By Quirine Ketterings & Karl Czymmek

Manure injection requires more horsepower and fuel, but a higher corn silage yield response may more than pay for the extra input costs. More research will tell.

Manure injection grows corn silage yields

A couple years ago when we started on-farm research to test whether shallow incorporation of manure could deliver the same yield as plowdown of manure, we stumbled on an interesting phenomenon at one dairy farm site: Direct injection of 9,000 gallons per acre of liquid manure resulted in a 4 ton per acre corn silage yield advantage over shallow incorporation at the same rate.

The dairy injects manure at a 6-inch depth (30-inch spacing). Five days or so later it uses a zone builder at a 7-inch depth (30-inch spacing), plus makes an aeration pass. Planting with no starter fertilizer follows at 15-inch spacing.

The other two treatments in our research were shallow mixing of manure with an aerator and surface application with no disturbance at the time of manure application, followed by the zone builder at a 7-inch depth, aeration and planting. The soil was moderately well-drained to somewhat poorly drained on the fields where plots were located.

The first year, 2008, was a good growing season. Soil nitrate data for all plots indicated nitrogen (N) was not limiting corn production. Presidedress nitrate test (PSNT) exceeded 25 ppm, and late season corn stalk nitrate test (CNST) levels were in the optimal range for corn in New York. The Illinois Soil Nitrogen Test (ISNT) as an indicator of soil organic N supply was in the nonresponsive range.

So why this yield increase with injection?

Fluke or not?

OK, we thought, this must be a fluke. So in 2009 we repeated the trial. This time excess moisture resulted in very low yields, but we still saw a 4 ton per acre difference in silage yield between direct injection and shallow incorporation or surface application of manure (**Table 1**).

Similar to 2008, PSNT values were well above 25 ppm, and ISNT values were in the nonresponsive range. While soil nitrate was adequate to support optimum crop production in 2009, CSNT values across the plots were low. This was most likely due to saturated soil conditions limiting root development and preventing plants from taking up the N that was present.

Seeing the 2009 crop yields and the low CSNTs, the dairy's field crew wanted to compare three manure injection rates in 2010 to evaluate if the 9,000 gallons per acre application rate was indeed sufficient. They spring applied three injection rates on two fields with well- and moderately well-drained soils – 9,000, 12,000 and 15,000 gallons per acre.

Since the dairy prefers to inject, we eliminated the shallow incorporation and surface application treatments used in previous years and focused on injection rates only. Also, due to compaction concerns from the wet 2009 season, the dairy operated the zone builder at a 14-inch depth.

Significant corn silage yield response with injection could have important implications for dairy farmers as they seek ways to control ammonia loss and make decisions about equipment purchases.

FYI

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■ Contact them if you're interested in implementing a similar manure application method and manure rate comparison to that done at the western New York dairy. The work will collect additional manure rate studies with injection equipment.

There was no yield response to the higher injection rates, indicating that the N supply from manure wasn't a limiting factor in crop yields. In fact, yield was exceptional, averaging 28.7 tons per acre in one field and 28.0 tons per acre in the other (**Table 2**).

The CSNT results increased as injection rates increased, but there was sufficient N to optimize yield with the lowest of the three rates in both trials. The PSNT results also indicated that N was not limiting production in either of the two fields.

Table 1. 2009 and 2008 forage quality at harvest as impacted by manure appliation method

Treatment	Stand density	Corn silage (35% DM)	Moisture content	Crude protein	Soluble protein	NDF	dNDF	Lignin	Starch
	plant/acre	tons/acre	%	--------------------% of DM------------------------					
				2009					
Surface	33,019 a	13.7 b	64.1 a	6.3 a	1.6 a	38.2 a	73.3 a	2.1 a	42.3 a
Aerway incorporation	33,219 a	14.1 b	64.4 a	6.1 ab	1.6 a	38.0 a	72.6 a	2.1 a	42.5 a
Direct injection	32,612 a	18.2 a	63.7 a	5.8 b	1.5 a	39.0 a	69.8 a	2.2 a	42.6 a
				2008					
Surface	30,574 a	22.4 b	68.2 a	6.3 a	1.7 a	38.4 a	71.1 a	2.7 a	36.9 a
Aerway incorporation	28,428 a	22.9 b	68.3 a	6.3 a	1.7 a	39.1 a	71.5 a	2.7 a	35.9 a
Direct injection	30,538 a	27.0 a	67.9 a	6.5 a	1.8 a	38.2 a	67.7 b	2.8 a	36.8 a

†*Average values with different letters within a column and year (a,b,c) are statistically different (a = 0.05).*

A further look

The yield response with injection in this very small number of trials is so large and consistent that the practice needs to be tested across a larger set of climate, soil and management conditions to confirm. We're applying for funding to expand this research at sites across New York. If we find a yield response at other locations, there are significant implications for the dairy industry in these areas:

■ Ammonia lost to the air when manure is surface-applied and not incorporated can be an economic loss to dairies if that ammonia must be replaced by purchased N fertilizer.

■ Environmentally, some atmospheric N will fall back to earth as wet or dry deposition of N. Some of this N may fall on or near water and can directly contribute to water quality problems. For example, airborne N sources are an important contributor to problems in the Chesapeake Bay.

Animal agriculture is considered to be a major source of ammonia in the atmosphere, and we'll see more emphasis on ammonia conservation in the future. While we will still have ammonia losses from barns and manure storage, manure incorporation can help dairies retain a significant portion of ammonia that can be lost with surface application of manure.

The ammonia conservation could prove to be a win:win for producers and the environment. And one day it might be a revenue source in sales to crop farms.

■ As producers make decisions about what equipment to use to better conserve ammonia, it will be valuable to know if injection gives a significant yield response compared to other methods.

Two years of on-farm trials at eight locations showed a 1- to 2-ton per acre silage yield benefit from incorporation with either a chisel plow or an aerator over manure that was surface applied and not incorporated. (See Shallow manure incorporation works, page 24.) But we have only this one location where we directly compared injection vs. aeration.

The test plots at the western New York dairy so far have all been treated with a zone builder after manure was either injected at a 6-inch depth or surface applied with or without shallow incorporation with an aerator (2008 and 2009 trials).

Did the extra vertical tillage, provided by the injector, cause the yield response? In 2008-2009, each plot received a zone builder pass at a 7-inch depth. So it seems unlikely that an additional, shallower vertical tillage pass with the injector five days earlier would result in such a significant yield response.

Injection is slow and requires more horsepower, fuel and equipment maintenance per acre than other application methods. But if the response observed in western New York occurs elsewhere, the considerably higher silage yield could easily pay for these extra costs or for a drag hose system or custom application if a dairy doesn't have the equipment. ❒

Table 2. Stand density at sidedress time, percent moisture content and yield as influenced by rate of spring injected manure

Field	Manure rate gallons/acre	Stand density	Presidedress nitrate test	Moisture content at harvest	Corn yield (at 35% DM)	Corn stalk nitrate test
		plants/acre	ppm	%	tons/acre	ppm
A	9,000	31,172 a	58.3 a	57.6 a	29.0 a	599 b
	12,000	30,873 a	66.9 a	57.9 a	27.8 a	1,821 ab
	15,000	31,514 a	73.5 a	57.8 a	29.4 a	3,952 a
B	9,000	31,001 a	40.4 b	55.9 a	27.2 a	1,569 a
	12,000	31,113 a	54.1 b	55.6 a	28.4 a	1,713 a
	15,000	30,883 a	86.4 a	57.3 a	28.4 a	2,724 a

Means within a column and field followed by the same letter are not statistically different (a = 0.05).