Evaluating liquid anaerobic digestate injection vs. surface application for NH_3-N conservation and corn yield response

Sailesh Sigdel[1], Heather Karsten[1], Curtis Dell[2], and Ronald Hoover[1] [1]Pennsylvania State University; [2]USDA-ARS-PSWMRU, University Park, PA

Background

- Growing dairy herd sizes, advancement in technologies, and economic incentives have contributed to the installation of anaerobic manure digestors
- Anaerobic digestion increases the pH and NH_4 concentration of the digested manure, increasing the potential for NH_3 volatilization
- Prior studies found that injection of the liquid digestated manure reduced NH_3 loss compared to surface application without incorporation.

Hypothesis

Liquid digestate injection will reduce ammonia (NH_3) gaseous loss as well as increase corn nitrogen availability and yield compared to surface broadcast without incorporation

Materials & Methods

Study sites: Three commercial dairy farms in PA with anaerobic digesters

- Farms apply liquid digested manure prior no-till corn-silage and winter rye or triticale grown for silage, sometimes also in March (2-3 times/annually)
- Farms vary in food waste anaerobic digester inputs, separate solid-liquid from anaerobic digestated manure

Table 1. Digestate application rate and contents for each farm vs. raw manure

	Farm A	Farm B	Farm C	Raw manure at DCS Expt.
Application rate (litre ha^{-1})	93540	56124	51446	42093
Total solids (%)	3.63	4.61	4.38	10.4
Total N (Kg 1000 L^{-1})	1.97	2.85	4.84	4.1
Ammonium N (Kg 1000 L^{-1})	1.25	1.64	3.27	1.4

Treatments: 1. Shallow-disk Injection 2. Surface application

Study design: Side-by-side field scale treatment strips (6.09 to 9.14 m) ranged in length from 187 to 387 meters, same application rate, replicated 5-6 times.

Fig . Side-by-side manure digestate being injected and surface applied at our research site

Total digestate N applied: 160-249 kg N/ha; NH_4-N: 92-168 kg N/ha

- Farms B and C applied inorganic N (49.3 and 27 Kg N/ha resp. as starter)
- Farms A and B applied side-dress N (67.3 Kg N/ha)

Sampling:

- Ammonia volatilization in the first 24 hours after the liquid is injected or broadcast
- Pre-side dress nitrate soil test (PSNT)
- Corn stalk nitrate levels at corn harvest (10 corn stalks/treatment plot)
- Corn silage yield

Statistical analysis: Data were analyzed using the MIXED Model in JMP Pro 16 (SAS Institute Inc.) with manure application method as fixed effects, and blocks as a random effect. Yield data were pooled after testing for homogeneity of variances with treatments as fixed effect, and loc and block(loc) as random.

Results and Discussion

Digestate injection reduced NH_3 volatilization

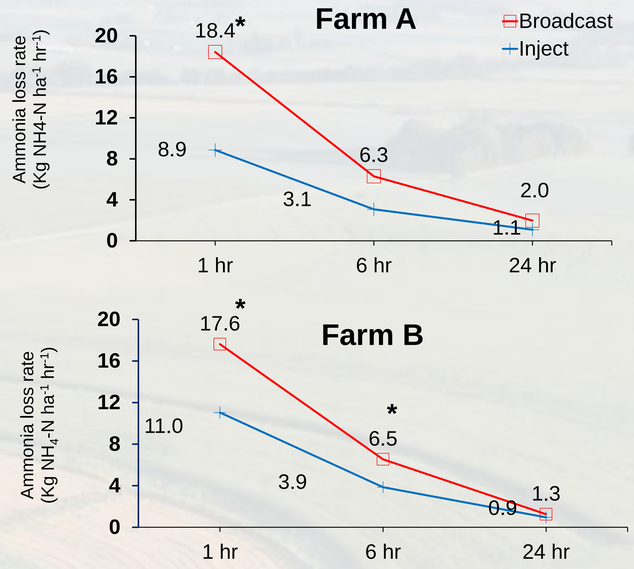

Fig 2. Ammonia volatilization after digestate was broadcast or injected for farms A and B respectively.
***** indicates values that differ at p<0.05

Table 2. Partial budget economic analysis for each farm

Partial Budget Economic Analysis	Farm A		Farm B		Farm C	
	Injected	Broadcast	Injected	Broadcast	Injected	Broadcast
Corn Silage Value	$1,151	$1,105	$1,115	$1,070	$1,117	$1,084
Cost of production/A	$790	$765	$674	$649	$342	$324
Injection Cost/A	$25	-	$25	-	$18	-
Net returns	361	340	$441	$421	$775	$760
Difference in net returns from Broadcast	$21		$20		$15	

Injection increased net returns compared to surface broadcast on all three farms.

PSNT and CSNT indicates there was more than sufficient N

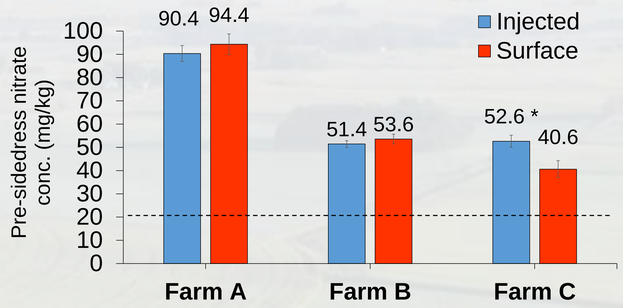

Fig 4. Pre-sidedress soil nitrate-N test results after digestate application.
* indicates values that differ at p<0.05

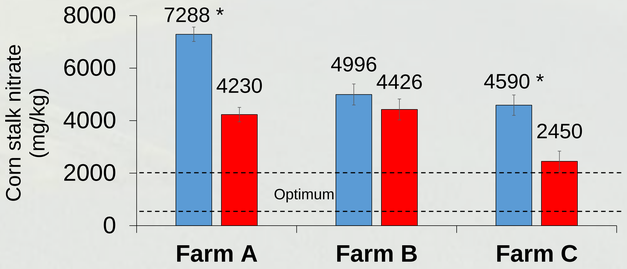

Fig 5. Late Season Cornstalk Nitrate Test (CSNT) results after digestate application. * indicates values that differ at p<0.05

Across farms, corn yield was greater with injection than surface broadcast at *p*<0.1

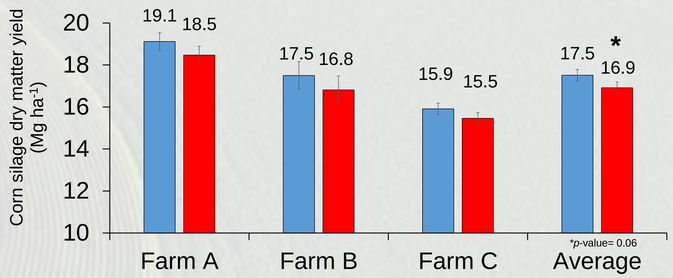

Fig 6. Corn silage dry matter yield and average corn silage dry matter yield across the farms. Standard error bar denoted pm each bar.

Implications

- Digestate injection can conserve N, potentially increase yield and returns on investment as N fertilizer prices are increasing
- Soil & crop N tests indicated N availability and potential for loss is high, farms could reduce or eliminate side-dress N, possibly starter N

www.agchange.org

United States Department of Agriculture National Institute of Food and Agriculture
Grant ID: 2020-68012-31824