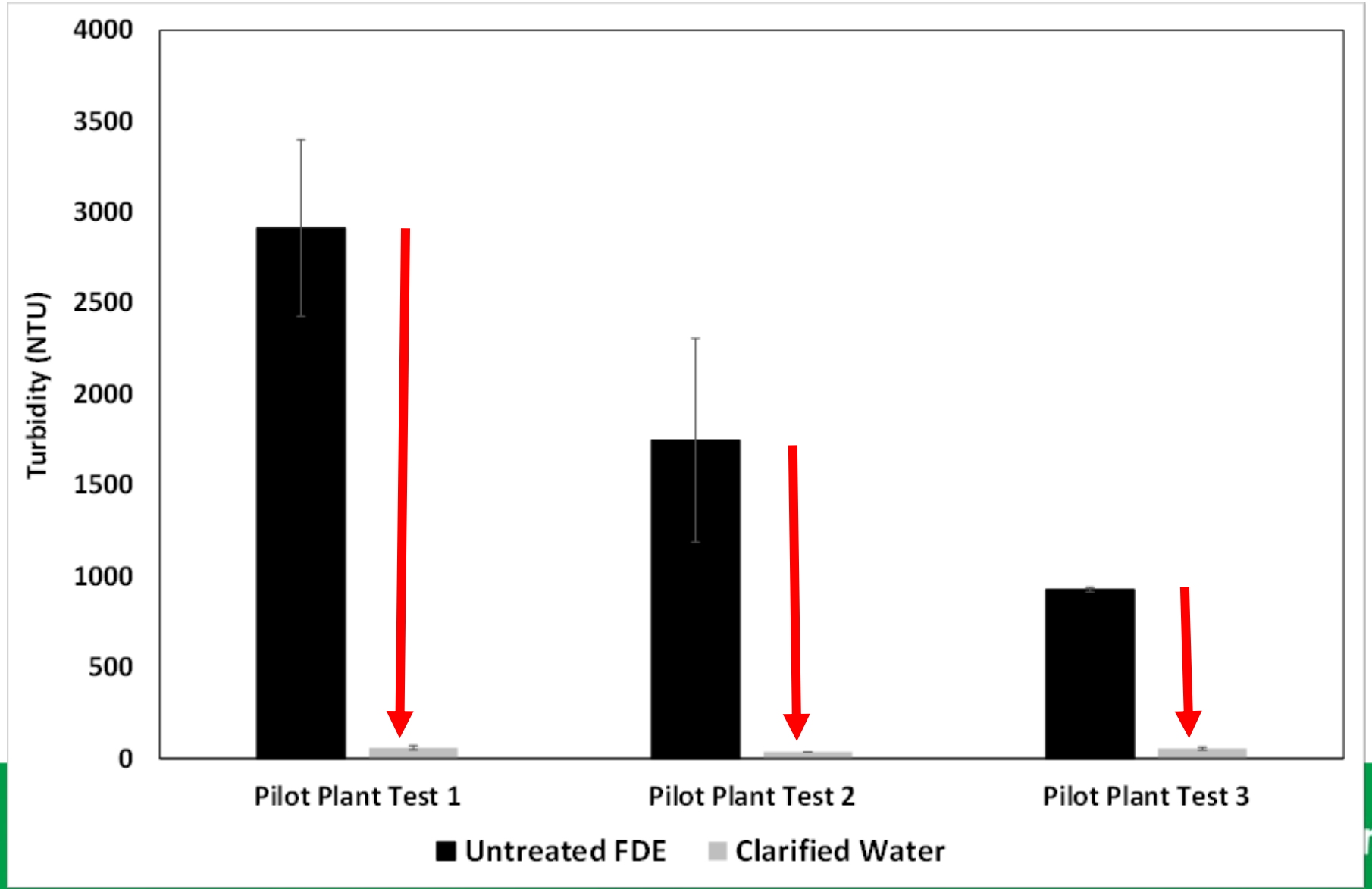
ClearTech system highly effective in treating farm dairy effluent to produce clarified water

(Cameron & Di, 2019)



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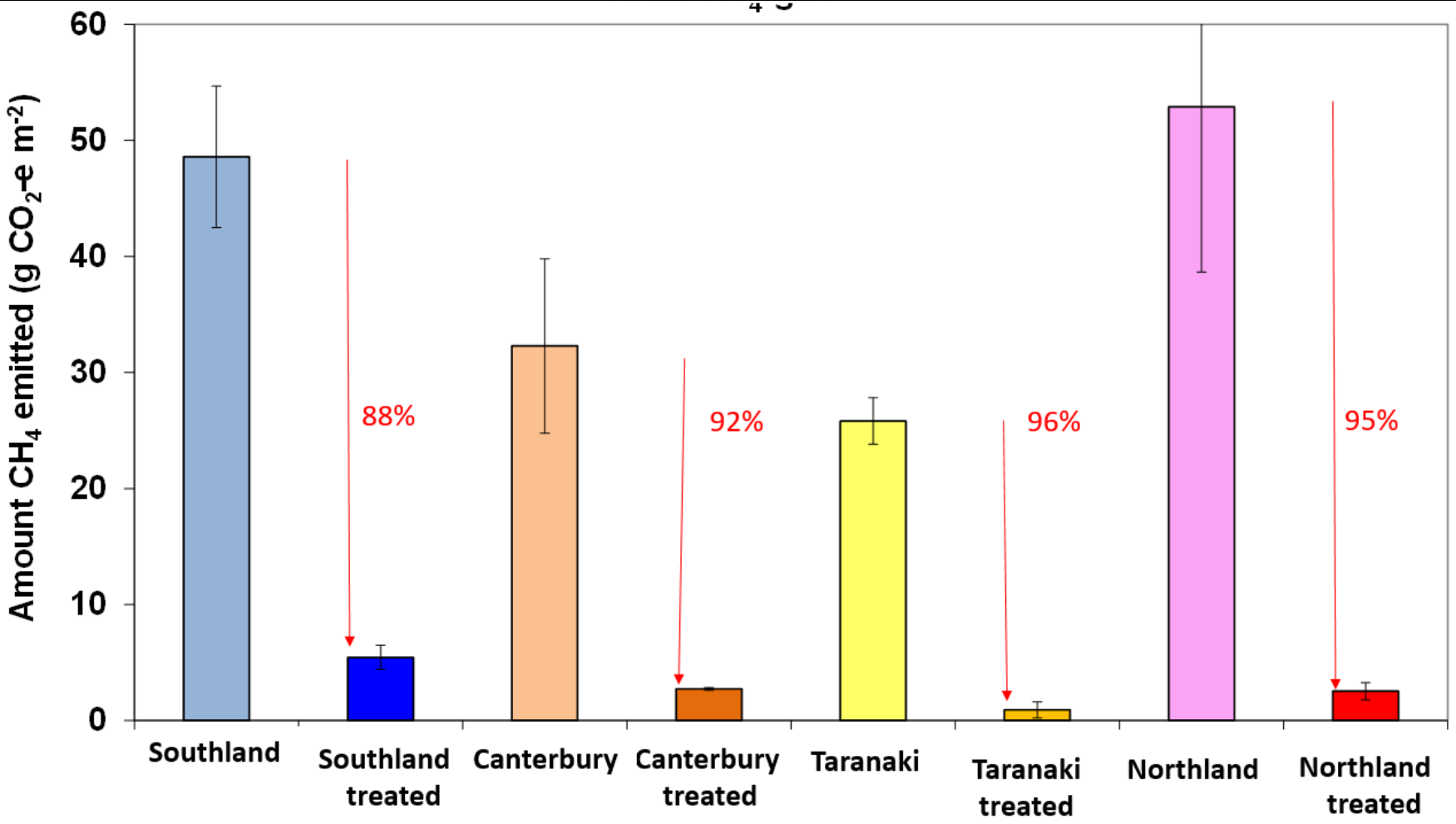
....serendipitously they found adding PFS to effluent storage ponds decreased methane emissions....



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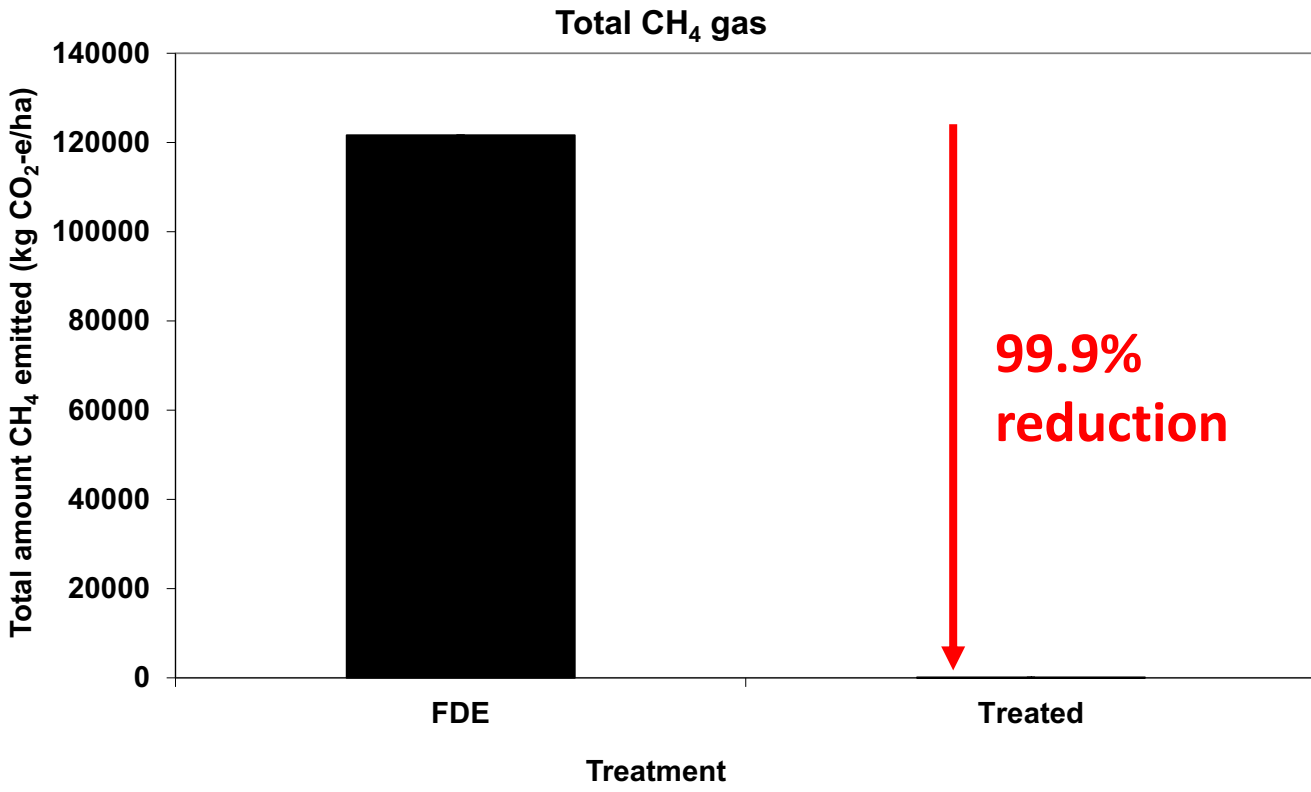
Farm scale measurements confirmed effectiveness to mitigate methane emissions

100,000 L effluent tanks (with gas capture facilities)



(Cameron and Di, 2021)

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This methane mitigation technology is based on robust science

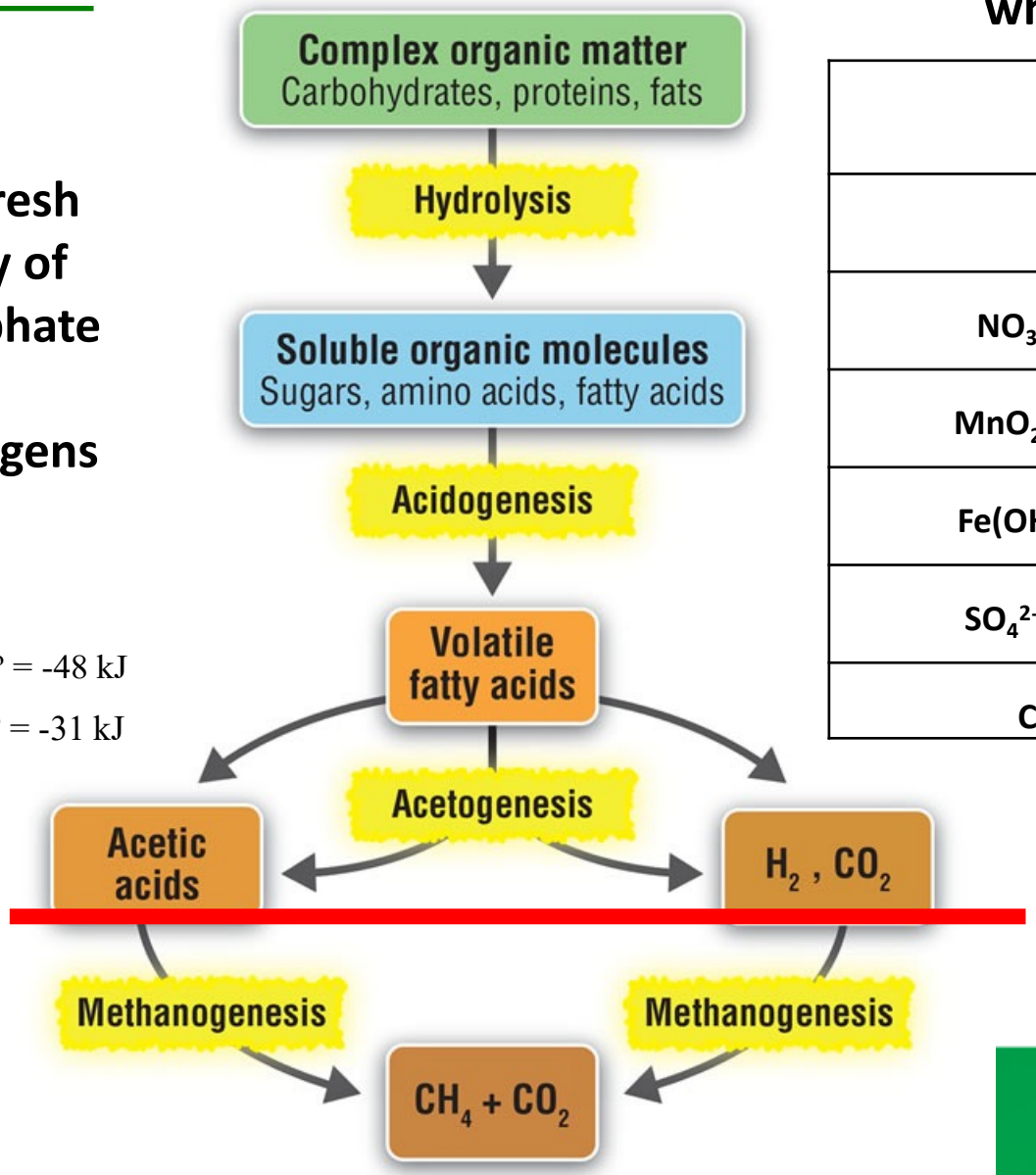
Addition of iron sulphate to fresh effluent increases the activity of 'iron reducing bacteria' & 'sulphate reducing bacteria' which inhibit the growth of methanogens

$SO_4^{2-} + CH_3COO^- \longrightarrow HS^- + 2HCO_3^- \quad \Delta G^o = -48\ kJ$

$CH_3COO^- + H_2O \longrightarrow CH_4 + HCO_3^- \quad \Delta G^o = -31\ kJ$

This stops the methanogens from producing methane.

Figure 1. Biological process of anaerobic digestion



Adding iron sulphate keeps the Redox poised above the value at which methanogenesis occurs

Reaction	Eh (mV)
$O_2 + 4H^+ + 4e^- = 2H_2O$	934
$NO_3^- + 2H^+ + 2e^- = NO_2^- + H_2O$	539
$MnO_2 + 4H^+ + 2e^- = Mn^{2+} + 2H_2O$	634
$Fe(OH)_3 + 3H^+ + e^- = Fe^{2+} + 3H_2O$	172
$SO_4^{2-} + 10H^+ + 8e^- = H_2S + 4H_2O$	-67
$CO_2 + 8H^+ = CH_4 + 2H_2O$	-126

In addition, sulphide produced from iron sulphate inhibits the methanogens

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...further research has confirmed..

- Decreases methane from ponds by >95%
- Kills >99% of E. coli
- …but also…

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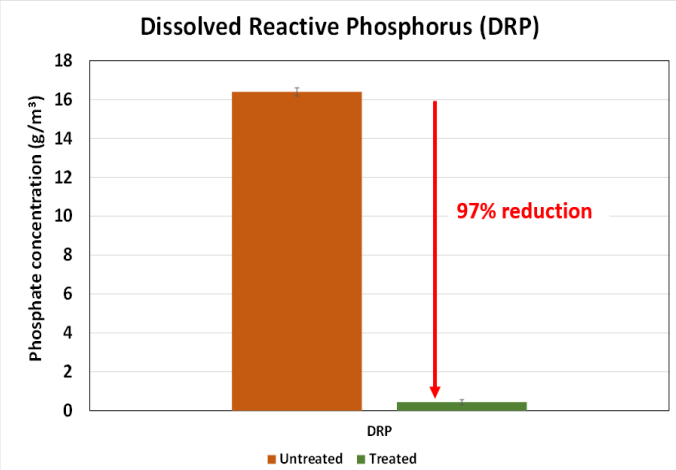
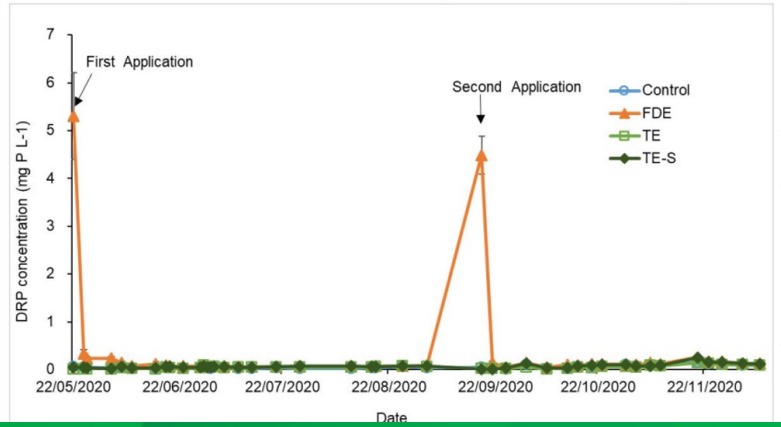
- **Decreases P leaching on effluent treated blocks by >90%**

- **Reduces ammonia volatilisation**

Reducing phosphate transfer to water is the main reason the farmer wants to use EcoPond at the Beaumaris farm = 97% reduction



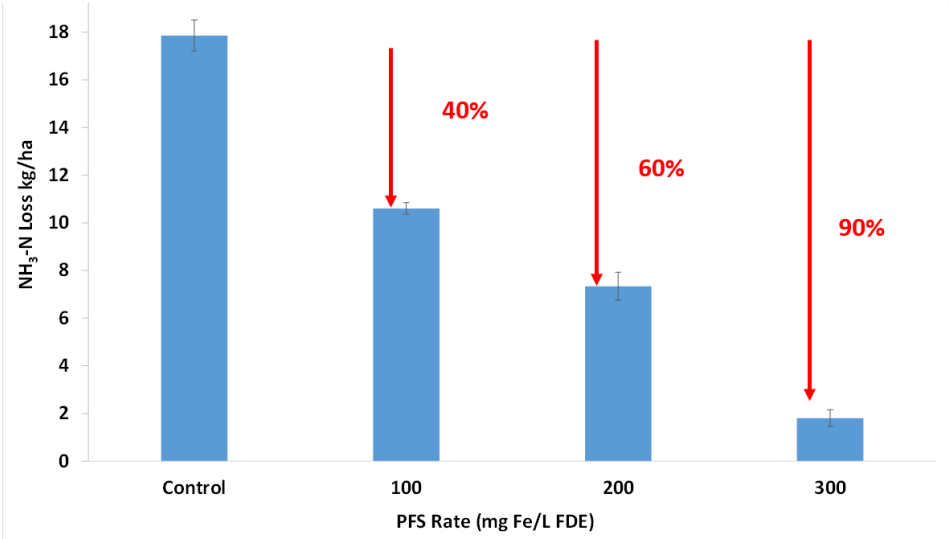
Dissolved Reactive Phosphate (DRP) leaching loss reduced to background (i.e. control) levels in pipe drain system (> 90% reduction)



Treatments	Total loss (kg P/ha)	
	DRP	
Control	0.24	a
TE	0.24	a
TE-S	0.27	a
FDE	3.48	b

(Che et al. 2022 SUM 'in press')

PFS treatment significantly reduced ammonia volatilisation losses from FDE over a 7 day period



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What is the potential benefit to NZ?

Enteric Fermentation Emission

Emissions from Option A

View Graph | Export Data

2020

Sector	Emissions (kt CO_2-e)
Dairy Cattle	+14,034.67

Enteric Fermentation Emission = 14,034,670 t
Manure Management Emission = 1,387,110 t
Total dairy farm methane emissions = 15,421,780 t

Manure Management

Emissions from Option A

View Graph | Export Data

2020

Sector	Emissions (kt CO_2-e)
Dairy Cattle	+1,387.11

Methane emissions from dairy effluent ponds represents about 90% of the total emissions in the Manure Management Category for dairy cattle is: 1,387,110 x 0.9 = 1,248,399 t CO_2-e.

A 90% reduction of methane from all NZ dairy effluent ponds = 1,248,399 t x 0.9 = 1,123,559 t CO_2-e)

Reduction = 7.3 %

https://emissionstracker.mfe.govt.nz/#NrAMBoDYA4F12ARnAIgHIFMAuL7AEzj6iICce0qAxAO4CGWGATgGZ0A27A+gEYCuWLAHsAdrlhA

https://emissionstracker.mfe.govt.nz/#NrAMBoHZIXXYCM4BEA5ApgF2XYAmcPUBATlwA4UBiAdwENN0AnAMzoBt2B9AIwFdMmAPYA7HDCA

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