Variability in composition of manure (nutrients, metals, minor elements) over the pump-out cycle of several hog manure stores in Manitoba

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Hog manure is recognized as a valuable resource, largely because the N it contains is mostly in the form of NH_4-N. This binds to soil and is less prone to leaching to groundwater than NO_3-N. Nevertheless, monitoring nutrient loading to land reliably is more difficult with manure than with inorganic fertilizer. Manure is variable in composition from one store to another, and difficult to maintain in a homogeneous state due to settling of particulate material. Few data exist on the variability in composition of hog manure during application to land.

For a study of the feasibility of analyzing hog manure rapidly with near-infrared spectroscopy, 121 manure samples were collected from 13 hog operations in the vicinity of Winnipeg MB between 28 September and 4 November 2000. All but two of these operations held the manure in earthen stores, one had a slurry store and a secondary lagoon, and one had above ground storage. Six of the operations were visited once and seven were visited from two to seven times during pump-out from agitated lagoons. Several of these were visited at the start and finish of pump-out, as well as periodically in between. At most sites, a pail was filled from the drop-out valve on the umbilicus during actual field application. The manure in the pail was well-stirred and four 1-L subsamples were taken immediately after one another in polyethylene bottles.

Samples were analyzed by the Freshwater Institute Analytical Laboratory for pH, conductivity, density, ammonium-nitrogen (NH_4-N), total dissolved nitrogen (TDN), particulate nitrogen, dissolved phosphorus (dissolved P), particulate P, and particulate carbon (particulate C, i.e., a measure of the particular organic matter). Eighty of the 121 samples of manure were analyzed for 31 metals and minor elements by inductively coupled plasma spectrometry, and for % moisture by Norwest Labs. Some or all of the values for Ag, As, Bi, Pb, Sb, Se, Sn, Ti and V were below the limits of detection for the method. These are not considered further here.

Table 1 shows that a few constituents, most importantly K, did not change during the pump-out cycle of the two-celled manure store studied here. Ammonium-N varied over 2.4-fold during pump-out, whereas particulate N varied 38-fold, and total N ranged over 3.5-fold. More remarkable was the variation in P during pump-out. Dissolved P varied 9.5-fold; particulate P, 230-fold; and total P varied 20-fold. Other constituents subject to large variability included Cr, Cu, Zn, Mn, and Mg (Table 1).

Table 1. Ranges in concentrations of constituents recorded from an agitated two-celled manure store sampled 7 times during pump-out for land application

Constituents	Range from lowest to highest recorded values
B, Be, Co, K, Na	1 - 2 x
NH_4-N, dissolved N	2.4 x
total N, Li, S, Si	3 - 5 x
dissolved P, Cd, Mo, Ni, Zr	10 - 12 x
total P	20 x
Ba, Cr, Cu, Sr	25 - 32 x
particulate N, Al, Ca, Fe	35 - 40 x
particulate C, Zn	55 x
Mn	66 x
Mg	150 x
particulate P	233 x

These results emphasize the inherent variability of constituents in manure, even over the course of a pump-out of an agitated store. Because the manure was not sampled continuously during pump-out, the chemical data provide a conservative estimate of the variability in composition of manure. From the point of view of management of the nutrients in hog manure, K is least variable in manure. A point-in-time sampling of the manure store may be adequate to represent the concentration of this nutrient for land application. The practice of measuring NH_4-N by gas bottle at the start of land application may over or under estimate the amount of this nutrient. Ammonium-N and total N may vary several-fold during pump-out. The most important variability is that for P where these results suggest that dissolved P may vary over an order of magnitude and total P over twice that of dissolved P. Most variable is the concentration of particulate P in the manure.

The greater variability in P than in N produces variation in the N:P ratio in the manure. This is represented in Figure 1 that shows that the N:P in the 121 samples in this study varies from 2 to 33. There is not a predictable relationship between the N:P ratio and the % dry matter, or inversely, the moisture content.

In order to meet regulatory requirements for the management of P as they are established by jurisdictions and to apply the N:P required for the crop, there is increasing need for the capability for continuous monitoring of the composition of the manure during the land application. This, combined with GPS mapping, would allow for variable rate

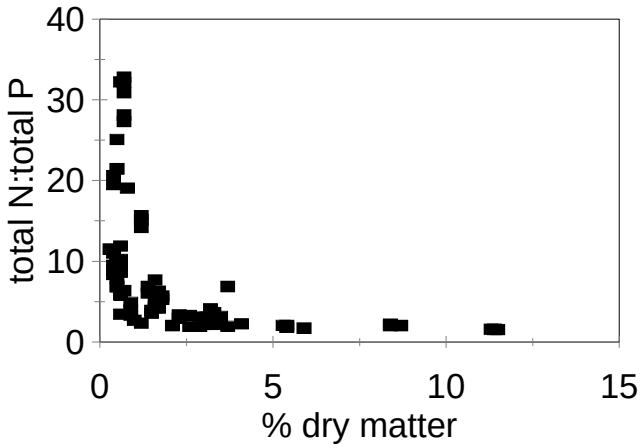

Figure 1. The ratio of total N:total P as a function of dry matter in 121 samples of hog manure from 13 operations collected in this study.

application of manure and monitoring of loadings of nutrients, metals, and minor elements to a field. Manure can be applied to land to meet the requirements for N or P. The N:P ratio can be brought into the desirable range for the crop by a second pass with inorganic fertilizer or by amending the manure with inorganic fertilizer in a patented process.

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