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Welcome to the New Frontier: Introducing Extension to the Next Generation of Conservation Planning Tools

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Welcome to the New Frontier: Introducing Extension to the Next Generation of Conservation Planning Tools

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Abstract. A new frontier of conservation planning capacity utilizing innovative decision support tools has emerged. Extension professionals play an important role in using these new data and tools to achieve conservation and water quality outcomes. Here, we detail the application of two conservation planning tools: Agricultural Conservation Planning Framework (ACPF) and Financial and Nutrient Reduction Tool (FiNRT). Tools like these are increasingly being used to guide conservation efforts in agricultural landscapes; provide information regarding potential resource concern; and offer valuable data about outcomes from best management practice (BMP) placement. Extension professionals' use of such tools could enhance conservation implementation and outcomes.

INTRODUCTION

Local and regional water quality concerns across much of the U.S. Corn Belt have been ongoing for decades (EPA, 2019). At the behest of the U.S. Environmental Protection Agency (EPA), over the past ten years twelve states within the Mississippi River Basin (MRB) have formulated nutrient reduction strategies. These strategies are variously designed to establish state-level nutrient loss benchmarks, conduct meta-analyses on field-level water quality best management practices and their outcomes, offer management scenarios to demonstrate scale, and articulate research and development needs (Christianson et al., 2018; EPA, 2020). As state strategies are updated, more attention is being placed on conservation planning that utilizes locally-derived social data, publicly-available high-resolution spatial data, and new planning tools for more precise spatial planning to meet conservation outcomes (e.g., enhanced water quality; Giri, 2021).

The conservation community, of which Extension professionals are a part, is entering a new frontier of conservation and water quality planning capacity that is innovatively harnessing the power of high-resolution spatial data and ground-breaking spatial planning decision support tools (Tyndall, 2021). Extension professionals play an important role in actualizing nutrient reduction strategies by leveraging the cultivated relationships they have with farmers and resource professionals in applying local knowledge and experience and extending applied water quality research findings (Bates & Arbutckle, 2017; Moore, Sheshukov, & Graber, 2019). To this end, Extension and other public outreach professionals are among the most trusted sources of information when it comes to soil and water conservation (Mase et al., 2015; Marks & Boemgen, 2019; Fox et al., 2021). For Extension professionals to continue and strengthen their role in conservation planning and operationalizing nutrient reduction strategies, it is imperative that they become familiar with the advancements in conservation planning capacity, data being used, and the decision support tools that will drive the new era of water quality management.

This article introduces to the Extension community a GIS-based decision support tool called the Agricultural Conservation Planning Framework (ACPF) and the Financial and Nutrient Reduction Tool (FiNRT; "fine art"). The ACPF is increasingly being used by watershed organizations and partnerships to facilitate stakeholder-driven planning approaches (Gesch et al., 2020; North Central Region Water Network, 2022), and the USDA Natural Resource Conservation Service (NRCS) is exploring opportunities to integrate the ACPF into its watershed planning process and using ACPF output as context for interacting with landowners (Ranjan et al., 2022). The FiNRT

has recently been released and adds critical financial analytical capacity to the planning process (Bravard et al., 2022).

TOOL DEVELOPMENT AND FUNCTION

The ACPF is a GIS-based conservation planning tool used in relatively small, agricultural watersheds (~ 4K to 20K hectares in size; watersheds with 12-digit hydrologic unit codes; Tomer et al., 2013; Porter et al., 2022). The framework itself is based on conservation principles and watershed management practices with the goal of improving soil and water quality in ways that synergistically enhance overall watershed health (Tomer et al., 2013). To do this, the ACPF identifies where areas of resource concern (i.e., soil, nutrient loss) may most likely occur based on excess run-off or leaching vulnerability according to soil, landscape, and hydrologic factors, and then characterizes opportunities for various water quality best management practice (BMP) at in-field, edge-of-field, and riparian locations (Tomer et al., 2013; Porter et al., 2022). While not a prescriptive tool, the ACPF allows skilled planners to evaluate opportunities for site-appropriate BMP options that biophysically target identified pathways for nutrient loss (e.g., via surface run off, subsurface flow, or both) and suit field conditions and landscape positions. In-field BMPs in the ACPF toolbox include drainage water management, contour buffer strips/prairie strips, grassed waterways; edge-of-field BMP options include filter strips, bioreactors, nutrient removal wetlands, and water and sediment control basins (WASCOBs); riparian zone practices involve riparian buffers with varying functions and saturated buffers. The ACPF uses practices promoted by the Iowa Nutrient Reduction Strategy (Benning & Lawrence, 2019) and appear in other state-level nutrient reduction strategies to enhance its utility and practical application.

THE AGRICULTURAL CONSERVATION PLANNING FRAMEWORK AND THE FINANCIAL AND NUTRIENT REDUCTION TOOL

The ACPF is an ArcGIS-based tool that uses high-resolution LiDAR-based elevation data, National Agricultural Statistics Service Cropland Data Layer (NASS CDL) land-use data, NRCS gSSURGO soils data, field boundary, and watershed boundary data, to enable: (1) hydro-conditioning, terrain processing, and hydro-enforcement of elevation data; (2) delineation of the perennial stream network and catchments; (3) identification of fields in a watershed most likely to contribute nutrients and sediment to surface water; and (4) targeting-opportunities for in-field and edge-of-field BMPs (Tomer et al., 2017; Porter et al., 2022). Running the ACPF toolbox processes requires moderate ArcGIS ability and knowledge of local landscapes and practices; using the ACPF outputs to assist in conservation planning can be done by a variety of resource professionals - no GIS experience is required for using outputs. Input data for use in the ACPF ArcGIS Toolbox as well as comprehensive tutorial materials can be found and downloaded at <https://acpf4watersheds.org>. Input data are presently available for over 12,000 HUC-12 watersheds across 11 states in the US Corn Belt.

The FiNRT allows ACPF-based conservation scenarios to be evaluated for expected nitrate-N reduction along with total costs of various BMPs and to perform cost effectiveness analysis, comparing costs and per unit nitrate-N reduction from field to watershed scale (Bravard et al., 2022). The FiNRT itself involves multi-state financial and nutrient reduction datasets and is operationalized through two new ArcGIS-based tools that work as add-ons to the current ACPF toolbox and outputs. The BMP output layers from the ACPF are used as inputs in the FiNRT to conduct financial and nutrient reduction calculations. The FiNRT, like the ACPF, offers flexibility to planners to select which types and individual BMPs are included in each scenario assessed.

As described in Bravard et al.(2022), the FiNRT: 1) calculates the nitrogen requirements for each field and assesses the proportion of nitrogen likely to leach from the field as potential nitrate-N load; and then 2) quantifies the expected nitrate-N load reduction from application of selected BMPs and the direct and spatially determined opportunity costs of the BMPs present in the scenario. To assess potential nitrate-N leaching, the FiNRT uses ACPF available information about land use by field, nitrogen application estimated by Maximum Return to Nitrogen (MRTN), and leaching potential. To evaluate nitrate-N reduction potential, FiNRT uses BMP nutrient reduction efficiencies (as percentages) from state-level nutrient reduction strategies. To assess financial information, the FiNRT uses default direct costs for each BMP based on up-to-date enterprise budgets; opportunity costs for area of land removed from production by certain BMPs are estimated using state-specific soil productivity index values and the regional average cropland rental rate to calculate a dollar amount per productivity index point. Total costs are calculated using standard discounted cash flow techniques (i.e., a default partial budget financial analysis is

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conducted for each BMP to quantify the direct and opportunity cost of establishing and managing the BMP over a 20-year period using a real 2% discount rate).

Output information generated by the FiNRT includes nitrate-N load reductions, total direct and opportunity costs, and cost-effectiveness (total annual cost divided by load of nitrate- N reduced) for each scenario at practice, field, and watershed scale (Bravard et al., 2022). Currently the FiNRT has necessary nutrient and financial data for the states of Iowa, Minnesota, Illinois, and Indiana, with Ohio data availability planned for Fall 2024. The FiNRT can be found and downloaded at <https://acpf4watersheds.org/toolbox/finrt/>.

The addition of the FiNRT tools to the ACPF can provide conservation planners, landowners, and local conservation entities, including Extension conservation specialists, with increased and easily accessible information that empower local decision making, particularly relative to capital budgeting, allocating scarce resources, and creating and disseminating information to all partners. Ultimately, public and private partnerships, such as watershed associations, need to be able to conduct long-term financial planning for their own resource allocation needs and identify viable modes of cooperation (Wagner, 2021).

CONSERVATION PLANNING TOOLS AND EXTENSION

Being able to interact with and apply conservation planning tools like the ACPF and FiNRT and their outputs regarding conservation opportunities will allow Extension personnel to maintain and strengthen their role in the social infrastructure that initiates, operationalizes, adaptively manages conservation efforts at temporal and spatial scales meaningful to society (Wagner, 2021). Using the ACPF and the FiNRT as part of a conservation planning process involves several activities in which Extension personnel can play various roles. Depending on GIS expertise, Extension professionals may be involved in initial data acquisition and running of the ACPF to identify potential areas of resource concern and characterize potential BMP opportunities. Extension experts who are not designated to run of the tool itself, can collaborate with other local resource professionals to share their experiential insights about the planning process. Extension professionals' expertise from working locally with landowners, farmers, and farm advisors can be key regarding assessing conservation awareness, need, and favored BMPs to be included in the scenario development phase. Local Extension expertise can advise on verification of modeled analyses and scenarios regarding ground-truthing, identifying field boundaries, verifying the presence of culverts (and other conveyances/impoundments), pre-existing conservation practices, and so on; on-the-ground verification is critical to the use of the ACPF and other decision support tools (Ranjan et al., 2020). Beyond the ACPF and FiNRT modeling process, Extension is very relevant when working directly as partners with conservation project personnel on developing viable conservation plans, and in guiding communication and information among landowners, farmers, and other partners to meet aggregate conservation goals. Challenging topics that Extension can continue to take leadership in, particularly in interactions with landowners, farmers, and farm advisors, include biophysical expectations of preferred BMPs including cost, management, and available cost-reducing programming (Tyndall & Roesch, 2014; Prokopy et al., 2015). It is also important to note that direct and management costs of conservation plan practices can vary considerably from site to site and depend on initial site conditions, weather, practice design, management characteristics, farmer experience, availability of technical services, and contractors utilized. Again, this is a situation where a trusted Extension professional who is conversant in the elements of variability in the use of a practice and its alignment with a client's agronomic and conservation goals can be invaluable in fostering the type of investment required for long-term water quality management.

CONCLUSION

The ACPF and FiNRT can help Extension professionals and conservation partners involved in conservation planning and water quality to spatially focus their approach to working with landowners, farmers, and other stakeholders. Engaging farmers in the conservation planning process and identifying conservation opportunities is crucial, especially with targeted approaches like the ACPF (Zimmerman et al., 2019; Ranjan et al., 2020). Farmers and planners alike agree that prioritizing conservation efforts in areas that contribute most to increased water quality benefits for the least financial cost makes sense (Ranjan et al., 2020). Providing more information (financial costs and nitrate-N reduction benefits) through the FiNRT could allow for a stronger collaboration among conservation professionals, farmers, and a variety of other partners from field-level to watershed scale.

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