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An Integrated Approach to Nutrient Management on Dairy Farms

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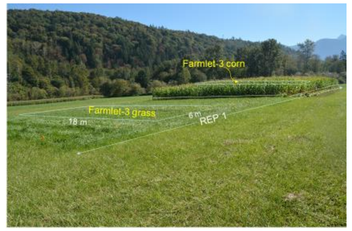
Introduction

Animal production is criticised for excessive environmental impact. The dairy industry has improved nutrient efficiency through cow genetics and feeding but further improvements require an integrated farm approach that ensures efficient measures with limited side-effects. Here we report on a novel experimental approach for improving nutrient efficiency, with four integrated model dairy farms represented by semi-virtual farmlets; combining replicated field plots (corn and grass) with simulated cattle feeding enables integrated assessment.



Farmlet field plots: one of four replicates with grass and corn

Table 1. Description of Farmlets
(photos on right depict some of the measures)

Farmlet	Grass Management		Corn Management	
	Nutrients	Harvesting	Nutrients	Cropping
1. *Reference farm*	***Whole slurry broadcast***	***5 cuts (standard)***	***Whole slurry broadcast + starter P fertilizer***	***Long season corn, no cover crop***
2. **Advanced nutrients**	Separated liquid fraction, band spreading *(Photo top left)*	5 cuts (standard)	Precision injection of separated sludge fraction for P *(Photo bottom left)*	Long season corn , no cover crop
3. **Advanced Nutrients and strategic cropping**	Separated liquid fraction, band spreading	3 cuts (Relaxed)	Precision injected sludge + spring slurry on relay crop	Medium season corn with grass relay crop *(Photos on right)*
4. **Enhanced: Farmlet 3+ Remediation**	As Farmlet 3 plus nitrification inhibitor(DCD)	As Farmlet 3 plus irrigation	As Farmlet 3 plus nitrification inhibitor (DCD)	As Farmlet 3 plus Irrigation

Table 2. Crop and estimated milk production, and N losses from a reference BC farm (Farmlet 1) and 3 farmlets with improved manure (Farmlet 2), manure + cropping (Farmlet 3) and enhanced measures (Farmlet 4). Reference Farmlet has 40% corn land, Farmlets 2-4 have 70% corn land (rest is grass).

Farmlet	Description	Land	DM yield	N uptake	Crude Protein	Est. Milk from grass	N_2O-N	Leaching
		% corn	*kg ha^{-1}*	*kg ha^{-1}*	*g kg^{-1}*	*kg ha^{-1}*	*Emission factor*	*kg NO_3-N ha^{-1}*
Farmlet 1	Reference	40	14.4	231	160	14164	0.48	90.4
Farmlet 2	Manure	70	17.5	226	129	14940	0.88	101.6
Farmlet 3	Manure+Crop	70	17.0	260	153	17033	1.26	39.0
Farmlet 4	Enhanced	70	18.7	286	153	18310	0.58	32.0

Findings

- Compared to Reference, with improved manure managements Farmlet 2 had higher crop and estimated (grass) milk yield, lower P input, similar N uptake, higher (grass) milk production but higher N_2O emission and NO_3 leaching losses.
- Compared to Reference, Farmlet 3 with improved manure and crop management had higher crop and estimated (grass) milk yield, higher N uptake, lower NO_3 leaching losses but higher N_2O emission.
- Compared to all farmlets, Farmlet 4 had highest crop and estimated grass milk yield, N uptake, and low N_2O emission and NO_3 leaching losses.
- Preliminary animal feed modelling suggests that based on a diet balanced for high milk production, Farmlets 2-4 have higher milk production but also higher manure N excretion than Reference. These preliminary results need further assessment.

Conclusion

Crop production, N uptake and estimated milk can be increased while reducing N losses and P loading, with a suite of practices and measures, including precision application of separated manure fractions, strategic crop management, and replacing about half the grass land with corn and relay crop. Initial animal modelling suggests based on high milk production goals, the advanced farmlets will secrete more milk but excrete more N.