



Impact of Manure Application in Different Seasons on Phosphorus Loss in Runoff



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BACKGROUND

- Phosphorus (P) loss in runoff contributes to non-point pollution of freshwaters, and surface-applied manure that is left unincorporated can be a major source of P.
- In northern states, surface application of dairy manure during late fall and winter is common. Frequent runoff from winter and spring snowmelt has prompted states to restrict winter manure spreading, but restrictions are not always based on research.
- Winter manure runoff studies are limited. While most report substantial P loss, results are mixed about how specific manure and field management practices affect runoff and nutrient loss. P loss varies due to infiltration, runoff, erosion, nutrient cycling processes, and spreading practices.
- Modeling all these winter manure processes can more scientifically quantify the risk of P loss from winter manure application.

OBJECTIVES

- Use the SurPhos manure P runoff model to estimate dissolved P loss in runoff from winter applied dairy manure, testing the model with monitored field data.
- Use measured runoff and precipitation data in SurPhos to estimate the risk of P loss in runoff from dairy manure applied in different seasons.

SUMMARY

- Risk of P loss increases 3-4x for winter manure application (Table 2), with winter being anytime from mid-November to early-March.
- Low runoff fields may be OK for winter spreading, while medium to high runoff fields may have a high risk of P loss; BUT same field can have low, medium, or high runoff depending on winter conditions.
- The SurPhos model can reliably predict runoff dissolved P concentrations.
- Modeling tools such as SurPhos can be used to develop better manure management and policies.

MODEL DESCRIPTION AND TESTING

- SurPhos (Vadas et al., 2007) is a daily model that predicts dissolved P loss in runoff from surface-applied manure. SurPhos simulates manure and P application to soil, manure P transformations, leaching of P from manure by rain or snowmelt water, translocation of leached P either to soil via infiltration or to runoff, and soil P cycling and dissolved loss in runoff (Figure 1).
- We tested SurPhos with measured runoff data from 3 fields in WI (Komiskey et al., 2011). Liquid dairy manure or solid beef manure was applied after fall corn harvest at different times in different years (September through March, Table 1).
- We input measured runoff, precipitation, and manure application times and rates to SurPhos and compared measured and predicted dissolved P in runoff. Figure 2 shows SurPhos reliably predicted runoff dissolved P concentrations.

Table 1: Measured runoff and manure P application rates for 3 WI fields where manure was winter-applied and runoff was monitored.

Winter period	Runoff (mm)	Manure P applied (kg ha ⁻¹)	Measured runoff total P (kg ha ⁻¹)
2003-2004	19 - 32	13 - 17	0.4 - 3.5
2004-2005	69 - 111	24 - 80	1.8 - 4.0
2005-2006	0.1 - 13	11 - 45	0.1 - 1.1
2006-2007	7 - 27	28 - 38	0.2 - 1.1

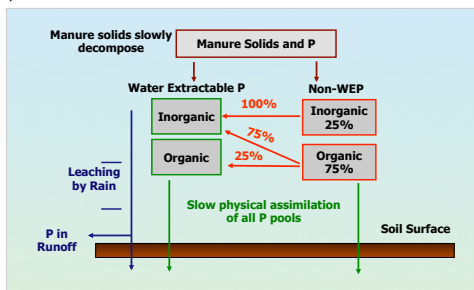


Figure 1: Schematic of the SurPhos manure P runoff model.

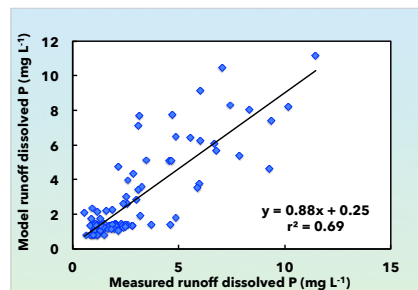


Figure 2: Measured and simulated dissolved P in runoff from 3 fields where winter manure was applied and runoff monitored.

MODEL ASSESSMENT OF MANURE P LOSS IN DIFFERENT SEASONS

We used SurPhos and measured precipitation and runoff data from WI to assess the risk of P loss in runoff from manure applied in different seasons.

- 108 site years of measured runoff and precipitation from 7 sites.
- Divided data into groups of Low, Medium, and High runoff, where Low was when winter runoff ranged from ~0-10% of winter precipitation, Medium was for runoff at ~10-25% of precipitation, and High was ~25-50%. Each category had 36 site years.
- Simulated a single dairy manure application (6% solids) of 6000 gallons/acre (35 lb P/acre), ran the model for 36 years for each runoff category, with manure applied the same day each year. Repeated simulations, varying only the day of manure application, until all days of year were simulated.
- Figure 3a shows winter is a time of high runoff risk. Figure 3b shows P loss results, where each data point represents average annual dissolved P loss when manure is applied on that day of the year.

Table 2: Summary of the increased risk of P loss from winter-applied manure.

Runoff group	Average winter P loss (kg/ha/yr)	Average non-winter P loss (kg/ha/yr)	Season effect	Average runoff effect over Low
Low	0.33	0.12	2.8x	--
Medium	1.19	0.33	3.6x	3.4x
High	2.63	0.63	4.2x	7.2x

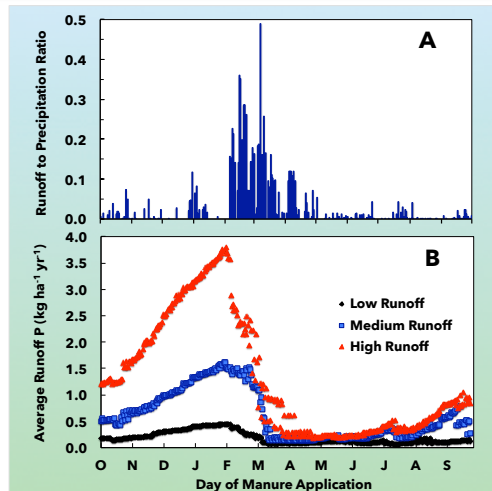


Figure 3: Average daily measured runoff to rain ratios from 7 sites in WI, and simulated average annual P loss in runoff for each day manure is applied.



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- Komiskey, et al. 2011. Nutrients and sediment in frozen-ground runoff from no-till fields receiving liquid dairy and solid beef manures. J. Soil Water Conserv. 66:303-312.
- Vadas, et al. 2007. A model for phosphorus transformation and runoff loss for surface-applied manures. J. Environ. Qual. 36:324-332.