LETTER

Long-term fate of nitrate fertilizer in agricultural soils is not necessarily related to nitrate leaching from agricultural soils

Accounting for the fate of inorganic N fertilizer in agricultural systems is critical to sustainable production. Sebilo et al. (1) provide a unique long-term record of $^{15}NO_3$ fertilizer fate that demonstrates N molecules from a discrete fertilizer application are transferred to soil organic matter (SOM) and subsequently mineralized over the course of approximately 100 y, during which they contribute to NO_3 leaching. The authors conclude "attempts to reduce agricultural nitrate contamination of aquatic systems must consider the long-term legacy of past applications of synthetic fertilizers" (1). Furthermore, Sebilo et al. suggest that a recent decrease in anthropogenic N inputs to the Mississippi River Basin, without a concomitant decrease in riverine NO_3 loads, is consistent with their conclusion.

In contrast to the authors' interpretation, we highlight that short-term changes in agricultural management can lead to large short-term reductions in NO_3 leaching. We attribute the authors' results to long-term SOM turnover and associated NO_3 losses that occur in the absence of high biological N demand. We suggest that changes in agricultural management that produce rapid reductions in total NO_3 leaching would produce proportional reductions in NO_3 leaching derived from historical fertilizer applications.

Diversified cropping systems, conversions to perennial biofuels, and cover crops all provide direct evidence of the short-term potential for decreases in NO_3 leaching. In maize–alfalfa cropping systems, NO_3 leaching under alfalfa is 75–80% lower than the preceding maize crop (2). Perennial biofuel crops can reduce NO_3 leaching by >90% within 4 y of establishment (3). Nonlegume cover crops provide on average a 70% reduction in NO_3 leaching during 2- to 3-y experiments (4).

^{15}N labeling studies demonstrate that the proportion of fertilizer transferred to SOM is rapidly distributed among pools with fast and slow turnover rates (e.g., ref. 5). Consistent with ecosystem models, a small portion of the ^{15}N transferred to slow-turnover SOM-N pools will mineralize every year. In annual cropping systems where plant uptake is not fully synchronized with N mineralization, a portion of the mineralized N will nitrify and leach. As such, we expect strategies that reduce total NO_3 leaching will provide proportionally equal reductions in all sources of NO_3 leaching independent of whether the NO_3 is derived from fast- or slow-turnover SOM-N pools.

We also question the suggestion that net anthropogenic N inputs (NANI) to the Mississippi River basin are decreasing. None of the cited papers demonstrate a decrease in NANI, and recent analyses show NANI to be relatively static over the last 20 y.

With a goal to reduce N losses to the Gulf of Mexico by 45%, we are concerned that readers will misinterpret the authors' data to suggest short-term agricultural management strategies cannot provide large, rapid reductions in NO_3 leaching. Strategies that minimize bare fallows and maximize plant N demand are well known to provide rapid reductions in NO_3 leaching (2–4). Although mineralization of historical N fertilizer applications cannot be prevented, the mineralized N can be recycled into SOM, particularly with strategies that aim to restore depleted soil organic carbon stocks.

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