Emissions Management Practices

Protecting Air Quality

Subsurface Injection of Manure to Reduce Ammonia Losses and Odor

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Definition:

Manure is applied below the soil surface to reduce ammonia and odor emissions and the potential for nutrient runoff to surface waters.

Purpose:

All of the ammonia in manure, which can comprise 30% or more of the total nitrogen, can be lost through volatilization following land application. Research has shown that depositing manure below the soil surface can reduce ammonia losses by as much as 100% compared to surface-applied manures. Preventing ammonia volatilization increases the amount of nitrogen available for crop growth, thereby potentially benefiting producers through a reduced need for nitrogen fertilizer. In addition, decreasing the loss of ammonia from land-applied manures reduces their potential impact on air quality. Other benefits include the reduction in odor that occurs following subsurface application of manure and a reduction in the runoff of nutrients to surface waters.

How Does This Practice Work:

Liquid and solid manures should be deposited 3 to 6 inches below the soil surface. For liquid manures this can be accomplished via shank injection, or with a system that combines some form of tillage to incorporate the manure. Solid manures (tested with poultry litter and composted manures) can be deposited below the surface with a device developed by the Agricultural Research Service referred to as the Subsurfer. In both instances, a shallow trench is created in the soil and the manure is placed in the trench and then the soil is closed over the manure.

Where This Practice Applies and Its Limitations:

This practice applies to all livestock operations that produce liquid manure or compost and poultry operations that produce dry litter with a moisture content less than 25% (broiler, breeder and turkey houses).

Effectiveness:

Depositing manure below the soil surface greatly reduces nitrogen loss through ammonia volatilization. When compared to surface-applied manures, ammonia losses from injected liquid dairy manure were reduced up to 67% (Leytem et al. 2009), and subsurface application was 100% effective in preventing ammonia loss from poultry litter (Pote et al. 2011). This decrease in atmospheric ammonia emission results in more soil nitrogen available for crop production, but also decreases air pollution (ammonia is a precursor to the formation of particulate matter), acid precipitation, and atmospheric nitrogen deposition. Depositing manure below the soil surface can also decrease nutrient losses in storm and irrigation runoff following land application by 50% (Rotz et al., 2011), which can reduce the potential for manure application to impair water quality.

Cost of Establishing and Putting Practice in Place

Use of subsurface application increases the equipment cost and power required and slows the manure application operation, increasing fuel and labor requirements. Therefore, the net cost of manure application depends upon the added equipment cost and the price of fuel and labor. To inject liquid manure using a drag hose method, the cost of the equipment needed (pumps and hose) is estimated at $140,000 plus a cost of $0.01 to $0.015 per gallon for application up to

one mile from the wastewater pond or lagoon. Alternatively, liquid manure can be injected with the use of a slurry tank wagon fitted with a shank injection system where additional fuel and labor use are the main expenses.

The cost of the Subsurfer is not currently known as it is not in full production, but the added fuel cost for operating the tractor-drawn Subsurfer are estimated to be about $2 per acre at current diesel prices ($3/gallon). The subsurface application of dry poultry litter can potentially prevent the loss of more than 30 lb of N from each ton of litter applied. Thus, the potential savings on a 3 ton/acre application could exceed 90 lb of N for each acre treated, and the reduction in fertilizer costs (dependent on price per lb) can be substantial. Injection of liquid dairy manure could replace up to 120 lbs of urea per acre. At current fertilizer prices ($600/ton urea), this saving in fertilizer is worth approximately $36/acre. A comprehensive comparison of injection and surface application methods on different types of farms has shown a range in the economic benefit for the use of injection from a small net cost to the producer to an increase in farm profit depending upon the crops grown and other nutrient management aspects of the farm (Rotz et al., 2011).

Operation and Maintenance:

For liquid manure injection, a shank injector or other tillage device is pulled behind a tractor with a hose attached for pumping liquid manure into the trench that is formed. Alternatively, injectors are added on the back of a slurry tank wagon that injects manure directly from the tank. The Subsurfer is pulled by a tractor and uses disks to open a trench for manure deposition. The manure is conveyed to the soil via a system of augers that crush the material. In all of these operations, maintenance is required on the tractor and manure applicator as well as any tillage implement that may be used. If a drag hose system is used, there is also maintenance on the pumps and hoses.

References:

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For Further Information:

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This practice falls under the NRCS Conservation Practice Standard 590 (Nutrient Management)

Subsurface deposition of liquid manure via shank injection (left) and subsfurace depostion of poultry litter using the Subsurfer (right)