Using Swine Manure Phosphorus More Efficiently In South Dakota Cropping Systems

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Why This Matters for Your Farm

Phosphorus is essential for crop production, but too much of it in the wrong place creates problems. Across South Dakota and the Northern Great Plains, phosphorus buildup from manure applications is becoming a growing concern for soil health, water quality, and long-term nutrient management flexibility.

Most manure application decisions are based on nitrogen needs. Because swine manure often contains more phosphorus relative to nitrogen than crops require, this approach can lead to phosphorus overapplication. Over time, excess phosphorus accumulates in soil and increases the risk of runoff into streams, lakes, and wetlands.

This fact sheet explains how feeding strategies, especially the use of low-phytate corn and related diet adjustments, can reduce phosphorus excretion in swine manure. These changes improve the nitrogen to phosphorus balance of manure and help producers better align manure nutrients with crop demand.

Why Phosphorus Is Important

Phosphorus plays a critical role in plant growth and development. It supports root growth, energy transfer, photosynthesis, and seed formation. Crops require phosphorus throughout the growing season, especially during early establishment.

Even though soils often contain large amounts of total phosphorus, only a small fraction is plant available at any time. Phosphorus easily binds to iron, aluminum, and calcium in the soil, which limits its solubility and availability to crops. This is why proper phosphorus management matters for both yield and environmental protection.

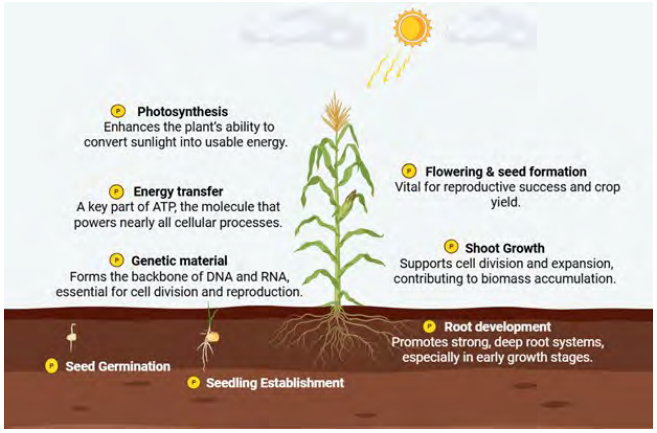

Figure 1. Illustrates the role of phosphorus in crop production.

Phosphorus Use in Modern Agriculture

Phosphorus fertilizer use increased rapidly from the 1960s through the early 1980s and has remained relatively steady since the 1990s. While commercial phosphorus fertilizers are well understood and predictable, manure-derived phosphorus presents more uncertainty in terms of crop response to P availability.

Producers often cite three reasons for hesitation when relying on manure phosphorus:

- Manure nutrient concentrations vary widely.
- Plant availability of manure phosphorus is less predictable.
- Uniform application is difficult to achieve.

At the same time, swine production practices have changed significantly. Animal genetics, diets, housing, and manure storage systems all influence manure nutrient content. As a result, manure characteristics today may differ from older reference values.

Phosphorus in Swine Manure

Swine manure is a significant source of phosphorus. Finishing pig manure typically contains about 1.3 grams of phosphorus per liter, although values vary by growth stage and diet. Pigs do not absorb all the phosphorus they consume. Research shows that nursery pigs excrete roughly one-third of their phosphorus intake, while grow-finish pigs excrete nearly half. What animals eat directly affects what ends up in manure.

Feeding pigs more phosphorus than they can absorb leads to unnecessary nutrient losses. Modern feeding strategies aim to match nutrient supply with animal needs, which reduces both feed costs and manure nutrient loading.

Why Nitrogen to Phosphorus Ratio Matter

Stored swine manure often has a low nitrogen to phosphorus ratio. Nitrogen losses occur during housing, storage, and field application, mainly through ammonia volatilization. When manure is applied based on nitrogen needs, phosphorus is commonly overapplied.

Research indicates that to avoid phosphorus buildup when manure is applied at nitrogen-limited rates, the nitrogen to phosphorus ratio needs to be at least 2.7. Most swine manures fall below this threshold, which explains why phosphorus accumulates in many fields receiving long-term manure applications. Improving this ratio is key to sustainable manure management.

Feeding Strategies That Improve Manure Nutrient Balance

Phase Feeding: As pigs grow, their nutrient requirements change. Phase feeding adjusts diets at different growth stages to better match these needs. This approach can reduce phosphorus and nitrogen excretion by approximately 5 percent, with greater reductions possible using multi-phase feeding systems.

Even with careful diet formulation, manure nutrient content still varies by growth stage. This reinforces the importance of regular manure testing when planning field applications.

Alternative Feed Ingredients: Producers increasingly use alternative feed ingredients to control costs. These ingredients can influence manure phosphorus content.

For example:

- Distillers dried grains with solubles increase phosphorus digestibility but may not reduce total manure phosphorus unless dietary phosphorus is adjusted.
- Algae and insect-based feeds are still under evaluation.

Feed Ingredient	Effect on Phosphorus in Manure	Notes	Key References
DDGS (a byproduct of ethanol production) contains low levels of phytate-bound phosphorus, making the phosphorus more digestible.	Improves P digestibility but may not reduce total P in manure unless dietary P is lowered	Can increase manure volume	Stein & Shurson (2009); Xu et al. (2006); Trabue & Kerr (2014); Kerr et al. (2018); Spiehs et al. (2012)
Dried skim milk	No significant change in nitrogen levels in manure	Effect on phosphorus not specified	Yen et al. (2004)
Algae and insects	Impact on manure P is still unclear	Under investigation as alternative protein sources	Urriola et al. (2018); Surendra et al. (2016)

Table 1. Alternative Feeds and Their Effect on Phosphorus in Manure.

What Is Low-Phytate Corn and Why Does It Matters

Most phosphorus in corn and soybean-based diets is bound in phytate, which pigs cannot digest naturally. As a result, much of this phosphorus passes through the animal and ends up in manure.

Low-phytate corn is bred to contain less phytate-bound phosphorus. This allows pigs to absorb more phosphorus from their feed, reducing the need for inorganic phosphorus supplements and lowering phosphorus excretion.

What Research Shows About Low-Phytate Corn

Multiple studies demonstrate the benefits of low-phytate corn diets:

- Manure from pigs fed low-phytate corn contains about 40 percent less total phosphorus.
- Nitrogen to phosphorus ratios improve, moving closer to crop demand.
- Water-soluble phosphorus decreases, reducing runoff risk.
- Phosphorus availability to crops remains comparable to traditional manure.

A 2-year study conducted by Wienhold and Miller (2004) in Nebraska, USA compares manure phosphorus (P) composition from swine fed: Traditional corn (TC), high in phytate-bound P (less digestible), and Low-phytate corn (LPC), same total P, but more digestible due to reduced phytate. Researchers found that feeding swine LPC diets reduces manure P concentration and improves nutrient ratios without altering P availability for crops. LPC manure is environmentally favorable and agronomically comparable to TC manure (Table 2).

Aspect	Traditional Corn (TC)	Low-Phytate Corn (LPC)	Notes
Total P in manure	33.6 g/kg	19.8 g/kg	LPC manure had 41% less P
N to P ratio	3.3	4.5	LPC manure better matches crop needs (corn ~6:1)
Water-soluble P	Higher (~17-21 g/kg)	Lower (~10-12 g/kg)	Important for runoff risk; LPC reduces environmental impact
P form distribution	Similar across diets	Similar across diets	Most P was inorganic (≈80%)
Dry matter in manure	3.6%	7.2%	LPC manure was drier

Table 2. Comparison of Nutrient and Phosphorus Characteristics in Swine Manure from Traditional vs. Low-Phytate Corn Diets.
~ means “approximately”
≈ means “is approximately equal to”

Field and laboratory studies in Nebraska, Minnesota, and Indiana consistently show that low-phytate corn reduces soil phosphorus accumulation without sacrificing crop phosphorus availability.

Implications for Manure Application

Low-phytate manure supports more sustainable nutrient management, especially when manure is applied based on nitrogen needs. However, because total phosphorus content is lower, more land may be required if manure is applied strictly on a phosphorus basis.

Soil type also matters. Sandy soils with low organic matter are more prone to phosphorus movement than finer-textured soils. This reinforces the need for site-specific planning.

What This Means for Producers

- Feeding decisions affect manure nutrient value.
- Low-phytate corn and phytase reduce phosphorus excretion.
- Improved nitrogen to phosphorus ratios reduce long-term soil phosphorus buildup.
- Crop phosphorus availability remains adequate with low-phytate manure.
- Soil testing and manure analysis remain essential.

Practical Takeaways

- Revisit feeding strategies if phosphorus buildup is limiting manure application options.
- Use manure testing to track nitrogen to phosphorus ratios over time.
- Match manure application rates to both nitrogen and phosphorus needs where possible.
- Consider soil type and landscape position when applying manure.
- Work with nutritionists and nutrient management planners to align feeding and land application strategies, including effective soil erosion control to prevent P losses.

Turning manure from a disposal challenge into a nutrient resource starts with decisions made in the feed ration. Small changes in diet can deliver long-term benefits for soil health, water quality, and farm flexibility.

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