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Characterization of Naturally Separated Dairy Manure Fractions

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Background and Context

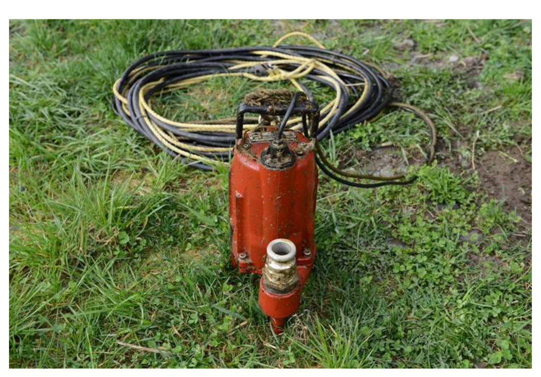
The traditional recommendation for land application of liquid manure has included prior agitation of stored manure to provide a uniform source of crop nutrients. However, research has shown that different crops have different nutrient requirements, and these nutrient requirements can often be better met by applying different separated manure fractions. There have been significant advancements in creating separated manure fractions, but many technologies, such as mechanical separation, are often cost prohibitive. Natural separation of manure fractions occurs in most liquid manure storages, through settling of solids. There is also potential for coarse solids to rise to the surface to form crusts. Under this scenario a certain amount of the thinner supernatant liquid below the crust can be pumped and land applied on one crop type, followed by agitation and land application of thicker slurry on another crop type. Thicker slurry generally contains more nutrients than thin supernatant, and phosphorus (P) / nitrogen (N) ratio may be greater, meaning that a higher percentage of P compared to N could be in the solid fraction.

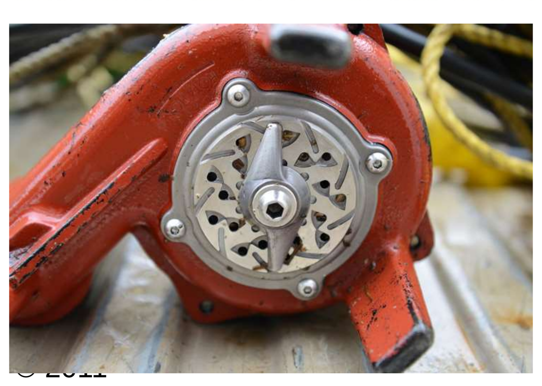
Objectives

1. To characterize the nutrient content of naturally separated dairy manure fractions in dairy farm liquid storages.
2. To determine how these fractions vary depending on management practices such as bedding and water inputs, and manure treatment/handling before entering storage.
3. To investigate the feasibility of land applying naturally separated dairy manure fractions for dairy farms in the Lower Mainland of British Columbia.

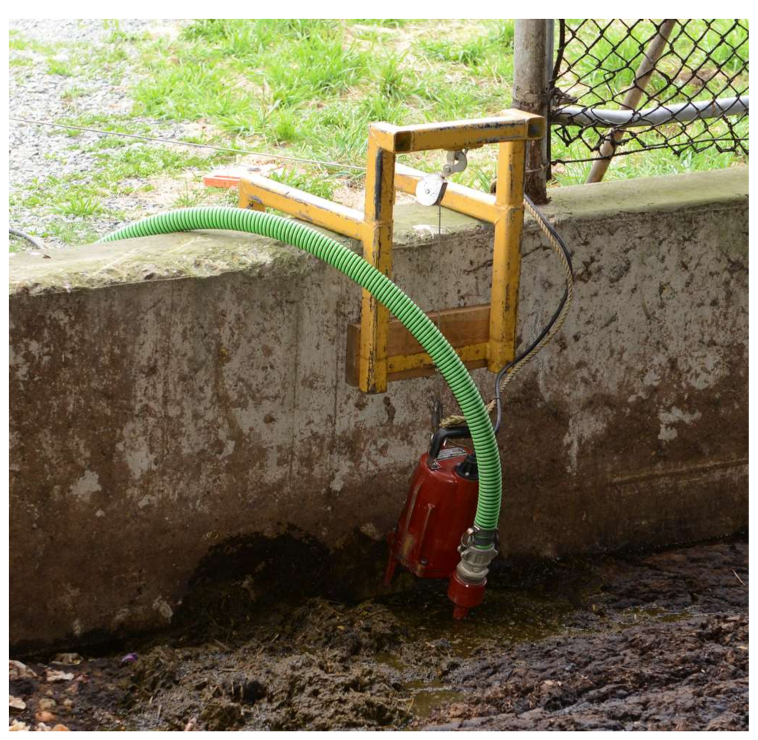
Methodology

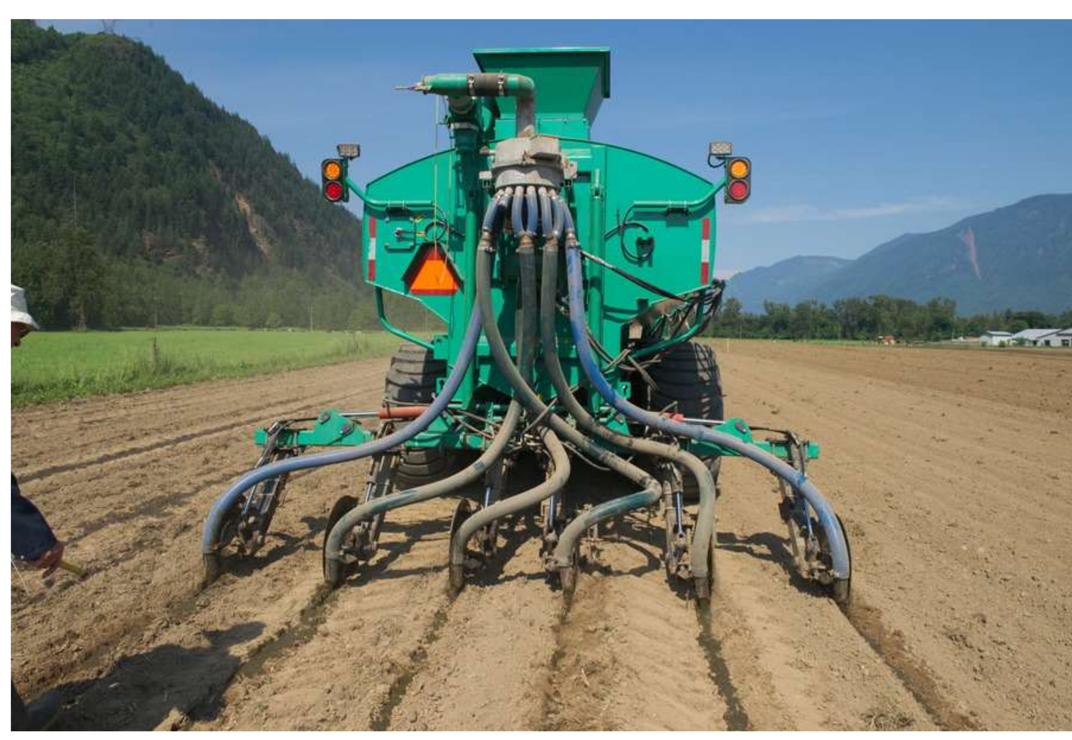
In 2014 and 2015, manure sampling was conducted at 21 different dairy farm manure storages. Most storages were sampled more than once, amounting to a total of 35 storages sampled. Samples were primarily taken in early spring, just prior to agitation and first field application, when storages were mostly full. They were typically taken at 2 locations per storage (if possible) and at various depths, using a submersible pump with a grinder knife to facilitate pumping of thicker slurries with solids. Depth of manure in storages ranged from 1.3 to 7.9 meters (3.6 average), and sampling interval was most often between 0.46 and 0.67 meters. Samples were analyzed for dry matter content, total N, ammonia N, and total P. Each farmer was surveyed to collect information on livestock type, feed rations, bedding management, manure management in the barn, and water inputs into the manure storage.





Submersible pump showing grinder knife, and in action lowered into manure storage via pulley and metal frame





Thicker slurry precision injected several days prior to corn planting. Corn is planted over injection furrows. Higher concentration P from manure eliminates need for starter P fertilizer.

Results

Table 1: Nutrient Composition at Shallowest [2] and Deepest Depths for 35 Liquid Manure Storages

Attribute	Location in Storage	Average	Minimum	Maximum	# of Storages with "____" Stratification: Negative < 0% change [1]	Little 0 - 20% change	Some 21 - 60% change	Considerable > 61% change
Dry Matter (%)	Shallow	1.89	0.37	5.84	1	4	6	24
	Deep	5.45	1.07	10.32				
	% Change [1]	336%	-3%	2149%				
Total Nitrogen (%)	Shallow	0.122	0.041	0.245	5	6	5	19
	Deep	0.191	0.050	0.291				
	% Change	94%	-21%	424%				
Ammonia Nitrogen (%)	Shallow	0.082	0.027	0.143	3	14	8	10
	Deep	0.111	0.029	0.185				
	% Change	49%	-7%	219%				
Total Phosphorus (%)	Shallow	0.0176	0.0041	0.0400	2	8	5	20
	Deep	0.0349	0.0107	0.0990				
	% Change	218%	-6%	1618%				
Total P/N Ratio	Shallow	0.142	0.036	0.322	10	6	8	11
	Deep	0.188	0.083	0.375				
	% Change	51%	-54%	274%				

Table 2: Nutrient Composition for Top Half and Bottom Half [3] of 35 Liquid Manure Storages

Attribute	Location in Storage	Average	Minimum	Maximum	# of Storages with "____" Stratification: Negative < 0% change [1]	Little 0 - 20% change	Some 21 - 60% change	Considerable > 61% change
Dry Matter (%)	Top Half	2.48	0.42	6.44	2	9	6	18
	Bottom Half	4.74	1.33	10.80				
	% Change [1]	165%	-3%	948%				
Total Nitrogen (%)	Top Half	0.140	0.039	0.237	6	11	8	10
	Bottom Half	0.177	0.057	0.279				
	% Change	44%	-21%	189%				
Ammonia Nitrogen (%)	Top Half	0.089	0.029	0.145	8	16	9	2
	Bottom Half	0.102	0.026	0.176				
	% Change	18%	-16%	113%				
Total Phosphorus (%)	Top Half	0.0205	0.0049	0.0396	4	12	4	15
	Bottom Half	0.0300	0.0113	0.0497				
	% Change	90%	-26%	686%				
Total P/N Ratio	Top Half	0.149	0.072	0.225	10	12	8	5
	Bottom Half	0.175	0.094	0.308				
	% Change	24%	-41%	174%				

Note: [1] % Change was calculated for each storage as (Deep – Shallow) / Shallow for Table 1, and (Bottom Half – Top Half) / Top Half for Table 2.
[2] Shallowest depth is the first liquid sample taken below crust, if present.
[3] Bottom half includes floating crust material. This scenario assesses potential for B.C. Lower Mainland farm application of thin supernatant on perennial grass (top half), followed by agitation and application of thicker slurry (bottom half) on land to be seeded to forage corn.

Key Conclusions

1. While a strong majority of storages showed stratification of dry matter (ie. settling solids), somewhat fewer storages showed stratification of total P and total N. For most storages there was little to no stratification of ammonia N and total P/N ratio.
2. Mechanically separating coarse solids prior to manure entry into storage had the greatest impact on reducing stratification. Higher manure disturbance (eg. pumping versus scraping) prior to manure entry into storage also contributed to less settling.
3. Despite minimal influence on total P/N ratio, naturally separated thicker slurry provides more nutrients at the same volume rate. This increases feasibility of certain practices such as supplying P requirements for corn via for precision injection (see photo).