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COMBINING TOOLS TO ATTENUATE REACTIVE NITROGEN ALONG SMALL AGRICULTURAL WATERWAYS

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Abstract

Reducing excessive reactive nitrogen (N) in agricultural waterways is a major challenge for freshwater managers and landowners. Effective solutions require the use of multiple and combined N- attenuation tools, targeted along small ditches and streams. But, despite opportunities to address headwater N export with complementary land- and stream-based management with multiple tools implemented across these scales, in practice, these are seldom combined. We developed a visual framework to guide novel applications of 'tool-stacking' that include edge-of-field and waterway-based options targeting N-delivery pathways, timing, and reducing fluxes to receiving environments. This framework should address the most common and pervasive challenges to reducing excessive N along small agricultural waterways. We kindly refer readers to the full version of this work in the peer-reviewed, open-access publication in Goeller et al. (2020). A brief summary is provided here.

Our approach emphasizes accommodating system variability, which entails fitting the hydrological landscape, including temporal and spatial inequality in N export, as well as working within the social and productive landscapes at a scale that makes a difference and at the most strategic locations along headwaters. Implementing tools at multiple locations and scales using a 'toolbox' approach will better leverage key hydrological and biogeochemical processes for N attenuation (e.g., water retention, infiltration and filtering, contact with organic soils and microbes, and denitrification), in addition to enhancing ecological benefits to waterways. Rather than predicting attenuation performance, our framework addresses the most common and pervasive challenges to reducing excessive N along small agricultural waterways, thereby ensuring that management is best-suited to the local context. A visual representation of the framework to help guide decision-making is presented in Figure 1, using a selection of N attenuation tools as examples. Our framework applies primarily to temperate or warmer climates, since cold temperatures and freeze-thaw-related processes limit biological N attenuation in cold climates. For a full discussion of the tools, attenuation mechanisms, and implications for practice, please refer to Goeller et al. (2020).

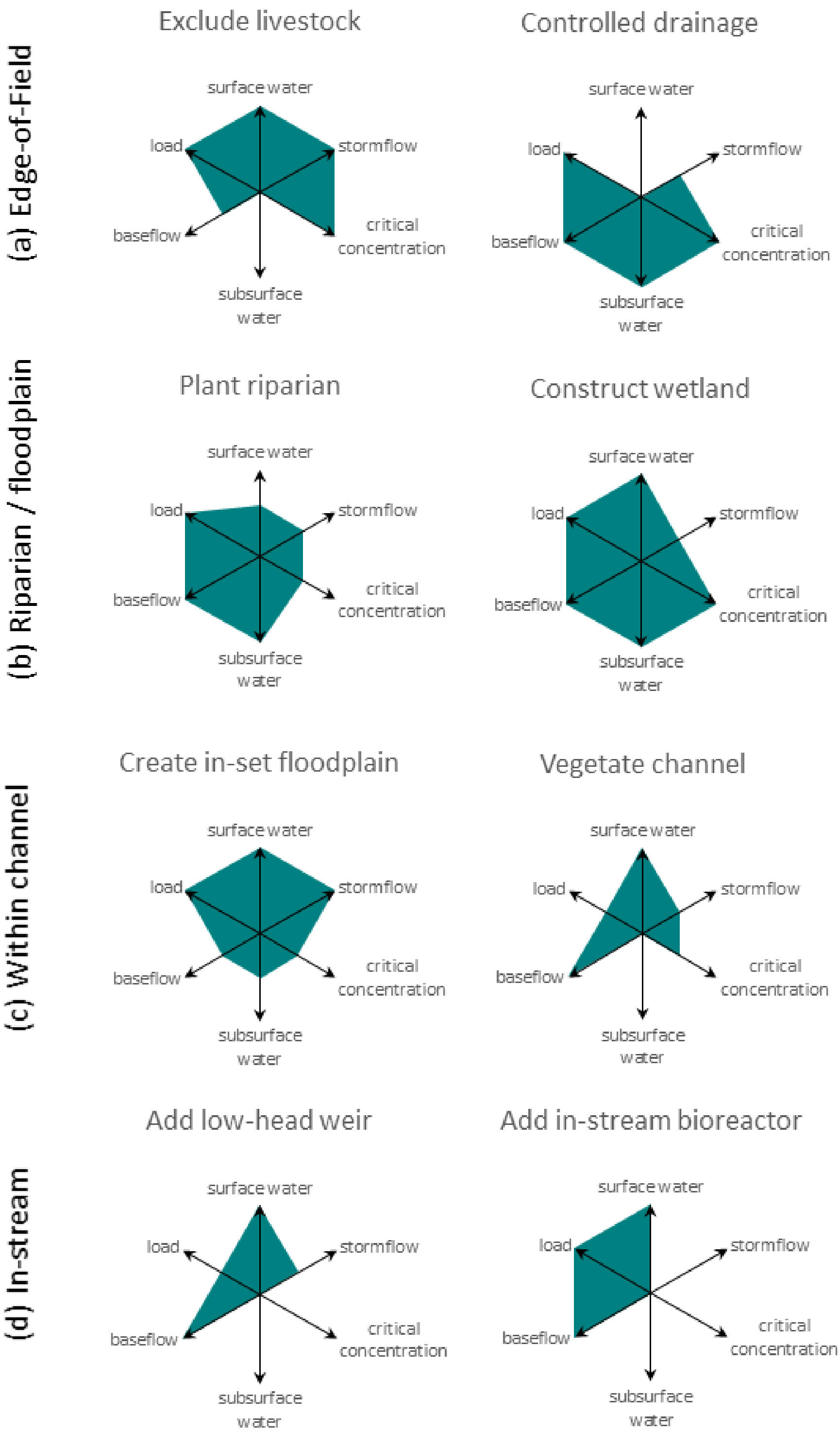

Figure 1. "Potential suitability of N attenuation tool combinations across critical locations ordered from (a) the edge-of-field, (b) the riparian zone or floodplain, (c) within the channel margins, and finally to (d) in-stream. The three-axis framework (delivery pathway, timing, and change in the receiving environment) of the toolbox provides a visualization of tool stacking. Shapes denote the relative strengths for tools to target the flow pathway (surface to subsurface), timing (stormflow versus baseflow), and the effect of flux reduction on N concentration or N load in the receiving environment." Reproduced with permission from Goeller et al. (2020).

Overall, we encourage scientists and managers to co-develop N-attenuation toolboxes with farmers, since implementation will require tailored fits to local hydrological, social, and productive landscapes. Moreover, we hope to stimulate future empirical work and testing of our framework in different climate and landscape-contexts where tool-stacking might challenge and improve the outcomes of conventional ‘one-size-fits-all’ N management approaches. However, we caution that these should be treated as adaptive management experiments rather than solutions to N loading issues, while better data on the catchment- and ecosystem-level impacts of combined land- and stream-based N management actions is obtained Goeller et al. (2020).

Literature cited

Goeller, Febria, McKergow, Harding, Matheson, Tanner, McIntosh, 2020. Combining tools from edge-of-field to in-stream to attenuate reactive nitrogen along small agricultural waterways. Water 12, 383. https://doi.org/10.3390/w12020383