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Precision Injection of Dairy Slurry to Improve Nutrient Uptake: Benefits and Risks

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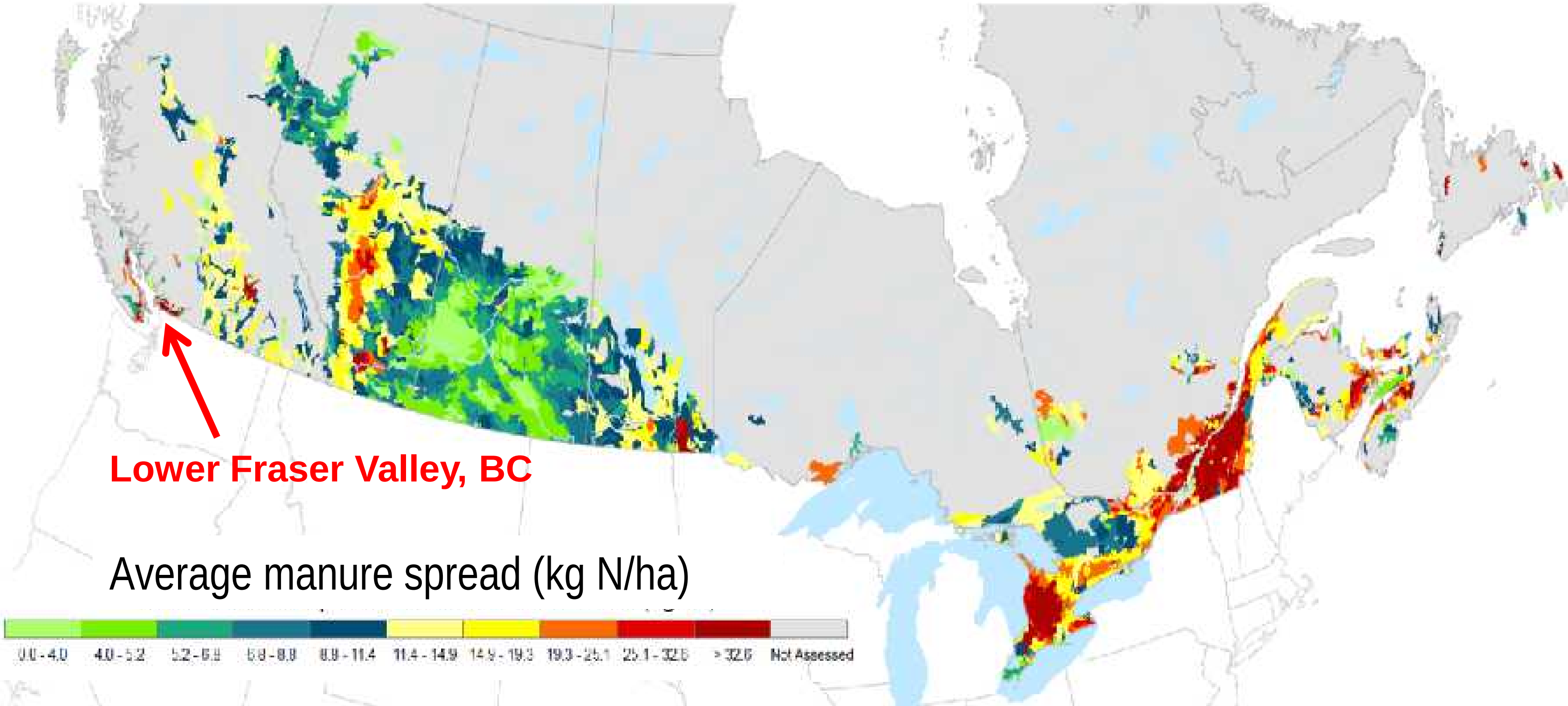
Canada

Manure intensity map of Canada
showing study location, Lower Fraser Valley



Background

- **Intensive dairy operations contribute to nutrient surplus in the Lower Fraser Valley of British Columbia, impacting aquifers, surface waters and air. Hence there is an urgent need to reduce nutrient imbalances on dairy farms.**
- **Methods are needed to replace fertilizer with dairy slurry manure without loss of yield or increase in nutrient leakage to environment.**

Concept of precision injection

Positioning slurry near corn rows can provide needed starter P and N that is currently provided by commercial fertilizer.

Injection conserves N by reducing NH_3 emission.

Objectives

- Can precision injection of dairy slurry replace current mineral fertilizer for corn?
- Are there environmental trade-offs due to placing large amounts of slurry into injection furrows?

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Specific goals:

1. To evaluate response of silage corn to precision-injected dairy slurry relative to broadcast slurry and mineral fertilizer.
2. To assess losses of N from injected slurry as nitrate (NO_3) leaching and nitrous oxide (N_2O) Emissions.
3. To assess mitigation N_2O emission by nitrification inhibitor DCD (dicyandiamide).

What is precision injection?

1, Dairy slury is injected at corn-row (75-cm) spacing to a depth of 15 cm, covered and left to soak for 5-7 days.

2. Corn is planted a few days later (same spacing) <u><10 cm </u>from the injection furrow.

Methods

Randomised complete block experiment was conducted on silty loam in a maritime climate.

Slurry manure was obtained from commercial dairy farms feeding mainly grass and corn silage and using sawdust bedding.

Manure had an approximate ratio

tot.N: mineral N: tot.P   5: 2.5: 1

Note:

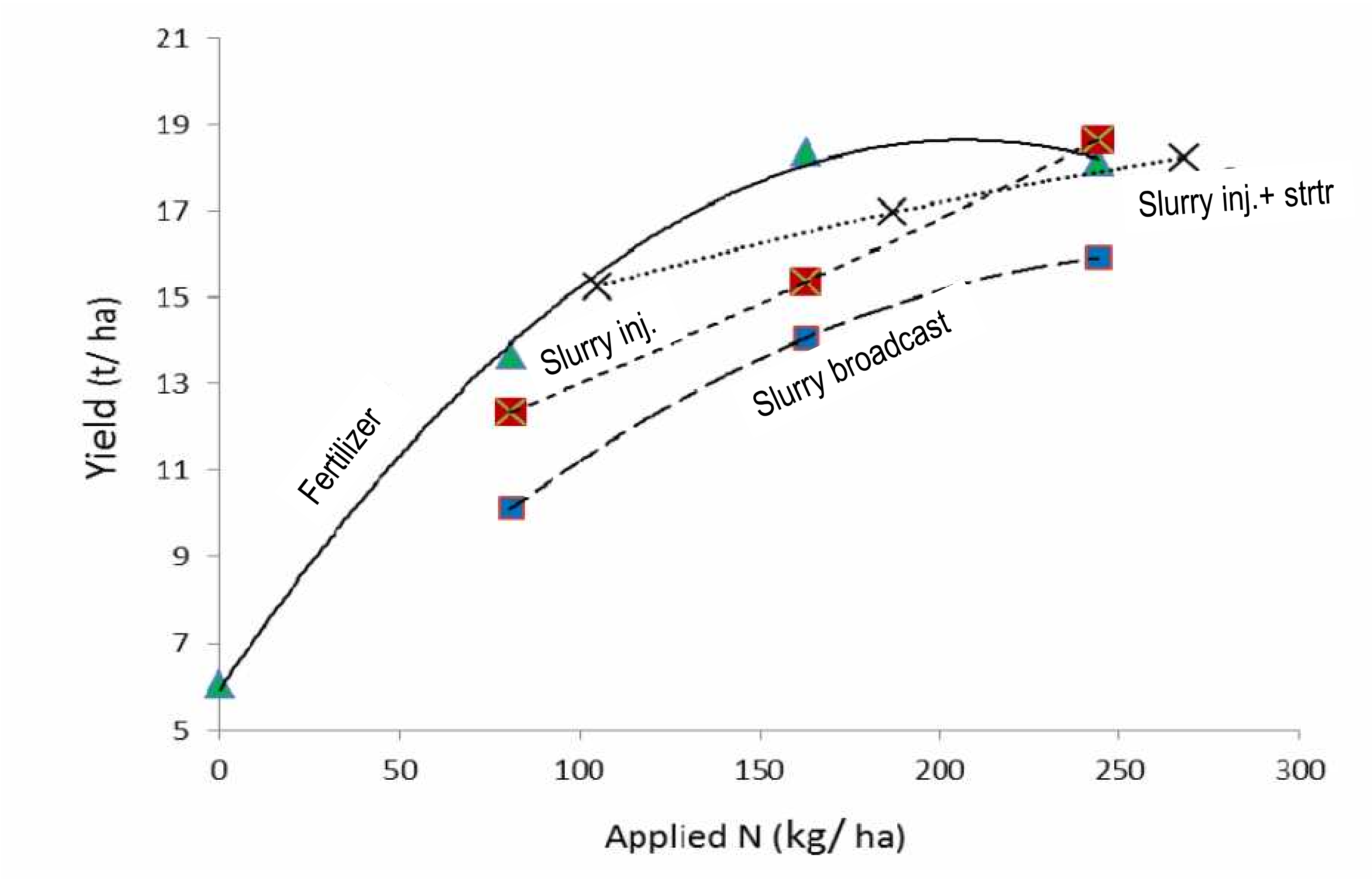
Trial was repeated for 5 years on same plots to include the legacy effects (positive and negative) of previous manure applications.

Treatment summary

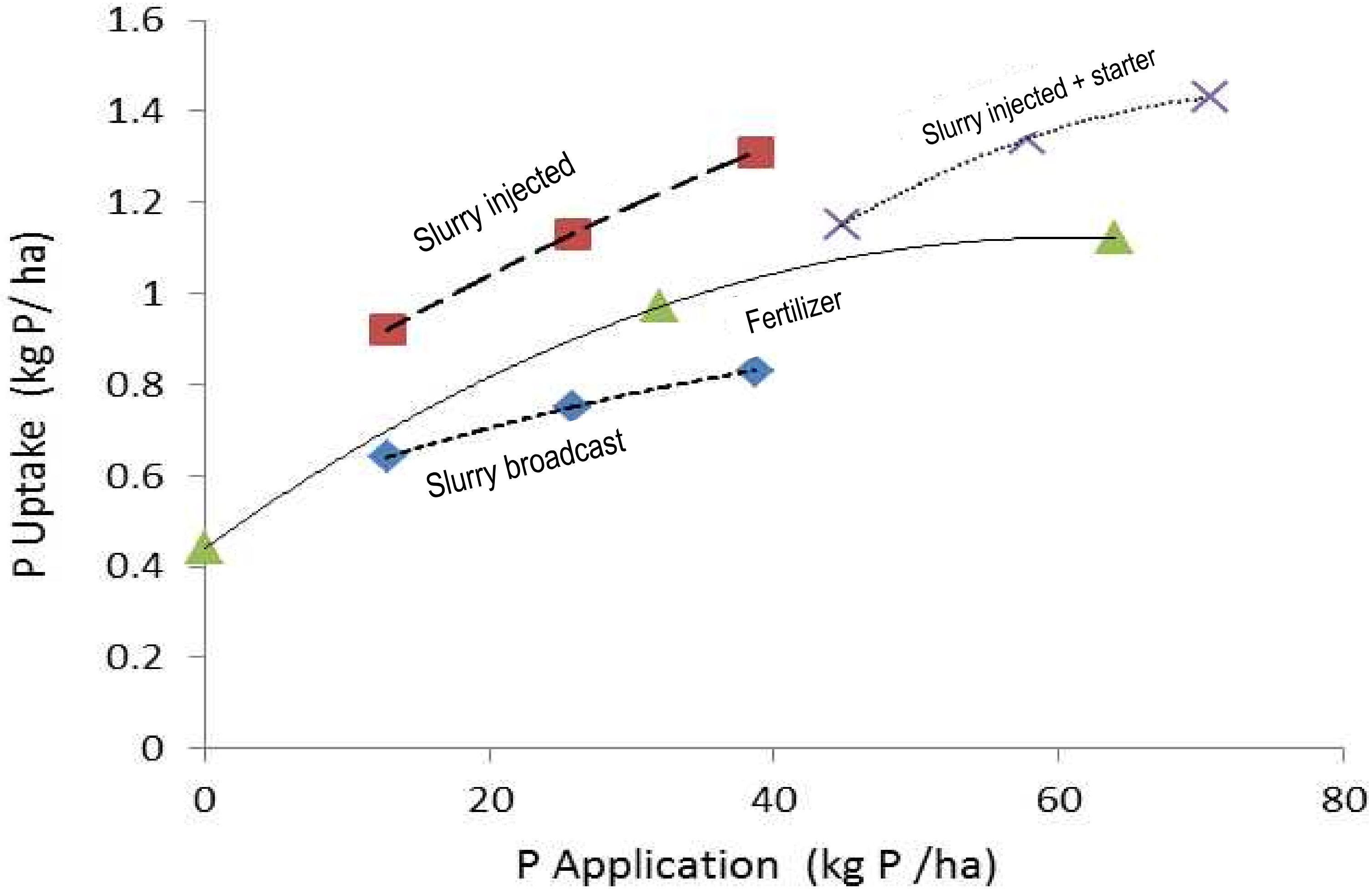
Nutrient	Method	Mineral Starter
Control	-	-
Commercial Fertilizer	Broadcast	+
Slurry	Broadcast	-/+
Slurry	Inject	-/+

Rates: 0-250 kg N ha^{-1}

Corn yield response to mineral fertilizer or dairy slurry applied by broadcasting or precision injection (2010-2014)

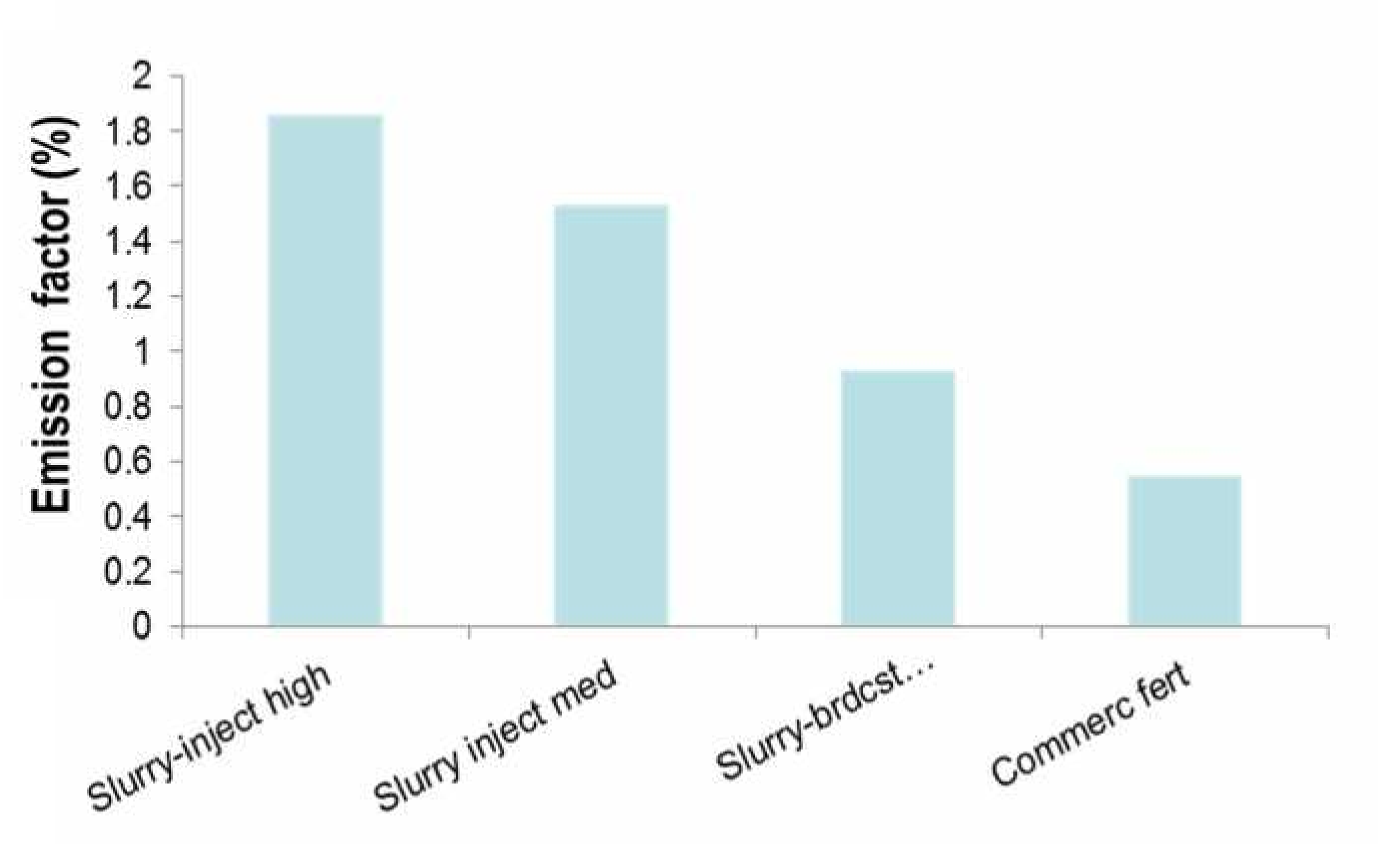


P uptake by 6-leaf corn from mineral fertilizer and dairy slurry applied by broadcasting or precision injection (2010-2014)

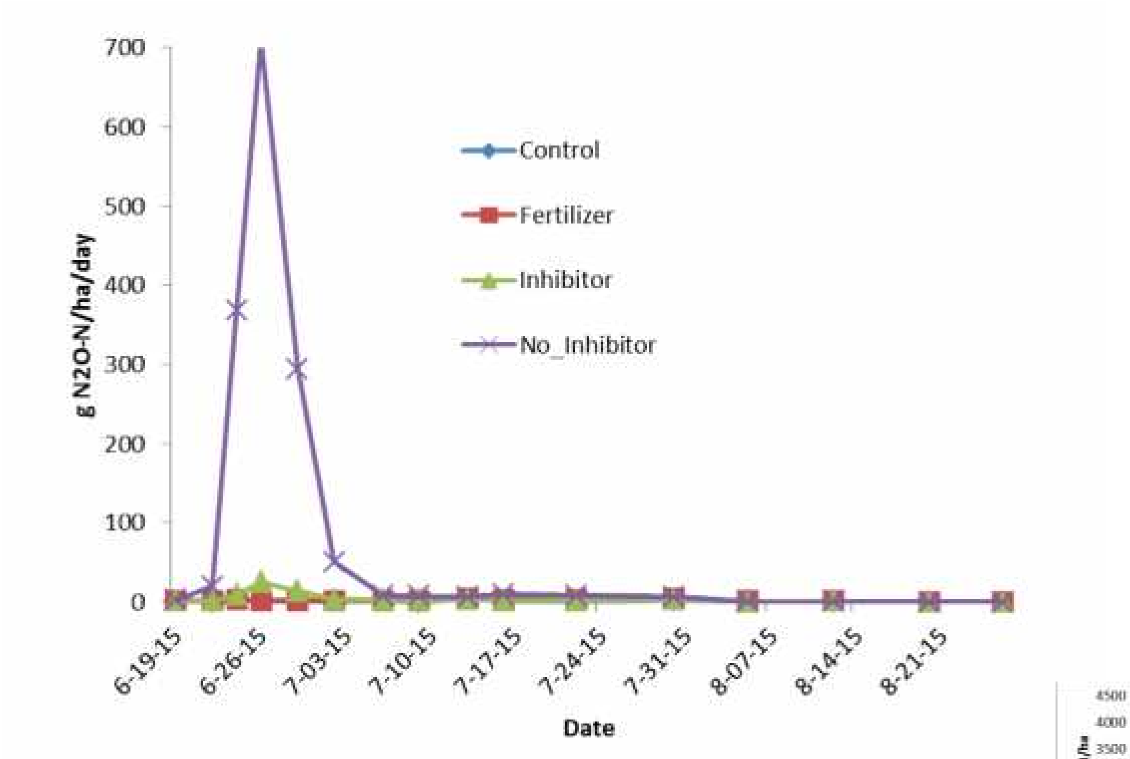


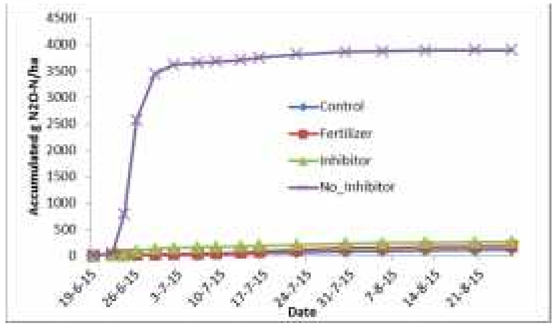
Unintended consequences?

Total annual N_2O-N emissions as affected nutrient inputs
N_2O-N above control as % of applied N (emission factor, 5-year mean)



Suppressing N_2O emissions from injected dairy slurry with nitrification inhibitor DCD



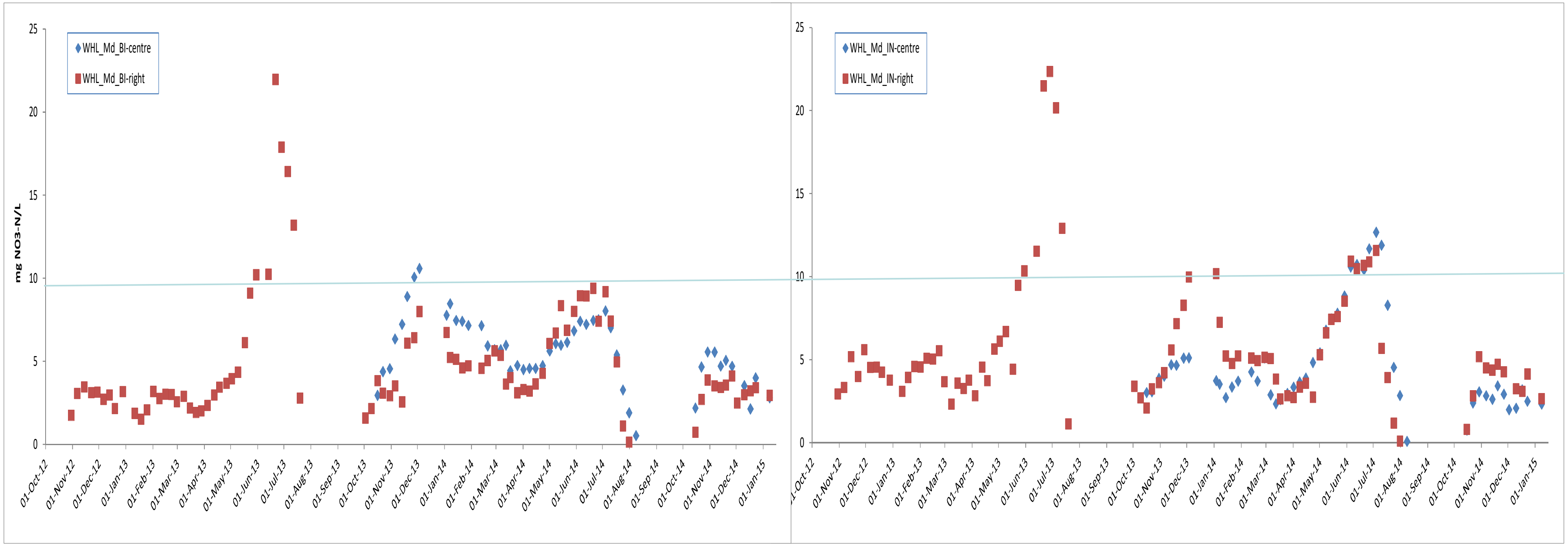


Corn responses to precision injected dairy slurry with and without nitrification inhibitor DCD

Treatment	N applied	Silage Yield	N Uptake
	kg ha^{-1}	t ha^{-1}	kg ha^{-1}
Control	0	11.0 [b]	125 [b]
Fertilizer	184	13.3 [a]	184 [a]
Slurry –N inhib	184	11.9 [ab]	165 [ab]
Slurry +N inhib	188	12.4 [ab]	151[ab]

Nitrate concentrations in suction lysimeters samples from 45cm depth

Broadcast and incorporated Injected



Conclusions

1. Maximum yield can be achieved with injected manure at 250 kg N/ha compared to 170 kg N/ha with mineral fertilizer due to lower uptake of organic N and possibly more denitrification and leaching losses.
2. There is excessive P applied at 250 kg N/ha of slurry (~50kgP/ha) so might benefit form manure separation.
3. P uptake from injected slurry exceeded mineral fertilizer
4. Injection of slurry increased N_2O and perhaps leaching
5. DCD reduced N_2O emissions but did not improve yield of corn.

Message

On intensive dairy farms, precision injected slurry can replace mineral fertilizer and increased emissions can be mitigated with DCD.

Work is needed to further improve this technique.

Thank you

Results

Treatments	Yield	N uptake	P uptake	P Uptake (6 leaves)
Mineral fertilizer	A[1]	A	AB	C
Slurry-broadcast	C	D	C	D
Slurry-injected	B	C	B	B
Slurry-injected +starter	A	B	A	A

[1]nutrient methods for each response variable not followed by the same letter are significantly different at $P<0.05$

Apparent N recovery from mineral fertilizer or dairy slurry applied by broadcasting or precision injection (2010-2014)