Liquid Manure Injection

Introduction
Manure is the byproduct of livestock and dairy operations that contains crucial nutrients which can be utilized as a fertilizer for crop production. Broadcasting (applying to the soil surface) of manure is a common practice of manure application but results in the loss of ammonia nitrogen (N), can cause odor issues, and increases the risk of phosphorus (P) runoff. Mixing manure with soil or placing it below the soil surface mitigates these effects. Manure incorporation is a method where surface broadcast manure is mixed with soil using tillage-based practices. This includes shallow aerator-based incorporation as well as chisel or moldboard plow tillage. Injection of manure offers the same advantages as incorporation but less soil is disturbed as manure is placed in the soil without full-width disturbance. This factsheet describes different methods of injection and describes benefits and challenges of injection compared to broadcasting and tillage-based manure incorporation.

How Injection Works
Injection implements separate manure into multiple streams for placement at or below the soil surface. Various injection methods exist including shallow disk injection (Figure 1), chisel injection (Figure 2) and other more experimental approaches. The distance between injection units (coulters/ chisels) can vary. This is a way to vary manure placement and delivery per unit area.

Shallow Disk Injection:
Coulters are used to create slits (typically 4-6 inches deep) in the soil, allowing manure to enter the subsurface with minimal soil disturbance. A second set of coulters may be installed to cover the slit to further reduce exposure of wet manure to the atmosphere, reducing N volatilization.

Chisel (Knife) Injection with Sweeps:
The chisel can be adjusted to a desired depth. Using sweeps (shanks) with chisels allows for better distribution of manure into the soil, resulting in greater N distribution in the soil than obtained by shallow disk injection. Shanks require less power than chisels alone, but can create more soil disturbance depending on type of shank used.

Figure 1. Tanker-mounted shallow disk injector unit without additional coulters to cover the slits.

Figure 2. Chisel and sweep injector.

Experimental Applicators:
Direct ground (high pressure) injection uses pressurized pumps to place manure into the soil, creating pockets of manure beneath the soil surface. Direct ground injection (Figure 3) was developed in Scandinavia to inject manure into stony soils. The technology is well-suited for injection in perennial grass but not suitable for injection in row crop stubble because it

collects residue resulting in the need for frequent cleaning. Furthermore, the extensive plumbing system requires considerably more maintenance than other forms of injection, a major reason why there are only few of these injectors currently in the US.

Figure 3. Direct ground injector (Photo credit: Peter Kleinman, USDA-ARS).

Benefits

- Injection can greatly reduce odor issues as compared to broadcasting, helping to maintain good neighbor relations.
- Liquid manure injection in the spring or into a growing crop reduces N volatilization loss, resulting in much greater retention of plant-available N. Improved N conservation will reduce and possibly eliminate the need for additional N fertilizer. See Agronomy Fact Sheet 4 (Nitrogen Credits from Manure) for details.
- Injection, when compared to tillage-based incorporation, also reduces risk of P runoff. Furthermore, particulate P loss is reduced with injection as risk of soil erosion is reduced compared to tillage-based incorporation.
- Injection allows for manure application to growing crops (grass, alfalfa, cover crops, etc.), and can be compatible with no-till.
- Injection may preserve more soil organic matter and soil structure as compared to tillage-based incorporation.
- Injection equipment combined with draghose systems and use of nurse trucks reduces risk of soil compaction. It may also reduce manure transportation costs (labor and fuel).

Challenges

- The initial investment of injection equipment (tank and injector) can exceed $100,000. Three factors should be considered when investing in equipment: (1) the size of and/or the number of animals in the operation, (2) the number of hours the equipment will be used in the field, and (3) the need for nurse trucks and draglines, including equipment, accessories, fuel, labor and operator costs.
- Manure injection is time consuming. Field ground speed is slower than broadcasting, requires more fuel, adds more labor costs, and can delay planting crops. This can affect crop production in an already short growing season in New York.
- Experience with the equipment is required and operators cannot solely rely on electronic guidance systems. Lack of experience can lead to damaged equipment.

Summary

Liquid manure injection helps reduce nutrient loss, is compatible with row crops and hay fields, and can be compatible with no-till. Injection can capture N that could otherwise be lost through volatilization, reducing odor issues and possibly reducing the need for N fertilizer. Timeliness, total cost and experience are considerations when developing a plan for injecting manure.

Additional Resources

- Nutrient Management Spear Program Agronomy Fact Sheet Series: nmsp.cals.cornell.edu/index.html.
- Manure Injection in No-Till and Pasture Systems. https://www.pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/CSES/CSES-22/SPES-5.pdf.

Disclaimer

For more information

Cornell University Cooperative Extension

Nutrient Management Spear Program
http://nmsp.cals.cornell.edu

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