Is Manure the Same as Fertilizer as a Crop Nutrient Resource?

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Manure has been land applied for centuries as a replenishment of nutrients removed with crop harvest, and to improve soil productivity. Manure contains all plant essential nutrients, and is therefore a complete crop nutrient resource. Use as a replacement for commercial fertilizer however, can be complicated due to unique manure characteristics and application uncertainties. These include multiple nutrient forms, variation in nutrient content ratios, nutrient analysis variation, differences between manure sources in crop nutrient availability, and application control and variability. Because of these issues, manure must be viewed and managed differently than fertilizer nutrient sources. In addition, management of manure as a nutrient resource has improved over time, and as applications are targeted more closely to crop needs, the aforementioned issues make further improvement in management increasingly challenging. This fact sheet will review some of the characteristics of fertilizer and manure, and implications for nutrient management.

Fertilizers commonly used today have high, if not complete, water solubility and contain chemical forms that are quickly converted to plant available forms or can be immediately taken up by plants. Examples are:

- Anhydrous ammonia – NH_3
- Urea – $CO(NH_2)_2$
- Ammonium nitrate – NH_4NO_3
- Urea-ammonium nitrate solutions – 50% urea and 50% NH_4NO_3
- Ammonium sulfate – $(NH_4)_2SO_4$
- Ammoniated phosphates – MAP ($NH_4H_2PO_4$); DAP [$(NH_4)_2HPO_4$].
- Potassium chloride – KCl

Commercially available fertilizers are typically refined to provide high availability, guaranteed analysis, consistent particle size and density, and often contain only one essential element. This makes planning for nutrient application relatively easy as an application can be tailored for the specific rate or rates of each nutrient required (because of guaranteed analysis, only one nutrient per material, and ability to blend materials), and the application rate is known due to the guaranteed analysis. Application variation can occur if fertilizer spreaders are not well calibrated or maintained, but the consistent physical characteristic of the fertilizer products greatly improve application uniformity.

Manure is different from fertilizer materials in several ways:

- Contain multiple organic and inorganic nutrient forms.
- Nutrient content, organic/inorganic proportion, and characteristic of organic material varies by animal species, feed ration, storage, and handling. For example:
  - Nitrogen (N) in manure is either inorganic ammonium (NH_4), or organic materials like amino acids and proteins. There is little to no nitrate (NO_3) in manure.
    - Lagoon swine manure is almost entirely NH_4-N.

        - Pit swine manure is about 84% NH_4-N.
        - Liquid pit beef manure is about 44% NH_4-N.
        - Poultry manure is about 25% NH_4-N.
    - Phosphorus (P) in manure is a complex mix of organic and inorganic compounds.
    - Potassium (K) in manure is essentially all in the inorganic K^+ ion.
- Nutrient analysis varies within storage structures and during load out.
- Manure and nutrient application rate control is more difficult due to manure physical characteristics, variability in nutrient content, water content, and high volumes.
- Organic materials can slow release of crop available nutrient forms and enhance loss of N from denitrification with wet soils. The longer the period from manure application to crop uptake can help give time for conversion of organic N and P forms to crop available inorganic forms, or can reduce N availability because of greater chance for nitrate loss with wet soils.
- Instead of essentially 100% in crop available forms like fertilizer materials, manure nutrient availability varies due to the above mentioned characteristics, and hence varies by manure source. Currently suggested first year crop N availability is
    - Liquid swine – 100%
    - Dry beef cattle – 30 to 40%
    - Dairy – 30 to 40%
    - Poultry – 65%

  For P it is 60% unless soil test P is high or very high and then it is considered 100%; and for K is 100%.

Confidence in nutrient application rate and crop availability will increase as more is known about the above differences or can be controlled, especially within specific manure sources. For instance, nutrient rate control is easier with liquid compared to solid manure sources. Flow and rate controllers, and distributors, on liquid applicators help with uniformity and desired rate of application. Stirring liquid storage structures helps reduce concentration variability during manure load out. Conversely, nutrient rate control is more difficult with solid manure due to more problematic spreading of solid materials compared to liquid, both in regard to material rate and distribution across the spread width. Nutrient composition can be more variable as it is more difficult to uniformly mix solid manure.

As the need to more closely target manure nutrient application increases, increased attention is being paid to differences in manure sources and to making manure nutrient use to more closely match nutrient recommendations for crop production. The reasons are many, but include record high fertilizer costs, environmental issues, and regulatory requirements. Also, considering manure as a source of just one nutrient is no longer a viable practice. Besides environmental concerns with nitrate in surface and groundwater, P in runoff and the tie to surface water quality concerns dictates that manure applications consider multiple nutrients. Although not an environmental concern, this applies to K as well. Despite manure being a complete nutrient resource, the variation in nutrient ratios, and the difference between crop nutrient needs and manure content (nutrient ratios) can result in over- or under-application of nutrients. Manure planning and application must include long-term implications on soil test P and K.

Manure can be used quite effectively as a crop nutrient resource. It takes careful planning, a thorough understanding of the specific manure characteristics, adequate manure sampling and analyses, and careful attention to rate and distribution during application. This is not unlike use of fertilizers as a crop nutrient resource. It's just that using manure effectively is different, more challenging, and takes more effort. The reward in achieving high crop yields with use of manure as a nutrient resource is accomplished on many acres each year in Iowa.

This article originally appeared in the Iowa Manure Manager Series, Vol. 6.
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