# Missisquoi Water Quality

Demonstration results from the Lower Missisquoi Water Quality Project in Franklin County, Vermont

# Manure Application Methods for Corn

**Field Studies on Direct Incorporation of Liquid Dairy Manure for Fall, Spring, and Sidedress Application in Corn**

## Introduction and Background

Manure is typically applied to corn land in the spring before planting or in the fall after harvest. Spring application is generally recommended to increase efficiency of N use and decrease potential for leaching and runoff losses. However, for practical reasons (limited storage, time constraints in spring, field conditions, etc.) many farmers need to apply manure in the fall. Besides increased susceptibility to leaching and runoff losses, if fall-applied manure is left on the surface until spring tillage much of the ammonium-N in the manure can be lost to volatilization.

We conducted two field studies to evaluate and demonstrate alternative application methods that provide direct incorporation of liquid manure at various times -- fall, spring, and sidedress time. Direct incorporation of manure refers to application by methods which incorporate the manure directly into the soil as it is applied. This includes injection of liquid manure with a knife or chisel resulting in a band of manure several inches below the surface. More recently developed methods include horizontal sweeps, which inject at a shallower depth, and others which apply a band of manure on the surface behind the spreader directly ahead of a set of cultivator tines or a pair of concave disks, so that manure is immediately mixed with the surface few inches of soil.

The main potential benefits of direct incorporation of manure are reduction of ammonia volatilization losses, odor, nutrient loss via surface runoff, and transport of pathogenic bacteria by runoff or wind. The option of sidedressing manure into a growing corn crop opens another window of time for applying manure. It also allows use of the Pre-Sidedress Nitrate Test (PSNT) to estimate the optimum manure application rate, something that is not possible with fall or spring application times.

The objective of these trials was to demonstrate new application techniques and to determine the effect of manure application method and timing on corn silage yield, efficiency of manure N use, and nitrate leaching potential.

## Methods

Manure on both trials was applied with a commercial 1500 gallon slurry tank spreader with tandem axles manufactured by Nuhn Industries of Sebringville, Ontario. Sweep injectors, s-tine cultivator shanks, or paired concave disks mounted on the rear of the spreader were used for direct incorporation of manure.

The sidedressed manure trial was carried out on a silt loam soil on the David Manning farm in 1995. Manure was applied at a rate of approximately 4000 gallons per acre on June 21 when the corn was 20 to 24 inches tall. The following sidedressed manure and fertilizer treatments were compared. Manure supplied the following, lb/acre:115 total N, 60 $NH_4$-N, 50 $P_2O_5$, 115 $K_2O$

1) Sweep injection (10-inch wide sweep, 4-5 inch deep)
2) S-tine cultivator (3 shanks per row)
3) Paired concave disks
4) Fertilizer N at 60 lb N/acre rate
5) Control (no manure or fertilizer N)

The trial to compare fall and spring application methods was conducted in 1996 and 1997 on a Raynham silt loam soil on the Steve and Richard Dodd farm. Manure supplied the following nutrients (lb/acre/yr): 210 total N, 110 $NH_4$-N, 80 $P_2O_5$, 150 $K_2O$.

Treatments were as follows:
1) Fall manure, surface-applied (Fall, Surf)
2) Fall manure, incorporated with shallow sweep injectors (Fall, Sweep)
3) Fall manure, incorporated with s-tine/field cultivator (Fall, Cult)
4) Spring manure, incorporated with s-tine/field cultivator (Spring, Cult)
5) Fertilizer nitrogen, applied as ammonium nitrate at sidedress time at rates of 0, 40, 80, or 120 lb N/acre (in addition to 36 lb/acre in starter).

To assess nitrogen availability and leaching loss we soil sampled to various depths in the fall, in the spring, and just before sidedressing fertilizer N.

## Results: Sidedressed Manure Trial

Silage yields ranged from 23 to 25 tons per acre (30% dry matter) with no effect of treatment. The lack of treatment differences can probably be attributed to the fact that the soil, along with starter N, supplied adequate N to the crop without the addition of manure or sidedressed fertilizer. The Pre-Sidedress Nitrate soil test from a sample taken the week before sidedress application was 24 ppm, which gave a recommendation of only 35 lb N/acre. Samples taken the day of application averaged 30 ppm, a level at which no additional N

is recommended. All methods worked adequately to incorporate manure, but we preferred the s-tine cultivator because it appeared less likely to cause root pruning and it provided supplementary weed control.

In a two-year research trial conducted on a N-responsive site in Chittenden County, manure sidedressed with s-tine cultivators produced yields similar to those from spring broadcast manure applied at a 50% higher rate, reflecting increased N efficiency from sidedressed application.

## Results: Fall and Spring Application Methods

### Soil Nitrate

The pre-sidedress nitrate test (PSNT) is designed to estimate N availability and, therefore, the need for additional fertilizer N. Results of the PSNT showed significant treatment differences in the 0 to 6-inch layer in 1996 and in the 0 to 12-inch depth in 1997 (no 0-6" depth measured) (Fig. 1). Nitrate levels from incorporated manure treatments, especially Spring-Cultivator, were greater than the surface-applied treatment, which was equal to the no-manure control in both years. They indicate increased N availability (less ammonia volatilization N loss) from manure incorporated into the soil promptly.

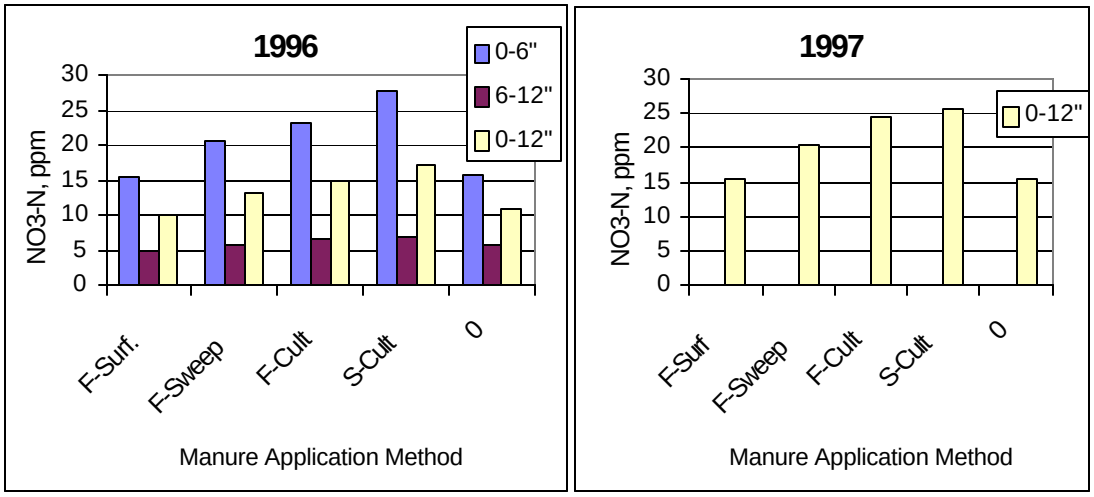


Figure 1. Pre-sidedress nitrate soil test results for 1996 and 1997.

We also sampled the 3-foot soil profile for nitrate-N in the fall (Oct.) and spring (May) of each year to assess nitrate leaching potential. The average NO3-N concentration in the profile in the fall (Fig. 2) shows a similar pattern to that observed in the PSNT, with lowest concentrations from the surface-applied fall manure (and the control). The highest concentrations (and greatest over-winter loss) were in the 120 lb/acre fertilizer-N treatment, which was higher than crop need in both years. Some manure treatments were only slightly less.

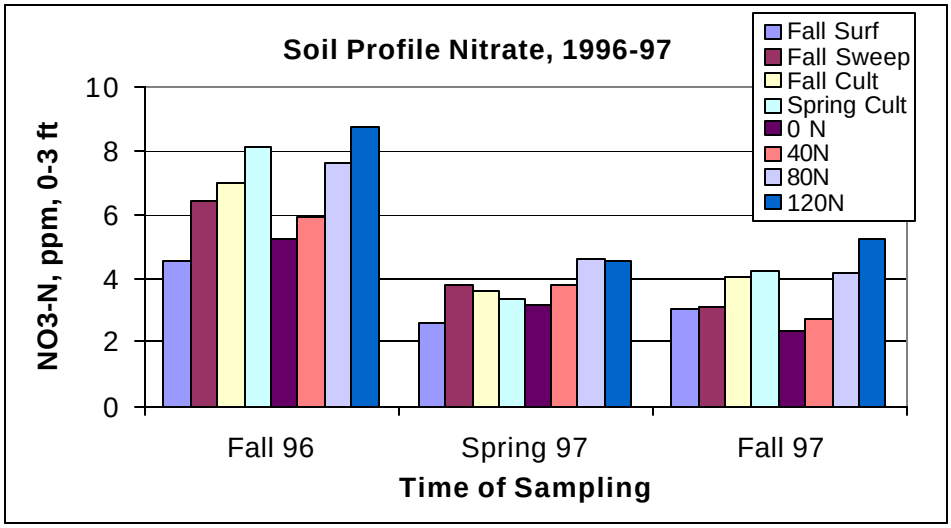


Figure 2. Soil $NO_3$-N concentration in 3-ft soil profile. 1996-1997.

## Corn Silage Yields

Silage yields ranged from 20 to 26 tons/acre in 1996 and 19 to 21 in 1997 (at 30% dry matter). In 1996 yield from fall, surface-applied manure was the lowest of the manure treatments and about the same as the control treatment that received no manure or fertilizer (except starter). This reflects the loss of ammonium-N from manure that is left on the surface. Incorporation of manure with either sweep injection or s-tine cultivators increased yields significantly (by an average of over two tons per acre) compared to leaving it on the surface. The yield results were consistent with PSNT results in 1996 (Fig. 1), although PSNT numbers suggested a greater N need than what was observed. The highest yields were obtained from the N fertilizer treatments. The lower yields from manure may have been caused by unusually high amounts of precipitation in the spring and early summer that provided conditions conducive to losses of manure N via leaching and denitrification. The sidedressed N was applied on July 2 – after much of the wet period had passed and just before the largest N demand by the growing corn crop. The lack of yield response in 1997, despite the PSNT results shown in Table 1, suggest that some other variable, perhaps related to weather, was limiting yields.

Table 1. Corn silage yields from manure and fertilizer treatments.

| Treatment | 1996 | 1997 |
|---|---|---|
| | tons/acre 30% DM | |
| Fall, Surf | 21.0 | 20.3 |
| Fall, Sweep | 22.4 | 20.0 |
| Fall, Cult | 24.3 | 21.1 |
| Spr, Cult | 23.8 | 21.3 |
| 0 N | 20.2 | 17.9 |
| 40 N | 25.7 | 18.9 |
| 80 N | 24.9 | 19.4 |
| 120 N | 26.5 | 18.8 |

## Summary:


- Liquid dairy manure applied in the fall or spring with immediate incorporation (sweep injectors, s-tine/field cultivator) had greater N availability and produced higher corn silage yields than manure surface-applied in the fall (in 1996, the year that yields responded to N).
- The pre-sidedress nitrate test (PSNT) reflected the differences in N availability from different manure application methods.
- Soil nitrate, both PSNT and profile NO3-N, was greater for spring and/or incorporated manure. Overwinter nitrate losses were greatest in treatments with the highest fall profile nitrate – the 120 lb/acre N rate and spring-cultivated manure.
- Direct incorporation at sidedress time provided another window of time for manure application. Results from another location showed improved N utilization compared to spring broadcast application.
- In general, application of liquid manure with direct incorporation methods can reduce ammonia N losses and protected manure nutrients from loss in runoff.


### Project Cooperators:

The Lower Missisquoi Water Quality Project is a cooperative effort among, the following participants:

- Missisquoi Watershed Project Area Farmers
- UVM Extension System
- USDA Farm Services Agency
- USDA Natural Resource Conservation Service
- Vermont Department of Agriculture, Food and Markets
- Franklin County Natural Resource Conservation District

## For More Information:

This factsheet is one in a series on the Lower Missisquoi Water Quality Project. To obtain other factsheets or for more information on the project, contact:


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