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Phosphorus transfer in hydrologic pathways connected to critical source areas in a headwater agricultural watershed

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Abstract:

Strategies for reducing phosphorus (P) losses from agricultural watersheds have emphasized targeting of critical source areas (CSAs) where high soil P locations overlap with runoff generation areas. This study focused on identification of CSAs and characterization of hydrologic pathways of P transfer in a 2.4 hectare grazed, pasture watershed in north Georgia where poultry litter is applied as fertilizer. The objectives of this study were to 1) identify CSAs through examination of spatial variation of soil P and runoff generation mechanisms and 2) characterize P forms in overland flow, shallow groundwater, and streamflow pathways. Spatial variation of soil P was determined through 30-meter offset-grid soil (5-centimeter) sampling, Mehlich-1 soil test P (STP) laboratory analysis, and soil P mapping by interpolation using ArcMap. Hydrologic methods included continuous (5-min) measurements of rainfall, streamflow, and depth to water at two pairs of shallow piezometersâ€”one located above the stream head and one at a near-stream wetland. Water quality samples were collected from streamflow (storm and non-storm conditions), shallow groundwater, and overland flow. All water samples were analyzed for reactive (Murphy-Riley molybdate blue) and unreactive P in both <0.45 and >0.45 Âµm fractions. During one storm event, overland flow occurrence coupled with water table measurements showed that infiltration-excess overland flow (IEOF) was the apparent runoff generation mechanism above the head of the stream. Saturation-excess overland flow (SEOF) was the mechanism at the near-stream wetland. These results suggest that the study watershed had potentially two P CSAs. During frequent, small storm events, the near-stream wetland will promote SEOF generation from a low STP area. During infrequent large events, IEOF may generate runoff within a high STP region above the stream. The two areas may require different best management practices to reduce P loss.

Impact Statement:

A small number of field-scale studies on P CSA identification have been performed, and of those that have been published, few-to-none focused on hydrologic P transfer in watersheds draining commercial poultry operations. An implication of this study's findings is that multiple types, or levels, of P CSA may operate in a watershed. The importance of one over another may depend on hydrologic regime and degree of hydrologic connectivity between the P source area and the receiving stream. This concept has direct implications for P risk assessment and load reduction strategies.

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