doi:10.2489/jswc.64.6.180A

TECH TRANSFER BRIEFING

Water quality effects of repeated annual poultry litter application

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This study, which is one component of a broader, long-term project on the environmental and agro-economic impacts of land applying poultry litter off-site of animal production operations, was designed to determine the water quality effects of repeated annual poultry litter application. To date, more than eight years of data have been collected from ten field-scale cropland and pasture watersheds. On cropland, increasing litter rates from 0.0 to 13.4 Mg ha^{-1} (0 to 6 ton ac^{-1}), with corresponding decreases in supplemental inorganic nitrogen, increased soluble phosphorus concentrations in runoff but reduced extreme high nitrate-nitrogen concentrations. On pasture, increasing litter rates increased both soluble phosphorus and nitrate-nitrogen concentrations in runoff because litter was the only nutrient source. Following seven annual litter applications, soluble phosphorus concentrations in runoff were strongly correlated with phosphorus levels in the soil on both land uses; however, the dynamic interactions of rainfall, runoff, vegetation condition, soil nutrient levels, and fertilizer application limited consistent, long-term trends in nitrogen and phosphorus runoff. In addition to these and other issues of scientific interest, the present study produced several practical outcomes.

First, combining inorganic and organic fertilizers can be an effective fertilization strategy on farms and ranches. With this strategy, organic fertilizers are applied at the phosphorus rate and thus provide necessary phosphorus and micronutrients, as well as organic matter and some nitrogen. Supplemental inorganic fertilizers are then applied to meet the remaining nitrogen requirement. For the cropland conditions studied, the ideal long-term litter application rate was shown to be 2.2 to 4.5 Mg ha^{-1} (1 to 2 ton ac^{-1}). Application rates in this range minimized water quality concerns in terms of nitrate-nitrogen and soluble phosphorus runoff compared to inorganic fertilization. For cropland, this environmentally optimal range was also shown to be economically optimal in terms of maximizing profit. The ideal long-term annual litter rate for pasture is anticipated to be 4.5 to 6.7 Mg ha^{-1} (2 to 3 ton ac^{-1}), which is slightly higher than for cropland due to increased nutrient uptake potential, increased infiltration, and reduced erosion (although no economic analyses were conducted on pastures).

Second, application of fertilizer (organic or inorganic) during forecasts of heavy rainfall increases the potential for considerable runoff nutrient losses (and wasted inputs) and thus should be avoided. Although it is widely recognized that the greatest nitrogen and phosphorus concentrations typically occur in the first runoff event following fertilizer application, runoff occurring weeks and even months after fertilizer application can still produce high nitrogen and phosphorus concentrations. Management of fertilizer timing cannot prevent this. In other words, the management of fertilizer timing should not be solely relied upon to reduce nitrogen and phosphorus loss in runoff.

Third, the tradeoff between reduced nitrogen and phosphorus loss potential and increased application costs with split fertilizer application should be carefully considered in fertilizer management. Because of water quality concerns, double litter rates applied every other year are not recommended except for the 2.2 Mg ha^{-1} (1 ton ac^{-1}) litter rate. At that average annual rate, applying liter at 4.5 Mg ha^{-1} (2 ton ac^{-1}) every other year is anticipated to have little adverse soil and water quality impact.

Fourth, high runoff nitrogen and phosphorus concentrations can occur on well-managed fields. This observation presents serious regulatory implications, especially in light of a recent suit against United States Environmental Protection Agency regarding regulation of nutrient runoff in Florida (Skoloff 2008). Determining appropriate edge-of-field water quality standards to regulate diffuse rural runoff is extremely challenging since most regulators and scientists do not know what environmentally significant and reasonably attainable nutrient concentrations are at that scale. It is not appropriate to simply "push downstream standards upstream" and apply them at the field scale given drastically different dilution, transformation, and channel contribution mechanisms. If overly strict edge-of-field standards are established, then attainment may be impossible even when proper management is implemented. Thus, when, and if, edge-of-field water quality standards are established, they should be based on data collected at the appropriate scale, such as inventoried in Harmel et al. (2008). In the meantime, farmers and ranchers should actively pursue best management practices to reduce nutrient losses and keep valuable fertilizer on their fields.

Finally, a change is needed and seems to be occurring in the animal industry mindset regarding manure and litter. Viewing these by-products as "resources to be marketed regionally and not wastes to be disposed of locally," as suggested by Janzen et al. (1999), tends to increase off-site application and thus mitigate environmental problems created by over-application on "waste" application fields. Within this paradigm, litters and manures represent potential revenue opportunities instead of costs to animal producers and provide attractive fertilizer alternatives to farmers and ranchers faced with increasing input costs.

For further information see the full paper on pages 400-412 of this issue (Harmel et al. 2009).

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