Dairy Slurry Fertigation Tradeoffs

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Fall injection of liquid dairy manure following corn silage harvest is a common management practice for dairy farmers. However, fall-applied manure nutrients are vulnerable to winter and wet spring leaching, particularly in fields with subsurface tile drainage. Better synchronization of manure application with peak crop nutrient demand may improve nutrient utilization and reduce drainage nitrogen (N) losses. In irrigated fields, fertigation is an alternative to fall injection that could accomplish this goal. Applying diluted, screened dairy-slurry through an irrigation system requires little machinery traffic, making growing-season application a realistic option. This may also allow for lower application rates over time, as a greater fraction of applied N can be utilized for plant growth, rather than lost to the environment.

Dairy slurry fertigation into silage corn. Diluted to 50:50 mixture with well water; applied with drop nozzles when corn was in late vegetative growth stages, typically in late June or early July.

Collaboration with a large dairy in west-central Minnesota from 2006-2015 evaluated dairy slurry fertigation on two adjacent 160-acre fields. One field was in continuous silage corn for the 10-year study, with manure fall-injected the first 3 years, then fertigated through center-pivot irrigation the last 6 years (no manure was applied in the 4th year). The adjacent field was in silage corn 6 years, alfalfa 3 years, and manure was fall-injected following silage harvest or applied via AerWay SSD applicator into alfalfa after first harvest.

Drainage Nitrate Loss Study. The objective was to compare silage corn yield, N uptake, and nitrate-N losses in tile drainage with summer manure fertigation vs. fall injection. Results show fertigation reduced nitrate-N losses from irrigated silage corn relative to fall injection without impacting corn silage yield (Table 1). Crop N removal and manurial N-use efficiency were greater during fertigation than injection, suggesting summer fertigation is more efficient at delivering N to the crop. With a greater fraction of applied N being utilized, manure application rates and subsequent N losses in drainage were reduced. Fertigation also reduced spring soil nitrate-N concentrations to a 24" depth by an average of 53% relative to injection. Fall soil nitrate-N concentrations from 12-36" depths were 48% lower, on average, under fertigation than injection.

Table 1. Responses during manure injection and fertigation.

Agronomic & Water Quality Response	Injection 2007 - '09	Fertigation 2010 - '15
Silage yield (tons DM/ac)	8.2	8.3 - *NS*
Silage %N	1.06	1.23*
Silage N removal (lb/ac)	182	205*
Manurial N-use efficiency† (lb/lb)	0.5	1.2*
Drainage N concentration (ppm)	57	48*
Drainage N loss (lb/ac/yr)	50	39*

NS = no significant difference between periods; * = significant difference between periods ($P<0.05$); † = Manurial N-use efficiency, calculated as ratio of crop N removal to manure N applied.

Soil Carbon Study. The objective was to quantify changes in soil organic carbon related to crop and manure management in the study fields. Liquid dairy manure applications can increase soil organic carbon (SOC), as slurry solids contribute to formation of stable organic matter in soil. In order to fertigate, however, slurry is screened to remove solids that could otherwise clog the irrigation system. Previously, it was unclear how removing solids would impact SOC relative to an application with regular slurry. After 10 years of monitoring, SOC stocks to a 6" depth declined by 2.1 tons C/ac (33.9 to 31.8 tons C/ac) where manure was fertigated and only silage corn was grown. Where manure was injected and alfalfa grown in rotation with silage corn, SOC stocks were maintained, and may be increasing (27.3 to 29.0 tons C/ac). Carbon stocks were also monitored deeper in the soil and no changes were found from 6" to 36" depths in either field. Results show the combination of continuous silage corn with fertigation doesn't return enough organic matter to the soil to maintain organic carbon stocks at this site. Although the unscreened slurry was typically only ~3-6% dry matter, those solids appear to be critical in maintaining soil organic matter. Since this study was field-scale, it's challenging to disentangle the effects of manure application from the alfalfa crop rotation field. Undoubtedly, alfalfa root turnover also contributed to maintaining SOC with the unscreened dairy slurry.

Summer fertigation can reduce nitrate losses from continuous silage corn production, but at the expense of soil organic matter maintenance. Although reduction in nitrate loads was substantial, ~22%, nitrate-N concentrations/loads in drainage water remained relatively high.