

Best Practices for Swine Manure Application

Azar Movaghatian, SDSU Graduate Research Assistant
Sushant Mehan, Assistant Professor and SDSU Extension Water Resource Engineer Specialist
John McMaine, Associate Extension Professor, Biosystems and Agricultural Engineering, University of Kentucky
Pavan Kulkarni, SDSU Field Research and Outreach Coordinator
Anthony Bly, SDSU Extension Soils Field Specialist
Robert Thaler, Farm Credit Services of America Endowed Chair in Swine Production, Distinguished Professor & SDSU Extension Swine Specialist
Sara Bauder, SDSU Extension Forage Field Specialist
John Maursetter, SDSU Environment Research Coordinator
Peter Sexton, Associate Professor, SDSU Extension Sustainable Cropping Systems Specialist and Southeast Research Farm Supervisor

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WHY THIS MATTERS FOR YOUR FIELD

Swine manure is more than a waste product. When managed correctly, it is a valuable nutrient source that can improve crop yields, build soil health, and reduce fertilizer costs. When managed poorly, it can lead to nitrogen and phosphorus losses, odor complaints, runoff, and water quality concerns. Across South Dakota and the Northern Great Plains, short application windows, variable soils, and weather uncertainty make manure management a challenge. This fact sheet summarizes research-based practices to help producers, consultants, and conservation professionals make practical decisions that protect both productivity and stewardship.



Figure 1. Visual overview of the key steps for effective swine manure application.

CHOOSING THE RIGHT MANURE APPLICATION METHOD

The best manure application method depends on manure form, equipment, soil conditions, residue cover, and labor availability. Each method involves tradeoffs between cost, nutrient retention, odor control, and environmental risk. For liquid swine manure, injection or immediate incorporation is strongly recommended because most of the nitrogen is in the ammonium form and is rapidly lost to the atmosphere if left on the surface.

Surface Broadcast Application (Not Recommended for Liquid Swine Manure)

Broadcasting spreads manure uniformly across the soil surface without incorporation. Although this method is simple and flexible, it is not suitable for liquid swine manure unless the manure is incorporated within 24 hours.

Why some producers use it

- Lowest equipment and labor requirements
- Can be applied in most seasons

Why surface application is not recommended for liquid swine manure

- Nitrogen losses to the air can be high due to ammonia volatilization
- Odor and runoff risks increase when manure remains on the surface

- Surface phosphorus accumulation raises runoff concerns
- Most swine manure in South Dakota is liquid, making surface application without incorporation ineffective and environmentally risky

Broadcast With Incorporation

Incorporation mixes manure into the soil shortly after surface application using tillage tools such as disks, chisel plows, or aerators.

Why it can help

- Reduces odor and ammonia losses
- Improves nitrogen availability by promoting mineralization
- Limits surface runoff risk

Tradeoffs to consider

- Additional labor, fuel, and equipment costs
- Soil disturbance may increase erosion risk
- Reduced residue cover can affect weed suppression

The depth and intensity of incorporation matter. Shallow, low-disturbance methods preserve residue better than aggressive tillage.

Injection

Injection places liquid manure directly below the soil surface using knives, sweeps, or coulters and why do many producers prefer injection is because of the following reasons:

- Lowest nitrogen losses to the air
- Excellent odor control
- Places nutrients close to crop roots
- Compatible with reduced tillage systems

Limitations

- Higher equipment cost
- Slower application speed
- Requires careful setup to avoid excessive soil disturbance
- Uneven distribution can occur if not calibrated properly

Injection is often the best option where odor control, nitrogen efficiency, and water quality protection are priorities.

Irrigation Application

Liquid manure can be applied through irrigation systems, such as center pivots or traveling guns, either directly (irrigation) or diluted with water (fertigation). Both approaches use existing irrigation infrastructure but differ in nutrient concentration, management needs, and risk.

Advantages

- Covers large areas quickly
- Can reduce labor and fuel costs
- Integrates with existing irrigation systems

Risks to manage

- Uneven application if equipment is not well maintained
- Increased ammonia loss
- Drift, runoff, and odor concerns
- Potential crop injury under hot or windy conditions

This method requires careful monitoring and is best suited for experienced operators. Fertigation remains an emerging practice and may not fit all operations.

HOW APPLICATION METHOD AFFECTS SOIL, AIR, AND WATER

Manure application choices influence ammonia loss, phosphorus runoff, soil disturbance, residue cover, odor, and erosion risk.

- Broadcasting has the highest nitrogen loss and odor risk
- Incorporation reduces losses but increases soil disturbance
- Injection provides the best nutrient retention with the least odor

Issue	Surface Broadcast	Broadcast Incorporation	Injection (knife or sweep)
Ammonia Volatilization	High nitrogen loss to the air	Reduced compared to broadcasting method	Lowest nitrogen loss to the air
Phosphorus Runoff	High risk due to surface accumulation	Reduces phosphorus losses in runoff water	May push phosphorus deeper into the soil over time
Soil Disturbance	Minimal disturbance	Moderate to high disturbance. This process disturbed macropores, which are critical for rapid water and bacteria movement	Lower disturbance than incorporation (depends on equipment)
Residue Cover	Maintained the highest residue cover	Reduced residue cover; may affect weed suppression	Maintained, residue disturbance varies widely by injector type
Odor Control	Odor remains high	Some reduction	Best odor control
Erosion Risk	Lower (due to residue cover)	Higher (less residue, more exposed soil)	Lower
Ease of Application	Easiest and fastest	Requires more equipment and time	Most complex and equipment-intensive

Table 1. Comparison of Manure Application Methods on soil and environment: Pros and Cons.

TIMING MATTERS AS MUCH AS METHOD

When manure is applied, often it matters more than how it is applied.

Key Timing Options

Spring Pre-Plant

- Supplies nutrients close to planting
- Reduces time for nitrogen loss
- Risky in wet springs if soils are saturated

Fall Application

- Easiest from an operational standpoint
- Higher nitrogen loss risk before crop uptake
- Works best when paired with injection or nitrification inhibitors

Sidedress Application

- Aligns nitrogen availability with crop demand
- Improves nitrogen use efficiency
- Helps manage storage constraints

Winter Application

- Reduces compaction risk on frozen soils
- Increases runoff risk during snowmelt
- Often restricted by state guidelines

Winter manure application is not recommended for liquid swine manure and should only be used in emergency situations when storage limitations leave no alternative. Research shows that spring or sidedress injection generally produces higher corn yields than fall or winter applications, especially for liquid manure.

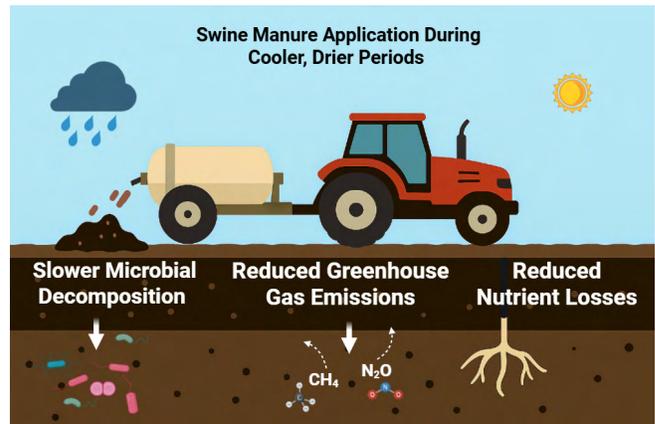


Figure 2: highlights why cooler, drier conditions reduce nutrient loss and greenhouse gas emissions.

APPLICATION RATE: GETTING THE RIGHT AMOUNT

Applying the correct manure rate is critical. Too little underfeeds the crop. Too much increases the risk of nutrient buildup, leaching, runoff, and salt injury without increasing yield.

What Drives the Right Rate

- Crop nutrient requirements
- Soil test results
- Manure nutrient analysis
- Soil texture and nutrient holding capacity
- Previous manure and fertilizer applications

All of the inorganic nitrogen (ammonium-N) in liquid swine manure is available in the first year. In addition, about 35% of the organic nitrogen becomes available

during the first growing season, with the remaining 65% mineralizing in the second year. Phosphorus and potassium are mostly available immediately. This difference makes rate planning essential. Figure 3 summarizes the key factors that influence manure application rate decisions.

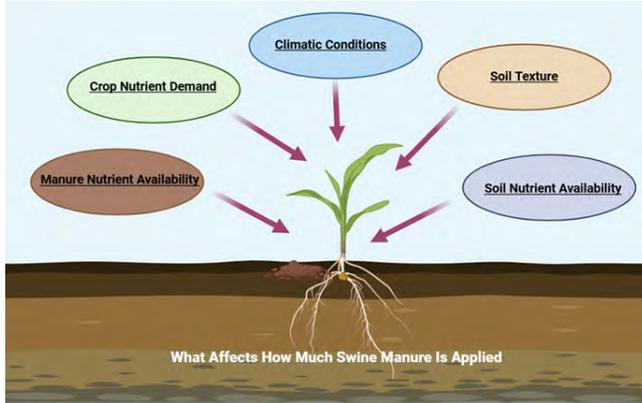


Figure 3: Factors Influencing Manure Application Rate.

Practical Rate Recommendations

- Always test soil and manure before application
- Match rates to crop demand and soil texture
- Avoid application before heavy rain or on frozen or saturated soils
- Account for all nutrient sources, including fertilizer and past manure
- Calibrate equipment regularly
- Apply manure at agronomically appropriate times

WHAT RESEARCH SHOWS ABOUT YIELD

A summary from different research across multiple states (Table 2) shows that:

- Injection consistently improves nitrogen efficiency and yield
- Sidedress applications better match crop demand
- Properly managed manure can match or exceed commercial fertilizer yields

Yield response varies by soil, weather, rate, and timing, reinforcing the need for field-specific decisions.

State	Method		
	Broadcast	Injection	Incorporation
Kentucky, USA (Sistani et al., 2017)	R1 ³ : 110.63bu/ac	R1 ³ : 139.33 bu/ac	-
Iowa, USA (Ahmed et al. 2013)	R2 ³ : 128.92 bu/ac R3 ² : 141.29 bu/ac	R2 ¹ : 132.13 bu/ac R2 ³ : 135.3 bu/ac R3 ³ : 142.53 bu/ac R3 ³ : 150.08 bu/ac	-
Indiana, USA (Sutton et al., 1982)	R4 ² : 162 bu/ac R5 ³ : 165.6 bu/ac R6 ³ : 167.73 bu/ac	R4 ³ : 198.64 bu/ac R5 ³ : 198.91 bu/ac R6 ³ : 194.66 bu/ac	-
Minnesota, USA (Wilson et al., 2020)	R7 ⁴ : 188-217 bu/ac	-	-
Tennessee, USA (Safley et al., 1980)	R8 ³ : 72.7 bu/ac R9 ³ : 92.78 bu/ac	R8 ³ : 90.97 bu/ac R9 ³ : 104.22 bu/ac	-
Indiana, USA (Xu, M. 2014)	-	R10 ⁴ : 166.54 bu/ac R11 ¹ : 151.67-181.41 bu/ac R12 ³ : 157.62-165.05 bu/ac R13 ³ : 171-187.36 bu/ac	-

Table 2: Effects of Swine Manure Rate, Timing, and Method of Application on Corn Yield

¹: Fall; ²: Winter; ³: Spring; ⁴: Summer

R1: Swine effluent 179 kg available N ha⁻¹; R2: Liquid Swine Manure 168 kg N ha⁻¹; R3: Liquid Swine Manure 336 kg N ha⁻¹; R4: Liquid Swine Manure 90 (t/ha, wet wt); R5: Liquid Swine Manure 135 (t/ha, wet wt); R6: Liquid Swine Manure 180 (t/ha, wet wt); R7: Liquid Swine Manure 3,500 gal ac⁻¹ =140 lb N ac⁻¹; R8: Liquid swine manure slurry 150 lb N/acre; R9: Liquid swine manure slurry 300 lb N/acre; R10: Liquid Swine Manure 426 kg N ha⁻¹; R11: Liquid Swine Manure 417 kg N ha⁻¹; R12: Liquid Swine Manure 476 kg N ha⁻¹; R13: Liquid Swine Manure 379 kg N ha⁻¹

For more information, please refer to the references.

Good manure management is about balance. The goal is not simply to apply manure, but to apply it at the right rate, at the right time, using the right method for your soils and cropping system. Smart decisions today protect yields, reduce fertilizer costs, and safeguard water resources for the future.

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