Best Environmental Management Practices

Farm Animal Production

Manure Nutrient Recycling

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Recycling manure nutrients is not new to livestock and poultry production. Before commercial fertilizer became readily available, farmers used manure as a valuable source of nutrients for crop and pasture production. However, with the consistency, ease and flexibility of commercial fertilizers, manure nutrients became devalued. In addition, farms are continually becoming larger, generating more manure and more nutrients. Producers must maintain a sufficient land base to land apply manure at agronomic rates or consider other options.

With several well-publicized manure discharges and offensive odor problems, society is demanding greater accountability of livestock and poultry producers to track and control nutrient flow on the farm. Thus, there is a renewed interest in the art and science of recycling nutrients from farm animals back through crop production while minimizing odor and reducing the risk of water contamination.

Nitrogen is a concern in the environment due to its ultimate conversion to nitrate, a form of nitrogen that can leach to groundwater when not taken up by crops. This can be managed by the proper timing and rate of manure applications. Phosphorus (P) is primarily a concern due to strongly binding with soil, and when soil erodes to surface waters, the phosphorus decreases surface water quality.

The goal of nutrient recycling on livestock and poultry farms is to create a balance of nutrient flow from the manure to the soil for crop production where the nutrients can be utilized to produce feed nutrients that can be fed to animals for meat, milk or egg production. Excess accumulation of nutrients in the soil and the potential of losing the nutrients to surface or groundwater must be controlled. Unless there are some regulatory or site-specific restrictions, recycling is still the most economical and useful way of maximizing the nutrient value of manures.

A challenge with using manure as a fertilizer substitute is that the N-to-P ratio in manure is lower than that required by crops. However, manure has distinct advantages. Besides being an excellent source of nitrogen, phosphorus and potassium, it also contains secondary and micronutrients that are essential for crop production. Most producers indicate equivalent or superior yields on manured fields compared to commercial fertilizers. This may be due to benefits of manure that are less clearly documented such as improvement in the organic matter content of the soil, increased nutrient and water holding capacity and workability of the soil.

Producers need to gain confidence in the fact that manure can indeed supply essential plant nutrients for crop production. Reducing fertilizer application rates to supplement manure applications as needed will reduce the fertilizer costs of the operation and still maintain yields.

There are several **myths** about manure that hold producers back from gaining the full benefits of manure nutrients. One, that all the nitrogen is lost into the air when not injected or incorporated. Two, that manure nutrients applied in the spring are not available soon enough to meet crop needs. Three, that manure is too inconsistent to be a reliable nutrient source.

It is true that some nitrogen, the ammonium fraction, can volatilize into the air as ammonia and be lost. The majority of ammonium-N (NH_4-N) is lost by volatilization, especially in hot weather, when manure is surface spread and not incorporated. However, there will be a portion of the nitrogen, in the organic form, which will be available to the next crop.

When manure is directly injected or incorporated relatively soon after application, very little (less than 2%) nitrogen is lost. Only a small portion of the NH_4-N is lost when manure is applied during cool weather. Generally, most manure is applied in the early spring and fall when daytime temperatures may be below 50 degrees, the soil is damp, and evaporation potential is low.

Records of manure applications, including weather conditions, will be useful in estimating plant available nitrogen for the next crop.

How much of the total N in manure will be plant available? A typical hog manure sample may test 44 pounds of total nitrogen per 1000 gallons, with 30 pounds being in the NH_4-N form. A significant portion of the 30 pounds of NH_4-N may be lost into the air if surface applied during hot weather.

However, when injected in the spring before the growing crop, there may be no nitrogen lost and the 30 pounds of NH_4-N plus a percent of the organic fraction will be readily available to a crop. This might total as much as 35 pounds of plant available nitrogen per 1000 gallons of manure applied in this example. At 4500 gallons per acre, this manure could supply all of the necessary nitrogen for a 140-bushel per acre corn crop.

Manure types and storage methods affect the percent of organic N and NH_4-N in manure. Manure samples should be taken to gain a more accurate estimate of nutrient values before fertilizer rates are lowered.

Another concern is whether spring applied manure releases the nutrients in time for corn's peak need.

When injected in the spring, all of the NH_4-N will be readily available, similar to commercial fertilizer, and a percentage of the organic N will become available as soon as the soil warms above 50 degrees.

Fifty to seventy percent of the phosphorus and 90-100% of the potassium are considered available in the first year after manure is applied. If a soil tests low in P, it may be more efficient to apply commercial fertilizer below and beside the seed row due to the lack of mobility of P when it is broadcast as manure. The long term strategy on livestock farms should be to spread manure where it is most needed, based on soil test and crop needs, reduce purchased P fertilizer and have sufficient land base and crop removal to maintain P levels, not build them excessively.

What about the consistency of available nutrients to plants from manure? Although commercial fertilizer sources of nutrients are more water soluble, most manure nutrients will become readily available in most for crop utilization.

To determine if manure nutrients are being utilized effectively, look at your soil test levels. Fields testing highest in P are probably the ones that have received the most manure over the years. Phosphorus is the nutrient that is most likely to build up in soils. This build up provides an opportunity to reduce or eliminate the cost of purchased starter fertilizers, especially those with high P analysis. Some producers are finding success with nitrogen starters and reducing or eliminating the phosphorus. High P soil tests are also alerting producers that they should be hauling manure to other fields, seeking additional acres for manure applications, or evaluating alternative management strategies such as reduced P in feed rations, composting, etc.

Manure nutrients are most needed and best utilized on fields with lower phosphorus and potassium tests. Taking current soil tests and following the recommendations will help direct manure to fields where the crops will benefit the most from the nutrients. This is important for both environmental protection and cost efficiency.

For example, if you have 200 acres that test low in P and the soil test calls for fertilizer, you have two options: hauling manure to this field or buying fertilizer. If producers are buying fertilizer for low testing fields, while applying manure to high testing fields, money is spent on fertilizer while manured fields build P soil test levels with no benefit to yields and potential risk to surface waters.

Manure is not a guaranteed analysis or as consistent in nutrient content as fertilizer, but it can be managed to produce excellent crop yields. Manure handling practices are different today than in the past. Bedding has been reduced in many manure systems, therefore less of the nitrogen is tied up by microorganisms in the decomposition process making more nitrogen readily available to the crops. Less bedding may also make the phosphorus concentrations per gallon/ton higher.

Manure is often agitated or re-circulated in storage systems, thus improving the nutrient consistency before hauling. This can provide more confidence in the rate of nutrients being applied per acre. Manure should be spread as evenly and consistently as possible in the field. **When manure is utilized as fertilizer, it needs to be hauled, handled and applied with the same care as commercial fertilizer.**

If soils test above the threshold level for P, manure and additional P fertilizer are not recommended. Manure should be applied at no more than the P crop removal rates, or rotate field applications on a 2-5 year schedule if higher P levels are applied in any one season. This will keep phosphorus levels from building thereby decreasing the potential for P to accumulate in soils and decrease the risk of non point source losses of P to surface waters.

The following is a table showing the recommended phosphate rates at various soil test levels for corn. Similar tables for other crops can be found in *Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa* (Purdue Extension publication AY-9-32 or Michigan State Extension publication E-2567), or contact your Extension Agent.

Phosphate (P_2O_5) Recommendations for Corn

P Soil Test Level		Corn Yield Potential - Bushels per acre				
P in ppm/A	P in lbs./A	100	120	140	160	180
		Lbs. of P_2O_5 recommended per acre				
5	10	85	95	100	110	115
10	20	60	70	75	85	90
15-30	30-60	35	45	50	60	65
35	70	20	20	25	30	35
40	80	0	0	0	0	0

Source: Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa.

Listed are some general recommendations for recycling manure nutrients to crop production:

- Take soil tests every 3 years.
- Prioritize manure applications to fields that test lowest in phosphorus (P) and potassium (K).
- Sample manure from all handling systems and obtain a laboratory analysis to develop a baseline of manure nutrient content for your farm.
- Apply manure ahead of crops that will benefit the most from the nitrogen (N), such as corn rather than soybeans.
- Calculate the expected N credit for legumes and other N sources. Do not apply manure at rates that exceed the crop's ability to utilize the total plant available nitrogen credit from all sources.
- Agitate manure before hauling, if possible.
- Use soil and manure tests to determine proper agronomic rates of manure application.
- Calibrate manure applicators, weighing a typical load if possible and recording the area covered by one load to determine the application rate per acre.
- Apply manure at known and consistent rates, to uniformly cover the entire field.
- Keep records of what, when, where and how much manure is applied to fields and note the weather conditions.
- Use pre-sidedress soil tests to measure the available nitrogen in the soil and adjust sidedress applications for corn accordingly.

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