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Nutrient contamination from an agricultural non-point source and its mitigation: A case study of EKU Meadowbrook Farm, Madison County, Kentucky

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NUTRIENT CONTAMINATION FROM AN AGRICULTURAL NON-POINT SOURCE AND ITS MITIGATION: A CASE STUDY OF EKU MEADOWBROOK FARM, MADISON COUNTY, KY

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Non-point sources are now responsible for most nutrient contamination in surface water and groundwater, leading to eutrophication and decreased water quality. Because of fertilizer use and animal husbandry, agricultural areas are prime sources for nutrient contamination. Consequently, it is advisable to mitigate entry of nutrients into watersheds from agricultural runoff and groundwater flow. Eastern Kentucky University (EKU) Meadowbrook Farm (Madison County, Kentucky) seeks to decrease its export of nutrients to Muddy Creek, which is tributary of the Kentucky River. To demonstrate the efficacy of any sequestration strategies, nutrient export must be measured both before and after sequestration efforts are implemented.

Over the past two field seasons, we have investigated the sources and behavior of dissolved nutrients (phosphate, PO_4^{3-}; ammonium, NH_4^+; nitrate, NO_3^-) and other dissolved ions, and their transport via hydrologic pathways at the Farm. Here, we present our findings in three parts:

(1) background nutrient concentration in surface water and groundwater during fair-weather times and identification of likely nutrient sources (Borowski et al.);
(2) details of cation and nutrient drainage from the Farm during rain events (Buskirk et al.); and
(3) quantification of nutrient export from a representative sub-watershed on the Farm during a major rainfall event (Winter et al.).

Meadowbrook Farm is a working farm raising crops (mainly corn and soybeans), and rearing dairy and beef cattle and other livestock. Livestock produce manure that is eventually applied to pasture and croplands; supplemental fertilizer is also used. These are the primary sources for excess nutrients that leave the Farm via overland and groundwater flow.

We sampled water from several different water sources and measured their nutrient content. Water types include that from drainage tiles, springs (groundwater), and surface water within intermittent streams on the Farm, other adjacent streams, and Muddy Creek. Water samples were passed through a 0.4 μm syringe filter and then preserved at a pH of 2 with sulfuric acid (H_2SO_4). Nutrient concentration, expressed in terms of phosphorus (P) and nitrogen (N) content, was measured colorimetrically using an UV-VIS spectrophotometer and the ascorbic acid (orthophosphate; $P\text{-}PO_4^{3-}$), sodium hypochlorite (ammonium, $N\text{-}NH_4^+$), and cadmium reduction (nitrate, $N\text{-}NO_3^-$) methods.

Nitrate is the nutrient contaminant with highest median concentration (~1.1 mg/L $N\text{-}NO_3$) in surface waters; median concentration for ammonium and phosphate are ~0.3 mg/L $N\text{-}NH_4^+$ and ~0.03 mg/L $P\text{-}PO_4^{3-}$, respectively. Relative to national data, Farm groundwater is enriched in all nutrients with median concentrations of ~0.04 mg/L $N\text{-}NH_4^+$, ~7.3 mg/L $N\text{-}NO_3$, and ~0.04 mg/L $P\text{-}PO_4^{3-}$. Enrichment in ammonium is more significant compared to that of nitrate and phosphate. These data provide fair-weather, background estimates for comparison to nutrient export that occur during rain events.

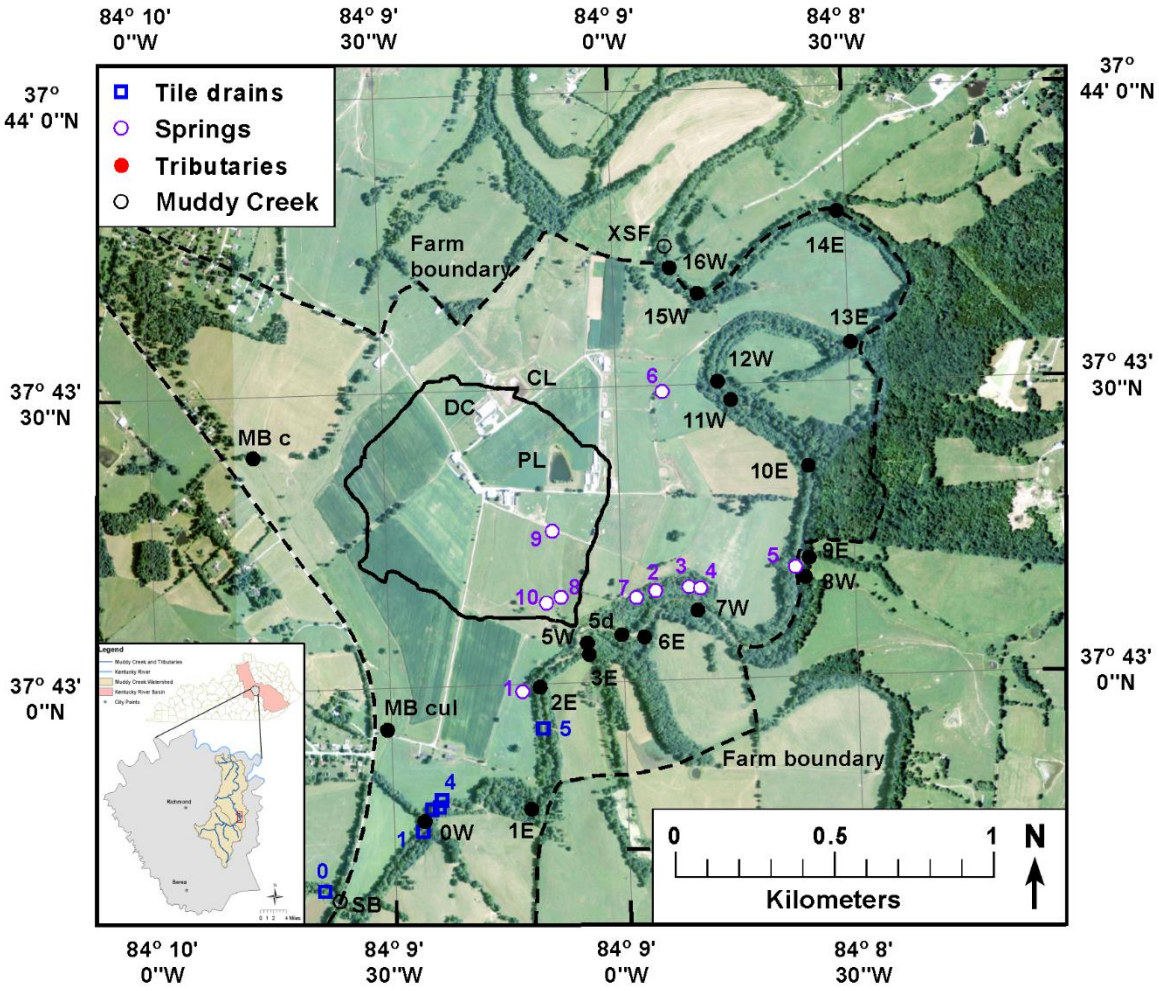

Figure 1. Map of EKU Meadowbrook Farm and sampling stations. The Farm (dashed outlined) is generally bounded by Muddy Creek on the east that flows from south to north. Symbols for sampling stations indicate water type. Note the black polygon that shows the BRC sub-watershed, which drains the cow (CL) and pig (PL) lagoons and the diary complex (DC), as well as pasture and cropland. The BRC flows through at instrumented weir at station 5W.