Leading at the Edge

A Roadmap to Advance Edge of Field Practices in Agriculture

The Nature Conservancy

MERIDIAN INSTITUTE

SOIL AND WATER CONSERVATION SOCIETY

COMMITTED COLLABORATION

A sector-wide commitment is needed to take action that brings us closer to an integrated, whole-farm, landscape-based approach to working lands conservation. To accelerate this movement, The Nature Conservancy (TNC), the Soil and Water Conservation Society (SWCS), and Meridian Institute brought together more than two dozen experts: senior leaders from agriculture, the supply chain, civil organizations, as well as former government officials. These experts partnered on the development of a cohesive set of recommendations that, if implemented together, will accomplish our collective goal for working lands conservation.

Partners met virtually six times over the course of six months in 2020. They analyzed the current state of the science underpinning edge of field (EoF) practices, reviewed the current policies and programs in place, and developed a shared understanding of efforts underway that both encourage and discourage EoF practice adoption. Building upon this knowledge base, the partners engaged in an iterative process to brainstorm and refine ideas for transformative change. These ideas were synthesized into a framework for action and the nine recommendations that comprise the Roadmap. (See page 4 for list of Partners.)

CALL TO ACTION

This Roadmap is a call to action for conservation groups, policy makers, farmers, farm organizations, supply chain companies and other agricultural stakeholders. Working collaboratively, stakeholders can elevate public awareness of EoF practices and the role they can play in helping the U.S. agricultural system meet environmental goals. If implemented, this Roadmap can help drive EoF adoption at scale, which is essential for improved water quality and resilient communities. Greater collaboration between agriculture stakeholders and a clear process for advancing adoption of practices will lead to greater sharing of EoF information, resources, and success; increased partnerships; and coordinated action. We invite you to dive deeper into the Roadmap and learn about the science, policy, and market opportunities identified. Then, join the movement to transform our agricultural landscapes—both in-field and on the leading edge of agriculture.

Download the full Edge of Field Roadmap report at:
nature.org/EdgeofField

◀ *Cover: Prairie strip © NRCS/SWCS photo by Lynn Betts*
■ *This page: Saturated buffer © NRCS/SWCS photo by Lynn Betts*

Many of the photos in this document came from the Soil and Water Conservation Society's Conservation Media Library, a multimedia resource open to all: www.swcs.org/resources/conservation-media-library

▲ *Prairie strips can help protect water and soil, while providing habitat for pollinators like the monarch butterfly. © Emily Akins*

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

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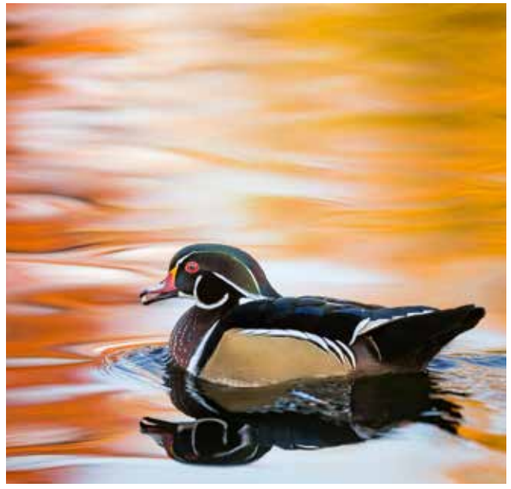
EXECUTIVE SUMMARY

INTRODUCTION

Farmers hold the key to help solve a number of environmental challenges. Science indicates that moving to a regenerative agricultural system—one that is focused on improving nutrient management and rebuilding soil health in farm fields—can deliver dramatic benefits for farmers and improve environmental outcomes. Research also suggests that tackling nutrient loss challenges within the field is not enough. Even widespread adoption of soil health and nutrient management practices won't meet state and regional water quality goals or restore critical habitat for wildlife. We must create conservation opportunities at the edges of farm fields, as well.

Farmers across the United States have successfully installed edge of field (EoF) practices to better manage water and filter nutrients and sediments from water leaving their fields. Individual farmers have seen the benefits of these conservation practices firsthand. Yet, more farmers need to implement these practices on a larger scale and at a faster rate to achieve meaningful environmental improvements. How can that happen? Coordinated and collective actions across the agriculture community can increase incentives, create more technical capacity and knowledge, and expand awareness and acceptance—all aimed at catalyzing widespread adoption of EoF practices to meet water quality and biodiversity goals.

We must create conservation opportunities at the edges of farm fields, as well.



▲ *Edge of field wetlands help remove harmful nutrients from water runoff before it reaches major bodies of water. These wetlands also provide habitat for wildlife like this wood duck. © Jeff Goudy*

THE NEED

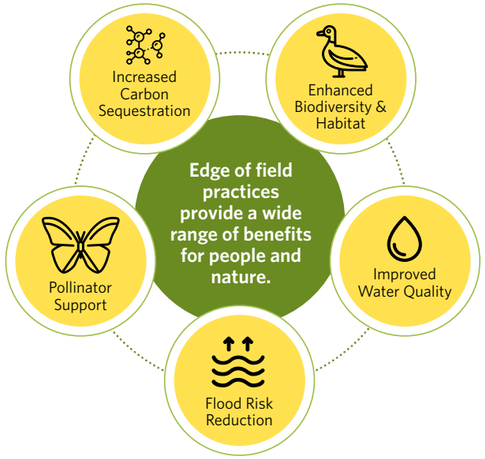
Throughout the United States, many of the natural landscape features that would slow, filter, and store water leaving farm fields have been altered or removed to support increased agricultural and urban development. Over a 200-year period beginning in the 1780s, the United States lost more than 50% of its historical wetlands. The portion of wetlands lost jumps to 80% in the Midwest states of Illinois, Indiana, Iowa and Ohio for the same time period (Dahl 1990). Also, habitat along rivers and streams has declined by an estimated 65% nationwide (Swift 1984), and only small remnants of once expansive grasslands remain. Additionally, the altered hydrology resulting from extensive implementation of tile drainage in some parts of the country has transformed and accelerated the ways water and nutrients move over and through the landscape (Sugg 2007).

These landscape changes have fragmented wildlife habitat, increased nutrient loads to surface waters, and made our watersheds more vulnerable to extreme precipitation events. On farms, increased flooding has led to crop failures, limited access to fields for planting, and reduced crop yields (Jager et al. 2020). Due to high nitrate levels, some downstream communities incur higher costs to provide safe drinking water (Tang et al. 2018). Further downstream, nutrient losses from agricultural fields contribute to significant long-term water quality challenges that impact people and nature.

Each year in the Gulf of Mexico, a hypoxic zone—an area of low to no oxygen—covers on average more than 5,400 square miles, an area roughly the size of Connecticut (USEPA 2000). This "dead zone" is uninhabitable to marine life and is devastating for the fishermen and women whose livelihoods are linked to a clean and healthy Gulf. In Lake Erie, phosphorus losses fuel the growth of harmful algal blooms in the western basin, threatening drinking water supplies and a multi-billion dollar sport fishery. Increased losses of nitrogen and phosphorus contribute to eutrophication, algal blooms, and hypoxic areas affecting freshwater and coastal systems across the U.S. and around the world (Diaz and Rosenberg 2008; Jenny et al. 2016). These impacts are the result of myriad environmental factors but can be significantly addressed through working lands conservation.

THE OPPORTUNITY

Implementation of conservation and stewardship practices at the edges of farm fields represents a crucial, but underutilized, conservation opportunity to reduce nutrient and sediment loss from farm fields and restore functional landscape features that benefit people and nature. These practices include tried and true interventions such as vegetated buffers and wetlands, along with engineered practices like saturated buffers, bioreactors, and controlled drainage systems designed to treat nutrients lost from tile drainage systems.



EoF practices are a critical and effective component of landscape scale watershed improvement efforts in the United States, including in the Chesapeake Bay watershed, Lake Erie, and the Mississippi River Basin, which have ambitious goals related to nitrogen and phosphorus reduction. For example, TNC estimates that **approximately 550,000 acres of restored and constructed wetlands could treat nutrient loss from 50 million acres of cropland** and, in combination with in-field practices and targeted floodplain restoration, help meet current water quality goals in these iconic basins. In other words, targeted restoration of less than 0.4% of agricultural lands in these three basins could help meet approximately one-third of the nutrient loss reduction goals, enhancing freshwater ecosystems and reducing the threats to drinking water supplies.

In addition to water quality benefits, TNC estimates that widespread implementation of restored and constructed wetlands could sequester 7.4 million tons of soil organic carbon adjacent to working lands over a 10-year period, a possible revenue stream for farmers who enroll in ecosystem services markets and a boon to climate change mitigation efforts gaining momentum across the food and agriculture sector. Strategic placement of wetlands in headwaters also has the potential to reduce flooding impacts in downstream communities (Tang et al. 2020). Overall, EoF practices can improve water quality, store more carbon, reduce flooding, support pollinators, and provide wildlife habitat connectivity in working landscapes.

THE EDGE OF FIELD ROADMAP AS OUR GUIDE

This Roadmap outlines the path to successfully achieve the scale of action needed to realize the widespread water and wildlife benefits previously described. Developed through a months-long collaborative effort, the Roadmap charts actionable steps and describes the necessary tools to help the food and agriculture sector transform U.S. working landscapes and achieve its conservation goals.

An Integrated Approach

Expanding adoption of EoF practices is one part of a **three-pronged approach** to achieve a robust, agricultural economy and resilient landscapes. A combination of **in-field, edge of field, and downstream practices** is needed to significantly reduce nutrient loss, rebuild soil health, enhance habitat, and improve resilience across working landscapes.

Edge of Field Pillars

To catalyze large-scale EoF practice adoption, three actions must take place simultaneously:

- **Build the economic case.** Enhance the value proposition for farmers to adopt EoF practices via payments for ecosystem services, improved targeting of state and federal programs, and whole-farm management that diversifies profitability and optimizes resilience.
- **Increase technical assistance and capacity to implement EoF practices.** Invest in and diversify the technical assistance that supports farmers' conservation efforts and integrate this capacity with in-field technical support.
- **Elevate a culture of conservation and innovation in agriculture.** Leverage farmer networks and momentum around soil health and nutrient management to grow the shared understanding that EoF practices are an essential part of a systems approach to improving management and conservation in agriculture.

Cross-cutting Themes

To cement the pillars as the foundation for an EoF movement, there are three cross-cutting themes that are essential to scaling adoption of EoF practices:

- **Invest in science, technology, and data** to increase understanding of the effectiveness of practices and provide farmers and conservation professionals with the information necessary to inform EoF practice implementation.
- **Align policies and programs** so they work in tandem and amplify corporate supply chain efforts and emerging ecosystem services markets to create watershed-level improvements.
- **Communicate a vision of a more holistic, regenerative U.S. agriculture system** to develop a shared appreciation of the importance of EoF practices among farmers, landowners, and others throughout the value chain.

Roadmap Recommendations

The Roadmap lays out recommendations we can take to advance effective public policy, support innovative private sector action, and create partnerships to advance EoF practice adoption. Together, we can:

1. **Elevate and replicate successful or promising local, state, and regional policies and initiatives.**
   Advance and replicate local, state, and regional programs and initiatives that show promise or have been successful in increasing EoF implementation.

2. **Remove administrative barriers to conservation practice implementation.**
   Improve the delivery of incentives and technical assistance by reducing burdensome program requirements and simplifying application and approval processes.

3. **Increase technical assistance by supporting the multiple sources of conservation expertise.**
   Strengthen the capacity of conservation professionals to administer, advise on, and help producers implement these practices.

4. **Integrate EoF as a nature-based water management policy solution.**
   Advance policies and programs that recognize the importance of EoF as a nature-based solution for water management, flood risk reduction, and resilience.

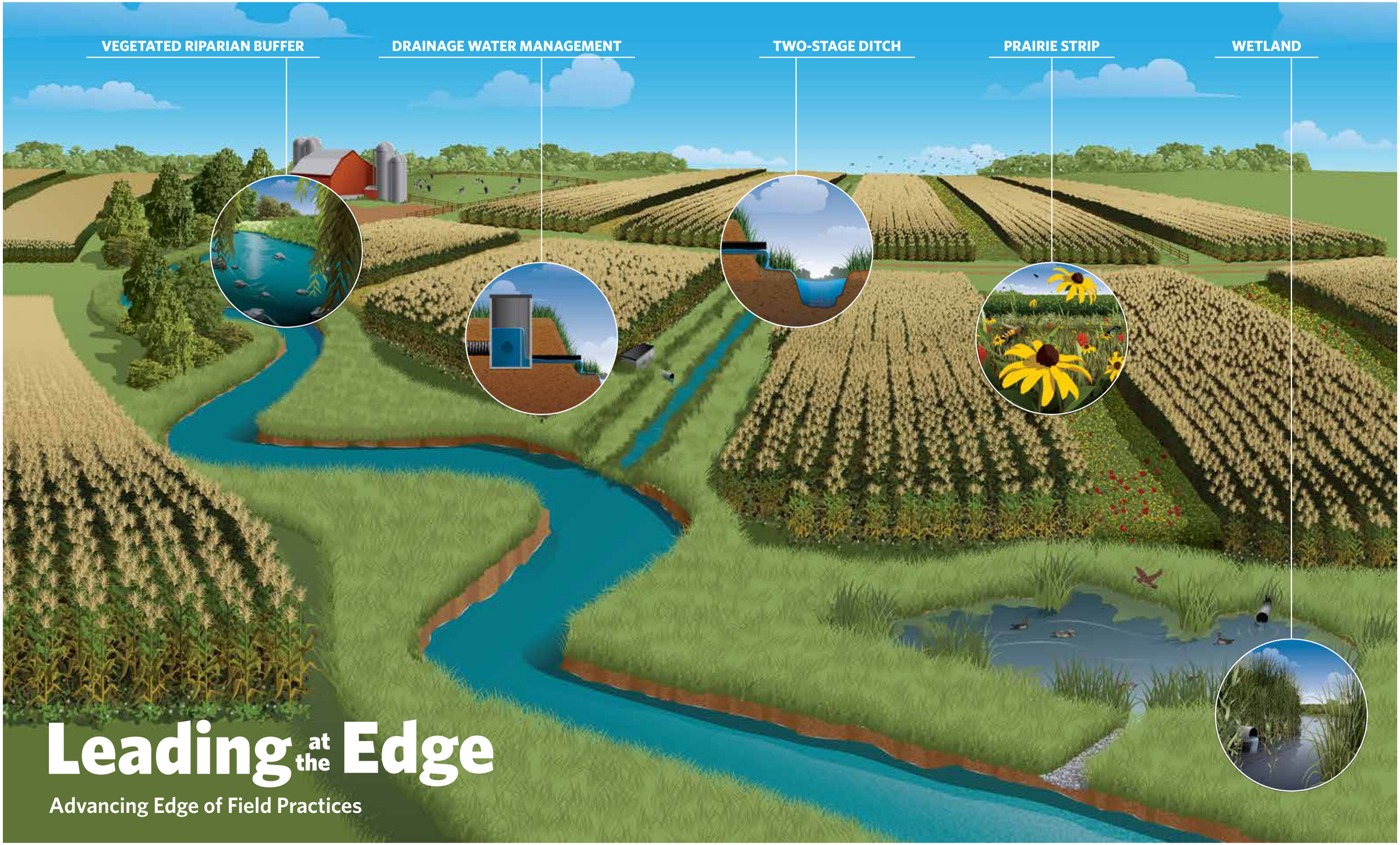
5. **Increase funding and better target conservation programs to achieve watershed-scale impacts.**
   Increase investment in state and federal conservation programs that encourage regional approaches that aggregate implementation and achieve larger-scale conservation impacts.

6. **Expand innovative funding approaches like ecosystem services markets.**
   Support and advance innovative financing methods that seek to improve environmental outcomes while providing new revenue streams for producers and landowners.

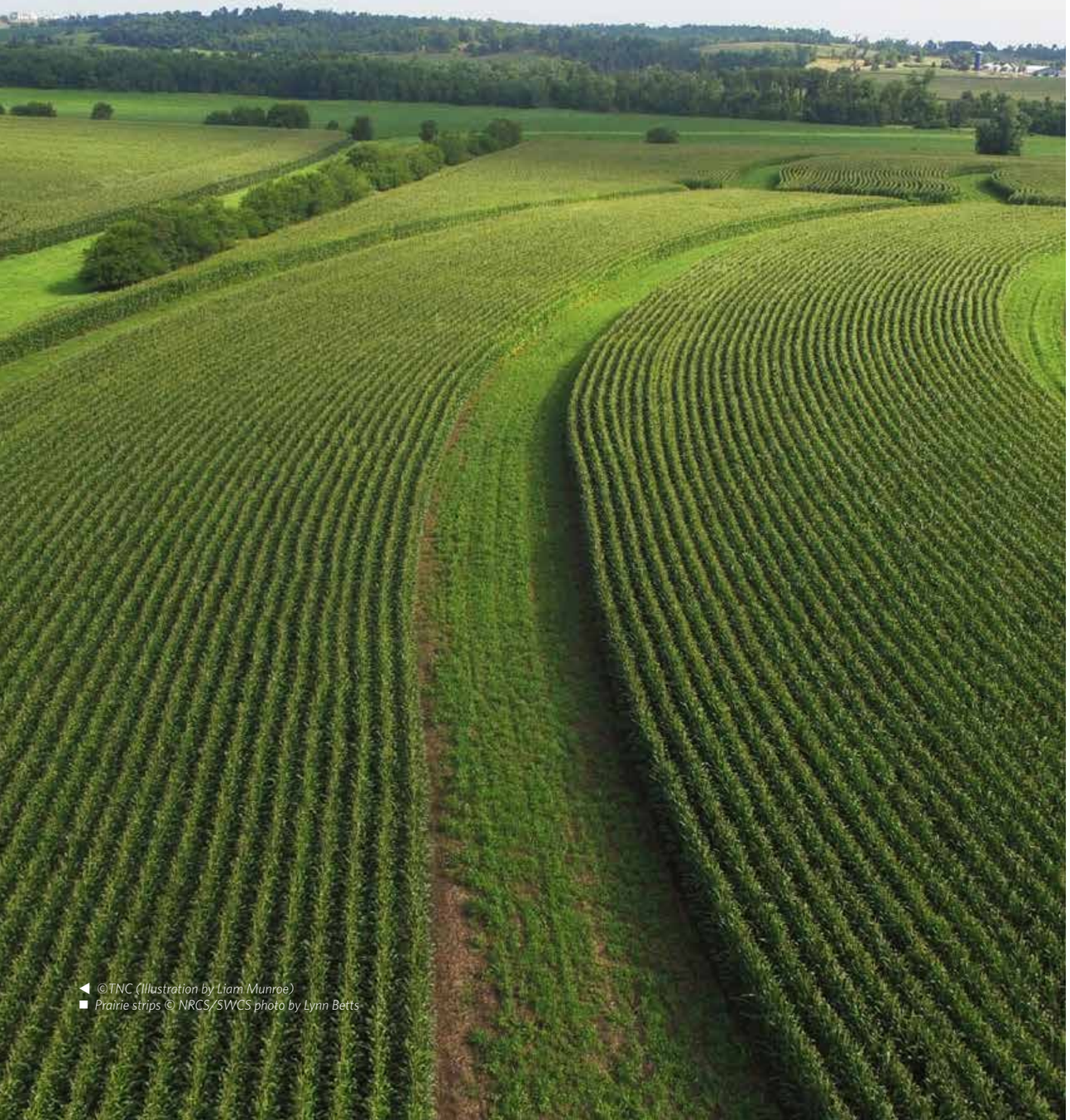
7. **Accelerate sustainable supply chains and corporate commitments to water and biodiversity.**
   Activate corporate climate, water, and biodiversity commitments to increase investments in EoF practices as a cost-effective strategy to improve the sustainability of supply chains.

8. **Harness and extend efforts to rebuild soil health to recognize the vital role of EoF in working landscapes.**
   Learn from and build upon the success of the soil health movement to grow awareness of the essential role of EoF practices to the vitality of working landscapes.

9. **Harmonize and coordinate national agriculture policy.**
   Improve alignment of national policies to increase the efficacy of public investment in working lands and ensure the economic and ecological viability of the agricultural sector into the future.


VEGETATED RIPARIAN BUFFER
DRAINAGE WATER MANAGEMENT
TWO-STAGE DITCH
PRAIRIE STRIP
WETLAND
Leading at the Edge
Advancing Edge of Field Practices

Installing edge of field practices on farmland provides multiple benefits to farmers, communities, and nature.



◀ ©TNC (Illustration by Liam Munroe)
■ Prairie strips © NRCS/SWCS photo by Lynn Betts

INTRODUCTION

Agricultural nutrient loss in the U.S. is a complicated and pervasive problem that results in degraded soil health and water quality. In addition, while nutrient use efficiencies of row crops have been improving, expansion of cropland and the resulting synthetic fertilizer use contribute to most of the nitrous oxide emissions in the U.S. exacerbating climate change (Cavigelli et al. 2012). While the context is complex, this issue can be solved, and a broad array of partners are working to develop strategies and advance solutions across the agricultural landscape. Awareness and concern about agricultural nutrient loss and the escalating economic and weather-related challenges faced by producers are growing, resulting in increasing stakeholder interest in developing solutions that benefit producers and the environment.

Concurrently, a body of research is developing on the efficacy of edge of field (EoF) practices to offer solutions (for a description of edge of field practices, see Box 1). These developments provide momentum for EoF practice adoption. The Edge of Field Roadmap is the result of deliberations by a group of U.S. agricultural and conservation leaders from across sectors who see an opportunity for coordinated and concerted action to foster the needed landscape-level change.

This Roadmap is grounded in the latest science, a deep understanding of key policy approaches, and careful exploration of the main structural barriers and challenges to addressing nutrient and sediment runoff from agriculture. In developing the Roadmap, participants used a systems approach to evaluate and select policy and programmatic interventions that work synergistically and minimize unintended consequences. More about the people and organizations behind the Roadmap can be found on page 4.

The Roadmap offers nine synthesis recommendations that—if acted upon—would motivate EoF practice adoption at scale. The scaling of these practices in watersheds and sub-watersheds would lead to dramatic reductions in agricultural nutrient loss and improve downstream water management (Mclellan et al. 2015). Achieving this scale will not be easy, but it can be done. The Edge of Field Roadmap provides a guide for how this change can be brought about on working lands across America.

Edge of Field Practices

Edge of field (EoF) practices are designed to slow, filter, and process both surface and subsurface runoff from farm fields.

Filtration practices include vegetated and riparian buffers, filter strips, and restored wetlands. These practices slow down surface runoff and capture nutrients and sediments before they reach lakes, streams, or rivers.

In agricultural watersheds with extensive subsurface drainage networks, tile drains are a significant pathway for nitrate and dissolved phosphorus loss. Conservation drainage practices such as bioreactors, saturated buffers, and constructed wetlands are designed to intercept tile flow and provide the conditions needed for nutrient assimilation and retention.

Once established, these practices require little hands-on management. In addition to their water quality benefits, many EoF practices can provide additional ecosystem service benefits including carbon storage, pollinator and wildlife habitat, flood water storage, and streambank stabilization. They are one part of a whole-systems approach to developing regenerative agriculture that also includes in-field soil health and nutrient management practices, as well as downstream floodplain protection and restoration efforts.

This report provides background information about non-point source water pollution and a theory of change for promoting prosperous farms, clean water, and resilient communities on a landscape-scale. It includes a scientific literature review that summarizes our current state of knowledge about EoF practices. This review is intended to add to the current knowledge base and awareness about what EoF practices are, their costs and benefits, and how they can be integrated into whole-farm and landscape-scale approaches to conservation. We also include an analysis of current policies in place at the federal, state, and local levels that can be used to incentivize agricultural conservation practices. Although this report is focused on the use of EoF practices for row crop operations, EoF practices are also beneficial for livestock and diversified production.

A policy analysis grounds the Roadmap recommendations in an understanding of what incentives and programs are currently in place, how they work together to promote conservation, and where gaps exist. Lastly, we present our nine synthesis recommendations for landscape-scale change, developed collaboratively with partners and informed by the science and policy reviews. Together, these pieces provide a comprehensive understanding of what EoF practices are, how they work, what incentives currently exist, and what is needed to significantly expand adoption across working lands.

BACKGROUND

Water pollution is a serious environmental and health issue in the United States (USEPA 2017a, Vedachalam et al. 2018). Non-point source (NPS) pollution from agricultural nutrient run-off is a leading cause, impacting both surface and groundwater quality (USEPA 2017b). A number of factors contribute to agricultural nutrient loss, including the timing and quantity of fertilizer use (Ribaudo et al. 2011), a lack of crop diversity, and tile drainage (King et al., 2015). Additionally, the loss and degradation of wetlands and floodplain forests in the United States, primarily from conversion to agriculture, has compounded this problem and reduced the capacity of ecosystems to mitigate agricultural impacts on various ecosystem services, including water quality and biodiversity (Dahl 1990). Unlike point source pollution, NPS is not directly regulated by the Clean Water Act. Instead, voluntary conservation is the United States' main policy approach to address agricultural NPS. On a federal level, the farm bill, through the conservation title, is a key driver of voluntary conservation. The conservation title provides billions of dollars in financial and technical assistance to help producers install conservation practices on their land. Even so, this public investment is insufficient to address NPS water pollution at scale (Ribaudo 2015). The reasons are three-fold:

1. Insufficient public funds to address the number of resource concerns on working lands;
2. Patchwork of practices where a watershed approach is needed; and
3. Lack of incentives (social and economic) for many producers to adopt conservation practices in the first place (Prokopy et al. 2019).

In addition to farm bill programs, a variety of policies and initiatives are used at various levels of government and increasingly throughout the supply chain to improve environmental outcomes related to agricultural production. The relative efficacy of these approaches depends on a host of factors, including funding, enforcement, political saliency, organizational leadership, land ownership, and producer engagement. In the absence of national, legally binding pollution reduction requirements, no approach has yet resulted in nutrient reductions at the scale necessary to address NPS pollution nationwide.

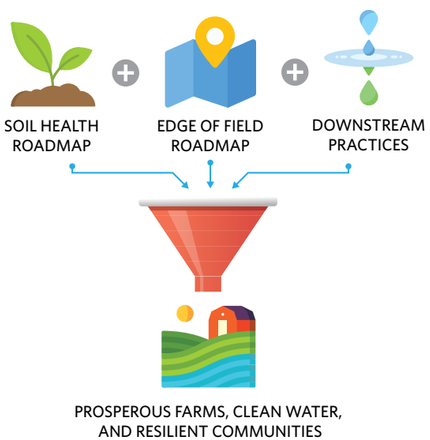
At the same time, we know that conservation practices are effective at reducing agricultural nutrient loss and providing co-benefits. In-field practices, such as planting cover crops, decrease nitrogen (N) and phosphorus (P) loss, as well as provide co-benefits such as increased soil carbon sequestration (Magdoff and van Es 2010). Likewise, EoF practices such as constructed wetlands, vegetated buffers, and grassed waterways are effective at reducing N and P losses. Consensus is growing that both nutrient management (in-field) and nutrient removal practices (edge of field and downstream) are needed in order to meet nutrient reduction goals (Mclellan et al. 2015). Further, research shows that improving environmental outcomes at scale requires strategic targeting of conservation practices to address nutrient loss from agriculture at the sub-watershed- and watershed-levels (USDA NRCS 2017).

THE BUILDING BLOCKS FOR REGENERATIVE AGRICULTURAL LANDSCAPES

Based upon scientific research, The Nature Conservancy (TNC) has identified three categories of conservation strategies that, when deployed in concert, can significantly reduce nutrient loss, rebuild soil health, enhance habitats, and improve resilience. The Soil Health Roadmap, developed by TNC in 2016, represents the first component of this comprehensive strategy. The Edge of Field Roadmap is the second component of the strategy; it focuses on nutrient removal at the field and farm level. The third component focuses on floodplains and other downstream nutrient removal and water management strategies; TNC launched the Floodplain Prioritization Tool in the Mississippi River Basin to inform floodplain protection and restoration. Together, the Soil Health Roadmap, the Edge of Field Roadmap, and the implementation of improved downstream practices will work to promote prosperous farms, clean water, and resilient communities on a landscape-scale, as depicted in Figure 1.

The Edge of Field Roadmap is a critical step in this vision for systems-level change. The nine synthesis recommendations outlined in this report work together to promote EoF practice adoption at scale, significantly reduce agricultural nutrient loss, and improve water quality downstream.

Figure 1. Theory of Change



▲ *University students view a constructed wetland used to control field runoff during a farm tour. © Timothy T. Lindenbaum/TNC*

OVERVIEW

THE EOF ROADMAP DEVELOPMENT PROCESS AND THE ROLE OF PARTNERS

TNC, Soil and Water Conservation Society (SWCS), and Meridian Institute designed and co-convened an interactive, virtual meeting series whereby a diverse group of partners collaboratively developed actionable recommendations to drive adoption of EoF practices. Staff conducted a scientific literature review, which assessed the current state of knowledge about EoF practices. The team also analyzed current policies in place at the federal, state, and local levels to incentivize agricultural conservation practices.

More than two dozen EoF Roadmap Partners were engaged in this process. They included senior leaders from agriculture, the supply chain, civil society organizations, and government. They are producer leaders and early adopters of EoF practices; representatives from environmental and conservation NGOs, commodity groups, professional associations, and private companies; and former government officials. A list of Partners can be found in the Acknowledgements on page 4.

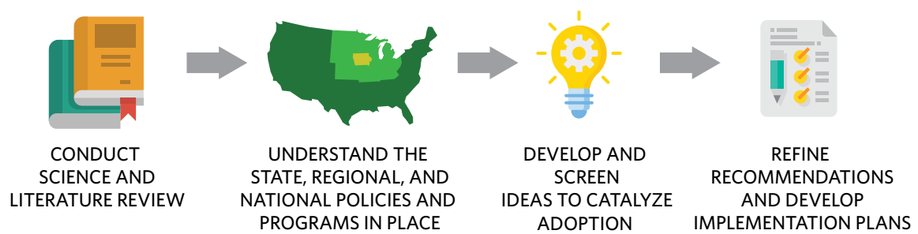
The Partners represent a range of agricultural geographies, levels of work (local, regional, and national), and experiences with EoF practices, policies, and programs. They are actively engaged in promoting the adoption of EoF practices, with specific knowledge about conservation practices, barriers to adoption, and examples of what is working across the landscape.

Over the course of six months in 2020, the Partners met virtually to:

1. Understand the science underpinning EoF practices, including what we know and do not know about their efficacy.
2. Understand the policies and programs in place that either encourage or discourage EoF practice adoption.
3. Develop and screen ideas to catalyze adoption.
4. Refine recommendations and develop implementation plans, including how to communicate the Roadmap to different audiences.

This Roadmap is the result of their engagement and commitment to fostering landscape scale change to promote prosperous farms, clean water, and resilient communities.

Figure 2. Roadmap Design Process



SCIENTIFIC LITERATURE REVIEW – EDGE OF FIELD CONSERVATION PRACTICES

EoF conservation practices are designed to slow, filter, and treat surface and subsurface runoff from agricultural fields and play an important role in keeping waterways clean and healthy. They are one component of a whole-systems approach to regenerative agricultural landscapes that includes in-field soil health and nutrient management practices, as well as efforts to protect and restore downstream floodplains, forests, and other natural infrastructure.

EoF practices are typically located outside the cropping area, and their establishment requires that producers set aside (or potentially remove from production) land adjacent to waterways. In the past, many farmers have been reluctant to adopt EoF practices because of the perception that they do not provide the on-farm benefits that some in-field practices can provide. Nevertheless, research and monitoring data show that many EoF conservation practices provide significant water quality improvements while also providing critical ecosystem service benefits, such as pollinator and wildlife habitats, flood storage, and streambank stabilization. Further, the long-term nature of these practices means benefits accrue over many years, making them a cost-effective conservation infrastructure investment.

A range of EoF options are available for implementation on the landscape, from simple vegetated buffers to highly engineered structural practices, such as constructed wetlands and drainage water recycling systems. Some practices are common and well-studied, while for others, understanding of performance and best placement is still evolving. To inform the EoF Roadmap development, TNC team reviewed scientific literature on established and emerging EoF conservation practices to assess their effectiveness for reducing nitrate-nitrogen (NO_3-N), total phosphorus (TP), dissolved reactive phosphorus (DRP), and sediment losses from agricultural lands. As part of this effort, practice costs, adoption barriers, and potential water quality co-benefits associated with each practice were also documented. The menu of EoF options provided in this document is organized to help Roadmap users quickly evaluate potential actions based on practice effectiveness, cost, and co-benefits (see Table 1). A comprehensive summary of the literature review is available as a supplement to the Roadmap.

Table 1. EoF Practice performance, cost-effectiveness, and expected co-benefits

Practice	Body of Literature	Effectiveness (Median % Removal)				Estimated Annual Cost Effectiveness			Co-Benefits
		Nitrate-nitrogen	TP	DRP	Sediment	Nitrogen ($/kg)	Phosphorus ($/kg)	Sediment ($/metric ton)	
Vegetated buffer*	Robust	84.5	78.0		87.5	$3.59-$4.21[1,2]	$26.40-$30.90[1,2]		
Grassed waterway	Limited	-	11.0	-	87.0	-	$562-$1,124[3]	$2.08-$158[3]	
Prairie strip	Growing	67.0	90.0	-	96.0	$1.59-$2.34[4]	$6.97-$10.25[4]	$7.79-$11.46[4]	
Wetland (Restored)	Robust	39.0	41.0		27.0	$0.06-$14.54[5]			
Wetland (Constructed)	Robust	44.0	44.0	62.0	50.6	$1.80-$4.40[6]			
Bioreactor	Growing	39.8	-	-	-	$1.10-$3.80[6]	-	-	
Saturated buffer	Growing	61.0	-	-	-	$1.76-23.13[7]	-	-	
Controlled drainage	Robust	38.5	-	-	-	$1.70-$4.50[6]	-	-	
Two-stage ditch	Limited	7.5	40	11	22	$4.61-$11.63[8]	$1.59-$470[3]	$1.14-$104[3]	
Phosphorus filter	Limited	-	-	40.0	-	-	$110-$1,102[9]	-	
Drainage water recycling	Limited	34.4	24.0	18.0	-				
Tailwater recovery system	Limited	54.5 (TN)	45.5	45.0	66.5	$0.13-396[10]	$0.61-3,316[10]	<$1-$770[10]	

Co-Benefits Key: : wildlife : pollinators : water storage : carbon storage : crop yield

(1) IEPA, IDOA, and IWRC 2015; (2) IDALS, IDNR and ISU 2013; (3) Tetra Tech Inc. 2019; (4) Tyndall et al. 2013; (5) Hansen et al. 2015; (6) L. Christianson et al. 2013; (7) Kult and Klein 2018; (8) Roley et al. 2016; (9) National Soil Erosion Research Laboratory 2017); (10) Omer et al. 2019

* Vegetated buffer values are for practices implemented on non-tile drained land.

▲ *Prairie strips provide diverse flowering plants, like this black-eyed Susan, to agricultural landscapes, which are essential for supporting and conserving pollinators. © NRCS/SWCS photo by Lynn Betts*

REVIEW METHODOLOGY

To best allow for comparison among EoF practices, the practice performance review focused on a narrow suite of parameters that are commonly reported across a range of studies, including percent removal of nitrate-nitrogen, total phosphorus, dissolved phosphorus, and sediment. The scope was limited primarily to peer-reviewed studies. However, in some cases, for example, to obtain information on practice costs and implementation levels, it was necessary to consult federal and state agency reports, white papers, and university extension publications. Additionally, the review was limited to studies of individual practice performance. While there is great interest in understanding water quality benefits that can be achieved by "stacking" practices, analysis of multi-practice application prevented comparison across studies and was therefore outside the scope of the review.

The following types of information were summarized for each practice:

- **Body of literature:** The body of literature available on each practice varies. We characterized the body of literature available as "robust," "growing," or "limited" to help demonstrate confidence in reported performance and cost values. The colors in the table reflect these characterizations.
- **Practice effectiveness:** As an estimate of practice effectiveness, we report the median percent removal of nitrate-nitrogen (NO_3-N), total phosphorus (TP), dissolved reactive phosphorus (DRP), and/or sediment from published literature. We selected the median as the summary metric because practice effectiveness was not consistently reported across the full range of studies. For each study, we recorded the mean percent removal and/or the minimum and maximum percent removal, then identified the median of these reported values.
- **Cost effectiveness:** Cost-effectiveness values are taken from the literature, agency, and university extension reports. They are based on practice installation and maintenance costs, land retirement costs, and reported performance over the life of the practice, but were not all calculated using the same methods. For ease of comparison, cost effectiveness is reported in dollars per unit of pollutant removed/retained. Estimates of cost effectiveness were not available for some practices.
- **Co-benefits:** Some practices provide a range of benefits beyond water quality that make them even more valuable for our agricultural landscapes and the ecological and human communities living downstream. Further, our ability to identify and assign value to these benefits can provide more opportunities to incentivize EoF practice implementation. For this effort, we classified benefits to wildlife and pollinators (habitat), water and carbon storage, and benefits to farmers in the form of a crop yield increase.

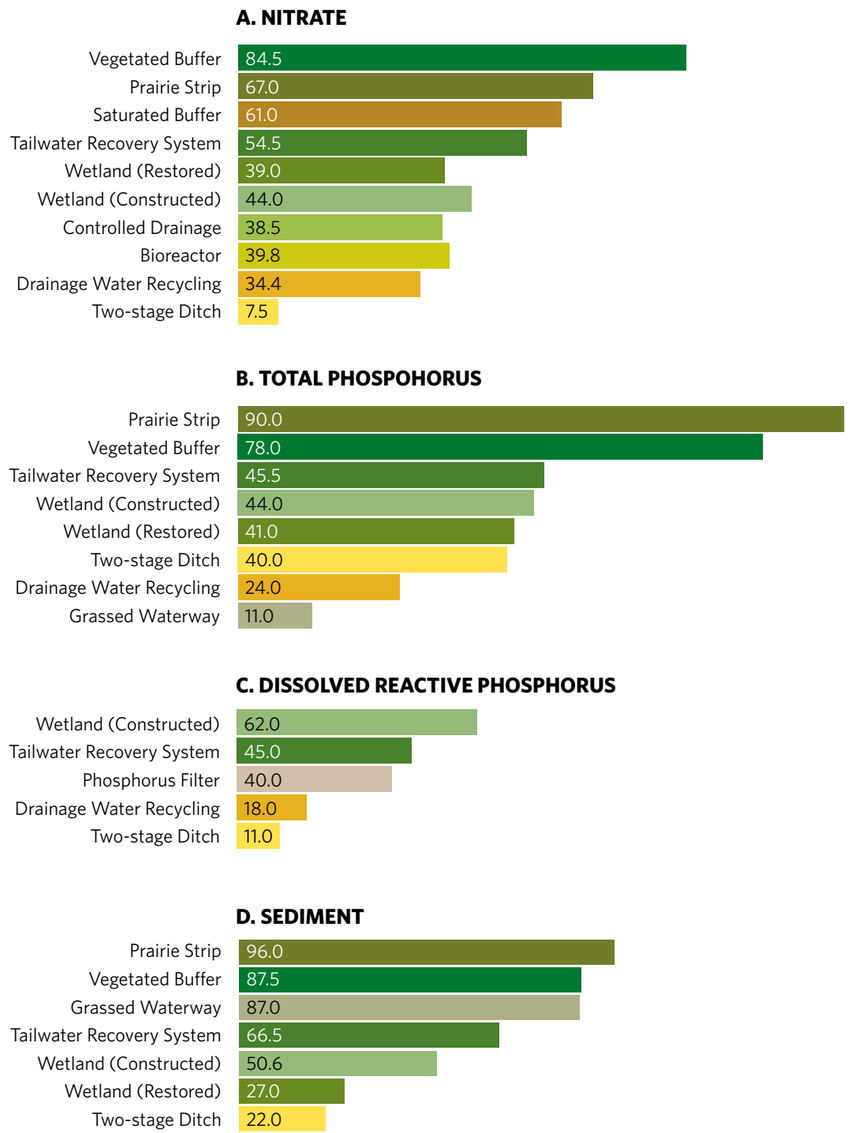
Table 1 includes a series of dash (-) marks and blank cells. As all practices are designed to address specific resource concerns, dash marks (-) indicate that a water quality benefit is not expected to occur with the addition of a practice (e.g., controlled drainage is not expected to reduce sediment loss). A blank cell indicates a data gap.

A limitation of this review is that while practice effectiveness is typically assessed at the field or small catchment scale over relatively short time periods, users of this Roadmap are likely most interested in performance at larger scales and over longer time periods. As we work to scale up the adoption and implementation of EoF practices, note that performance at the practice scale may not correlate with performance at the watershed scale due to impacts from other variables such as land cover, precipitation patterns, hydrology, and other landscape characteristics.

EDGE OF FIELD PRACTICES BENEFIT WATER QUALITY

Published literature shows that EoF practices vary in their effectiveness for NO_3-N (7.5-84.5%), TP (11-90%), DRP (11-62%), and sediment (22-96%) removal (Figure 3A-D). Producers then have flexibility to choose the EoF practice(s) that best address their resource concerns, are technically feasible on their farms, and complement their in-field and whole-farm management decisions. Of the practices reviewed for this effort, more established practices like vegetated buffers and wetlands are highly effective options for treating multiple resource concerns, while others such as bioreactors and phosphorus filters are designed to target much more specific nutrient loss pathways (e.g., NO_3-N and DRP respectively).

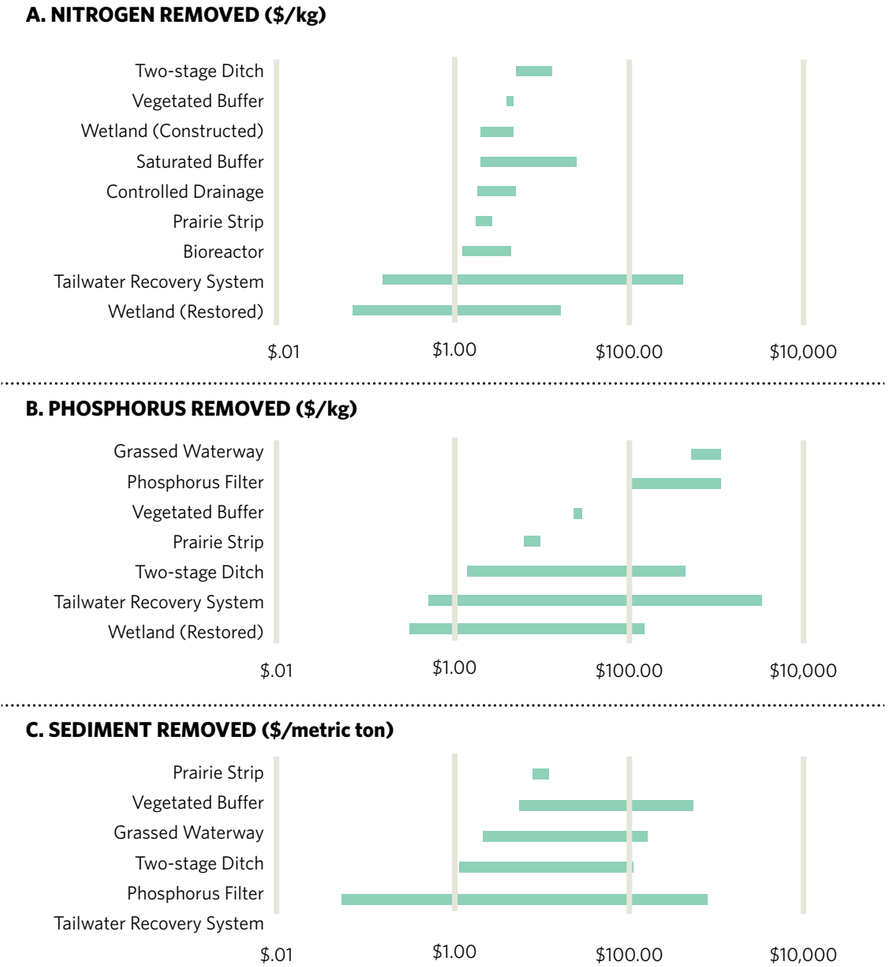
Figure 3A-D. Literature-reported values of EoF practice performance (median percent pollutant removal)



EOF PRACTICES ARE COST EFFECTIVE OPTIONS FOR REDUCING NUTRIENT LOSSES

Published data show that EoF practices are generally cost-effective options for reducing nutrient losses when they are properly sited, designed, installed, and maintained (Figure 4A-C). For some practices, there are large ranges in cost effectiveness values—particularly those practices requiring more extensive engineering and earth-moving (e.g., wetlands, tailwater recovery systems) and those with sparser and/or more variable performance data (e.g., two-stage ditches, grassed waterways). When considering practice costs, note that EoF practices tend to have larger up-front installation costs, but that they provide nutrient reduction benefits over a long period of time, many without extensive hands-on management. For comparison, the average reported cost effectiveness of a cover crop, which requires an annual commitment from a producer and favorable conditions for implementation, is $11.46/kg nitrate removed and $132.28/kg phosphorus removed each growing season (IDALS, IDNR, and ISU 2013).

Figure 4A-C. Cost-effectiveness of EoF practices for nitrogen, phosphorus, and sediment removal



EOF PRACTICES PROVIDE ADDITIONAL BENEFITS FOR PEOPLE AND NATURE

EoF practices provide a range of additional co-benefits for natural and human communities. For example, maintaining buffers wider than ten meters along streams has been shown to improve stream health and riparian corridor habitat (Sweeney and Newbold 2014; Lind et al. 2019). Restored and constructed wetlands also provide important biodiversity value, along with opportunities for flood and carbon storage. In studies of prairie strips, primarily implemented in Iowa, researchers have recorded notable increases in plant species diversity; crop pest predator, honey bee, monarch and abundance; and native bird species richness and abundance (Hernandez-Santana et al. 2013; Zhou et al. 2014). Drainage water recycling and tailwater recovery systems, which help provide producers with more control over their water management, can pay off through increased crop yields and reduced reliance on groundwater resources. For drainage water recycling, researchers have documented yield increases ranging from 28-91% for corn and 25-49% for soybeans in dry years (Tan et al. 2007; Allred et al. 2014)

Implementation of conservation and stewardship practices at the edges of farm fields represents a crucial, but underutilized, conservation opportunity to reduce nutrient and sediment loss from farm fields and restore functional landscape features that benefit people and nature.

A **vegetated buffer** provides a transition zone between the crop field and a water feature. Vegetation growing in the buffer slows surface runoff, filters out pollutants, and reduces bank erosion. Examples include filter strips, field borders, and riparian buffers.

© USDA Natural Resources Conservation Service

A **constructed wetland** is an engineered ecosystem designed to optimize specific wetland characteristics and functions to improve water quality. Constructed wetlands can be designed to treat surface and/or subsurface flows.

© USDA-NRCS, photo by Jason Johnson

A **two-stage ditch** is a trapezoidal drainage ditch with added floodplain benches that slow water flow and promote sediment and nutrient retention and bank stability.

© ColdSnap Photography

A **grassed waterway** is an erosion control practice that provides a stabilized flow path for water through a farm field.

© Jason Johns/Iowa USDA-NRCS

A **woodchip bioreactor** removes nitrates from tile drainage flows. Its small footprint makes it an attractive option for farmers who want to limit land taken out of production.

© SWCS/IDALS, photo by Lynn Betts

A **phosphorus filter** is an emerging technology that intercepts runoff and filters it through a sorption medium such as steel slag to remove dissolved phosphorus. Phosphorus filters are intended for targeted locations with high dissolved phosphorus loading.

© TNC

Prairie strips integrated with or planted at the edge of crop fields reduce nutrient and sediment loss while benefitting birds, pollinators, and other wildlife.

© NRCS/SWCS photo by Lynn Betts

A **saturated buffer** resembles a traditional buffer, but it is designed to capture and treat water from underground tile drains. As water seeps slowly through the buffer, high organic matter in the soil promotes denitrification.

© NRCS/SWCS, photo by Lynn Betts

A **drainage water recycling system** captures and stores water that would otherwise leave the farm through the tile drainage system. It allows an operator to use the stored water to irrigate crops when there is a water deficit.

© Purdue University, ConservationDrainage.net/MediaLibrary

A **restored wetland** recreates, to the extent possible, the hydrology, topography, native vegetation, processes, and functions of a historically occurring wetland.

© Don Poggensee

A **controlled drainage system** allows a farmer to manage the water levels in the field. When the volume of water leaving the field through tile drains is reduced, nutrients are also retained. In some years, a controlled drainage system can provide a small yield bump.

© NRCS/SWCS, photo by Lynn Betts

A **tailwater recovery system** allows an operator to capture and reuse water from irrigation. It decreases reliance on groundwater supplies for irrigation and reduces agricultural nutrient losses to surface waters.

© Jeff Vanuga/USDA

REMAINING RESEARCH NEEDS

Future research on EoF practices should address the technical aspects affecting practice performance and support the development and delivery of information that enables implementation at scale.

- **Practice performance:** Technical, practice-focused research is needed to understand the long-term water quality and ecosystem service benefits associated with EoF practice implementation, including their performance under future climate scenarios, which may require management of increased and/or unpredictable flow events. This research can lead to improvements in siting and design criteria to make the practices more effective.
- **Practice stacking:** Additional research is needed to fully understand the costs and benefits associated with the implementation of multiple practices at the field, farm, and watershed scales. This information can help practitioners recommend appropriate combinations of infield and EoF practices that cost-effectively achieve desired nutrient loss reductions while meeting each farmers' business and conservation objectives.
- **Performance metrics:** Research that builds on the environmental benefits of EoF practices is needed to accelerate the development of consistent tracking and verification metrics. Common metrics are important for evaluating the impacts of EoF practices across programs and geographies, for enabling valuation of benefits through the supply chain, and for supporting a process for compensating farmers for their efforts to provide ecosystem service benefits such as clean water and wildlife habitat.
- **Social science:** Continued efforts to understand barriers to EoF adoption, along with the messages and messengers, outreach strategies, and incentive packages that farmers respond to are needed to increase the rate and scale of EoF practice adoption.
- **Evaluating lessons learned:** Analysis of landscape-scale program interventions is needed to understand key factors contributing to success. The lessons learned from successful programs can provide valuable insights about how best to replicate and transfer initiatives to new watersheds.

▲ *Constructed wetlands improve water quality by reducing sediment, nutrients and pesticides in runoff. © Martin Pena/USDA*

THE ROLE OF POLICY

Policy is a key driver of conservation practice adoption. During the Roadmap development process, policies at the national, regional, and local levels were identified that are used or can be used to support EoF implementation through financial and technical assistance, research and technology, and market innovations. For example, farm bill conservation programs are a key policy strategy funded at the national level; the state Nutrient Reduction Strategies arising out of the efforts of the Gulf Hypoxia Taskforce* are one of the few prominent regional examples; and Minnesota's Buffer law is the first state mandate requiring buffers along all public waterways and ditches. Although not exhaustive, the policies identified in this review represent the main approaches currently in place to support EoF implementation, each with varying levels of efficacy and impact. A matrix of the curated policies by category considered in this review can be found in Appendix A.

Table 2. Example from the Policy Matrix used to evaluate existing conservation incentive programs. For the full Policy Matrix, see page 46.

Scale	Regulatory	Quasi-Regulatory Approaches	Voluntary	Market-Based	Research	Technology
Federal/ National	Clean Water Act 303(d) (TMDLs)	Conservation compliance (farm bill)	Farm bill conservation programs: EQIP, CSP, RCCP, CRP, CIG, etc.	CIG grants supporting Ecosystem services markets	USDA: NIFA, NRCS CIG CEAP, ARS, Extension, SARE	NSF engineering grants

WHAT POLICY STRATEGIES ARE NEEDED TO ACHIEVE SIGNIFICANT NITROGEN AND PHOSPHORUS REDUCTIONS?

The policy analysis provides a shared understanding of the policy landscape, which is key to developing solutions that scale EoF practices by better utilizing existing policy tools, improving alignment with sustainable supply chain efforts, and identifying gaps and areas where improvement is needed. The program and policy review revealed the following insights:

- Federal policy and funding are a driving force and focus on incentivizing voluntary conservation. Both the farm bill and crop insurance titles are key levers that influence what practices are adopted on the agricultural landscape.
- Regional collaborations are underrepresented. Much of the funding related to EoF practices is from the federal government and disbursed at the state level, although there have been some innovations in recent farm bills to push for regional approaches. Given the movement of agricultural nutrient loss across political boundaries, emphasizing watershed scale solutions was key in the development of the Roadmap recommendations.
- There are many redundancies and disaggregation in policies enacted by the federal and state governments. This is likely due to a lack of overarching, unifying federal policy that provides a strategic approach with measurable outcomes to address environmental issues related to working lands.
- Sustainable supply chains and ecosystem services markets are poorly supported by policy and public funding. However, a resurgence in the development of robust ecosystem services markets could create financial incentives for EoF practice adoption that would benefit from policy alignment and support.

Clearly, existing policy approaches have not been effective in addressing NPS, and current levels of practice implementation are not achieving agricultural NPS reduction at scale. Consequently, keeping in mind a set of screening "principles" (see below), Roadmap Partners evaluated current policy strategies, how to improve them, and what new policies may be needed given the implementation challenges associated with EoF practices. Building this understanding of current policy approaches informed the composition of each of the Roadmap pillars and, ultimately, the EoF Recommendations.

**Note: The Gulf of Mexico Hypoxia task force seeks to achieve a 41% reduction in nitrogen inputs and a 29% reduction in phosphorus inputs to the Gulf by 2035. Several states in the Midwest have adopted this goal in their nutrient loss reduction strategies in order to limit the hypoxic area in the Gulf to 5000 sq. km. (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2008)*

CHALLENGES AND PRINCIPLES

The Roadmap process identified challenges to scale (Table 3), summarized below, that must be addressed in order to increase adoption and implementation of EoF practices. Not surprisingly, these challenges or barriers apply to adoption of conservation practices in general.

To help evaluate the efficacy of policy approaches, the following screens were used to assess the policy landscape and identify key policy gaps. Ultimately, these considerations were used to guide the development of the final recommendations.

Table 3. Challenges to scaling up adoption of EoF practices

Challenges to Scale
Financial Resources or Lack of Economic Incentives: EoF practices can be expensive to install. Simply funding installation may not provide enough incentive for implementation, and current funding sources are insufficient.
Technical Assistance Availability: EoF practices can be complex to install, requiring engineering and other technical expertise that is often in short supply.
Social Attitudes: Social attitudes and motivations beyond economics play a key role in whether or not conservation practices are implemented. Understanding motivations of producers is, therefore, essential to policy design.
Policy Misalignment: Policies are not designed to work in concert to reduce risk and improve environmental and yield outcomes.
Lack of Data/Performance Metrics: Current programs do not require or measure outcomes, hindering an understanding of how well practices perform on the landscape.

In evaluating polices as part of the recommendations development process, a set of screening principles, summarized below in Table 4, were applied to identify what policy interventions are needed to overcome implementation challenges.

Table 4. Principles used to screen policy options for scaling EoF practice adoption

Screening Principles
Durability: Will the policy result in long-lived solutions?
Cost/Benefit: Is the policy cost-effective?
Measurability: What are the on-the-ground impacts of the policy?
Feasibility: Does the policy result in practice implementation that is practical for producers and technical assistance providers?
Scalability: Does the policy result in practice implementation on a landscape or watershed level?
Synergistic: Will the policy strategy work well with and complement other strategies in order to multiply benefits?
Co-Benefits: Will the policy result in other benefits?

THE ROLE OF MARKETS

Public dollars alone are insufficient to fund EoF practice implementation. Significant private equity is needed both through public-private ventures and corporate investments to scale EoF across the landscape. In fact, EoF practices may lend themselves to private funding mechanisms given their structural nature, which makes them durable and their impacts easier to measure. Several avenues of market development include ecosystem markets for clean water, habitat, and carbon removal; innovative finance instruments such as "green bonds" for municipal water systems; and emerging corporate commitments about water quality. Monetizing the various services that EoF practices provide is necessary to fully measure their value and to make the economic case to producers and payers (e.g., corporations, municipal water systems) of their cost-competitiveness.

Policy and science have important roles in accelerating private investment. Aligning policy with ecosystem market development would remove unnecessary barriers and provide a base of public investment. For example, linking farm bill subsidy payments to producer behavior that reduces risk such as EoF implementation could be matched with corporate investment to provide revenue to make such practices attractive to producers. Further, increasing public funding for research and technology transfer to better understand the impacts of EoF practices, alone and in combination with other conservation practices, is needed to better target practice implementation and cost-effectively measure outcomes.

Notably, several of the Roadmap Partners work at the leading edge of innovative finance for green infrastructure investments such as EoF practices. Their expertise helped inform the core Roadmap recommendations related to making the economic case for EoF practice implementation.

Ecosystem Services Market Consortium

The Ecosystem Services Market Consortium has been successful in organizing sector-wide dialogues, pilot projects, and working groups to develop protocols and a platform for launching a voluntary national ecosystem services market to sell carbon and water quality and quantity credits for the agriculture sector by 2022. This initiative is notable because it is not only focsed on generating carbon credits, but also credits from land stewardship practices that benefit water quantity and quality, habitat enhancement, and biodiversity.

▲ *Aerial view of a restored wetland. © Lynn Betts/USDA*

EoF practices can improve water quality, store more carbon, reduce flooding, support pollinators, and provide wildlife habitat connectivity in working landscapes.

THE EDGE OF FIELD ROADMAP

INTRODUCTION TO THE ROADMAP FRAMEWORK: PILLARS, GOALS, AND CROSS-CUTTING THEMES

In order to begin collaboratively developing the Roadmap recommendations, we first set out to define the Roadmap's pillars and goals. The "pillars" of the Roadmap are the critical elements that, in concert with one another, can create landscape-scale change. In order to successfully expand adoption of EoF practices, we must address the:

1. **Economics of conservation,** including the value proposition for producers and others along the value chain, including consumers;
2. **Capacity to implement conservation programs,** including the technical assistance needed to design, build, and maintain EoF practices; and
3. **Culture of production agriculture,** including how taking land out of production is perceived within rural communities.

This Roadmap is designed to elevate recommendations that address the core elements of these foundational pillars.

For each of the Roadmap pillars, Partners identified key goals to help achieve a pillar's purpose and shape the development of specific recommendations (Figure 5). In practice, the pillars and goals overlap and inform each other. For example, a fundamental challenge that hinders progress across all three pillars is the lack of an overarching national, coordinated agriculture policy. U.S. agriculture policy, of which the farm bill is a main component, is an accretion of policies, not a cohesive legislative effort with clear purposes designed to achieve specific goals. As a result, progress in improving environmental outcomes on working lands is slow and uncoordinated.

In addition to the Roadmap pillars and goals, Partners stressed cross-cutting themes that are critical to achieving each pillar's goals. Throughout the Partner convenings to develop this Roadmap, these three themes – science, technology, and data; aligned policies and programs; and communications and outreach – were repeatedly discussed and emphasized as integral to a coordinated effort to expand EoF practice adoption.

The following section describes the Roadmap pillars, goals, and cross-cutting themes in more detail, before presenting the Roadmap's nine synthesis recommendations.

Figure 5. The Roadmap's pillars, goals, and cross-cutting themes.

PILLAR ONE: BUILD THE ECONOMIC CASE	PILLAR TWO: BUILD CAPACITY TO IMPLEMENT	PILLAR THREE: ELEVATE A CULTURE OF CONSERVATION & INNOVATION
GOALS • Develop market-based solutions. • Increase & better target public investments. • Integrate EoF practices within whole-farm operations as a tool to diversify farm income &/or enhance financial risk management.	**GOALS** • Develop a coordinated, national plan for agriculture policy. • Promote & enable watershed-level & regional planning & leadership. • Invest in diverse & flexible technical assistance.	**GOALS** • Build a shared understanding among farmers & their partners of the role of EoF practices as part of a systems approach to improving conservation & water management. • Harness the momentum & capacity of groups already working with producers on in-field practices. • Activate farmers, stakeholder groups, & other leaders who can influence & overcome barriers to adoption.
CROSS-CUTTING THEMES: • Science, technology, & data	• Aligned policies & programs	• Communications & outreach

◀ *Prairie strip © NRCS/SWCS photo by Lynn Betts*

ROADMAP PILLARS AND GOALS

The pillars and goals of the Roadmap are the critical elements to catalyzing largescale EoF practice adoption. Identifying these pillars and goals was the first step in developing the Roadmap's synthesis recommendations.

PILLAR ONE: BUILD THE ECONOMIC CASE

Building the economic case for producers and other stakeholders to implement EoF practices is critical for any effort to expand adoption. Farm budgets are already strained, and the ability of producers to be profitable in their farming operations is a precondition for them to make any change in their practices. Furthermore, since the construction of EoF practices often requires the retiring of production land, and EoF practices do not directly confer on-field benefits to soil health or crop yield, it is imperative to create economic incentives for adoption. The goals to achieve this pillar are:

- **Develop market-based solutions.** The importance of market-based solutions is highlighted by the reality that even when 100% cost-share is offered, many producers still do not enroll in programs to expand conservation practice adoption. Market-based solutions may be more effective in engaging some producers because government programs have additional programmatic requirements and paperwork burdens, and many farming communities have a cultural distrust of government programs.
- **Increase and better target public investments** to expand EoF adoption in ways that are strategic, effective, and encourage state, local, and private investment through cost-share matching. Public dollars should be used more explicitly to pay for the public goods created through EoF practices.
- **Integrate EoF practices within whole-farm operations as a tool to diversify farm income and/or enhance financial risk management.** Depending on the practice, adopting EoF practices can provide environmental co-benefits such as flood/drought mitigation, water quality benefits, and wildlife habitat. Adopting EoF practices can be part of a whole-farm financial risk management strategy if producers are able to transition unprofitable farmlands to an EoF practice and/or stack EoF practice incentives to provide a diversified income source.

Improving Farm Profitability through EoF and Precision Agriculture in Colquitt County, Georgia

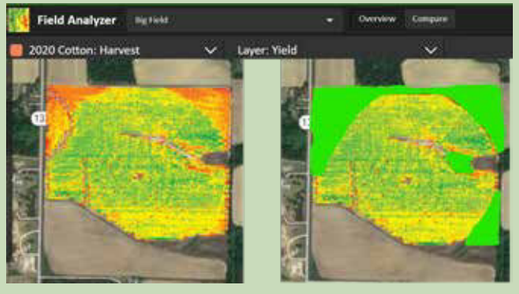
Davis Family Farm, located in Colquitt County Georgia grows cotton, peanuts, and corn, and manages registered and commercial angus cattle. They began working with Quail Forever's Precision Ag and Conservation Solution Program in 2019 to analyze 3 years of yield data stored in the John Deere Operations Center. This program in Georgia is made possible through a partnership with Cotton Incorporated, National Fish and Wildlife Foundation, USDA Natural Resources Conservation Service, American Society of Agronomy and Quail Forever.

After working with Chaz Holt, QF Precision Ag and Conservation Specialist, the Davis Family Farm applied for Natural Resources Conservation Service Conservation Stewardship Program (CSP) on 1,274 acres. They chose CSP enhancements including conservation tillage, cover crops and 17.5 acres of pollinator habitat to address revenue negative zones on their dryland irrigation pivot corners. The pollinator habitat will be planted in spring 2021.

The adoption of the 17.5 acres of Edge of Field pollinator practice on just one 85-acre field increased their whole field profitability from $86 per acre to $170 per acre.

	Before	After
Acres of crop	84.92	67.42
Acres of habitat	0	17.5
Yield* / Acre	1,195	1,315
Net Profit / acre	$86.00	$170.00
ROI / acre	10%	22%

**Yield = pounds of lint cotton*



▶ *These maps represent the 2020 Cotton Harvest precision ag yield data from the John Deere Operations Center "Field Analyzer". The map on the left shows the 'red' revenue negative dryland pivot corners and on the right the green zones show the location of where pollinator habitat will be seeded in 2021.*

▲ *Installation of a controlled drainage system on a family farm. © NRCS/SWCS photo by Lynn Betts*

PILLAR TWO: BUILD CAPACITY TO IMPLEMENT

Leveraging and improving the existing conservation delivery infrastructure, which is composed of a range of on-the-ground technical assistance providers, is key to providing technical assistance and information to producers who implement EoF practices. Fortunately, the United States has a long tradition of agricultural conservation and a wide network of public and private technical assistance providers from which to build. Coordinating national agriculture policy, enabling regional planning, and investing in technical assistance can develop capacity for large-scale EoF adoption. The goals to achieve this pillar are:

- **Develop a coordinated, national plan for agriculture policy** to create a shared vision for a more sustainable and resilient agricultural sector by aligning federal, state, and local policymaking efforts in pursuit of that vision. Currently, agriculture policymaking is disaggregated and often contradictory. Aligning policymaking efforts on multiple scales is necessary to generate consensus around conservation goals and maximize the effectiveness of both private and public sector investments.
- **Promote and enable watershed-level and regional planning and leadership** to drive demand for EoF practices and support interaction and conservation planning across scales. Supporting collaboration between federal, state, and local agencies to share resources and develop coordinated strategies will drive watershed- and whole-farm-level conservation planning. Conservation planning at larger scales lends itself to EoF practice adoption and also provides opportunities for incentive "stacking" (the ability to receive multiple payments for the same practice when multiple benefits are delivered). Planning at this scale also recognizes that EoF practices may not be needed on every farm and should be placed strategically to maximize impact.
- **Invest in technical assistance** to support the development and implementation of watershed-level plans. Technical assistance providers, which include USDA's Natural Resources Conservation Service (NRCS) staff, NGOs, certified crop advisors, and conservation districts, play an important role in driving implementation by working with farmers directly to develop conservation plans, generate and file necessary program documents, and physically implement practices. Investments are needed to both increase the number of staff working with farmers on the ground and to provide cross-sector training to technical assistance providers regarding EoF practices.

PILLAR THREE: ELEVATE A CULTURE OF CONSERVATION AND INNOVATION

Successfully expanding adoption of EoF practices requires a culture shift to embrace a shared understanding that working lands produce more than just food, fiber, and energy, but also produce ecosystem services critical to the well-being and resilience of our nation. By adopting EoF practices, producers are also farming for clean water, wildlife, and healthy, resilient working lands. These benefits should be clearly recognized by technical assistance providers, policymakers, and those who benefit downstream. In order to achieve this goal, significant work must be done to educate about EoF practices and overcome challenges to adoption. The goals to achieve this pillar are:

- **Build a shared understanding among farmers and their partners about the role of EoF practices as part of a systems approach to improving conservation and water management.** A comprehensive strategy to accomplish this goal could include case studies, field days on pilot farms to educate producers about practices, and quantitative information about the impacts of practices – both in terms of downstream effects and producer return on investment.
- **Harness the momentum and capacity of groups already working with producers on in-field practices** to develop strong collaborations for reaching farmers and expanding adoption of EoF practices.
- **Activate farmers, stakeholder groups, and other leaders who can influence and overcome barriers to adoption.** Key stakeholder groups and other leaders include non-operating landowners, commodity organizations, certified crop advisors, financial officers, downstream beneficiaries, and corporate supply chain actors. Leveraging the power of these influencers is key to build receptivity to EoF practices, particularly among farmers and commodity organizations.

CROSS-CUTTING THEMES

The cross-cutting themes are components of the Roadmap that have been identified as essential for any integrated effort to expand EoF practice adoption. Given their integral nature, they are not recommendations in and of themselves, but as a parallel imperative that must be included in any work to accelerate use of EoF practices.

SCIENCE, TECHNOLOGY AND DATA

Investments in science, technology, and data across the fields of environmental management, agricultural economics, and behavioral science are important to provide conservation professionals the best available information to effectively implement the Roadmap's recommendations. Research to better understand the return on investment of EoF practices, including how they interact with in-field practices, is essential to equip technical assistance providers with the information they need to make the case to producers to adopt EoF practices and to determine what combination of practices would work best on specific farms. In addition, the development of improved, cost-effective performance metrics to measure and report the environmental benefits of practices is key to support the development of programs to pay for ecosystem services and the markets themselves. Finally, behavioral science research is needed to better understand barriers to practice adoption and inform effective communications and outreach efforts.

Key to achieving these research goals is supporting research collaborations between USDA, NGOs, the private sector, and land grant university researchers. Across the agricultural field, siloed research institutions collect and hold important datasets that could be securely shared and analyzed to support collaborative research efforts with sector-wide benefits. Finding secure ways to share data while protecting producer privacy can catalyze new research partnerships, fuel a wave of agricultural science and technology innovations to support EoF adoption, and help create regenerative agricultural systems.

ALIGNED POLICIES AND PROGRAMS

Current agriculture policies are, in general, not designed to work together to improve productivity and environmental outcomes and diversify producer revenue streams. Similarly, these policies are not designed to work in tandem with and amplify corporate sustainable supply chain development and emerging ecosystem service markets. For example, the Federal Crop Insurance Program (FCIP), a key component of the farm safety net, is a powerful policy lever to improve risk management. But, the FCIP has been slow to consider how conservation practices and improved planting practices can reduce risk, including enhancing long term productivity. In fact, some research indicates that crop insurance may actually reward riskier planting practices, such as planting in poor soils and excess fertilizer use (Plastina 2019; Woodard 2016).

In addition, farm bill conservation programs, while critically important, are mostly aimed at helping producers address priority resource concerns on their operations. Consequently, conservation funding is targeted at the farm level, making aggregating conservation benefits up to the watershed and landscape level technically and administratively challenging. Maintaining these programs, while acknowledging their limitations, is important. Meanwhile, supporting a shift to regional, watershed, and landscape approaches such as those reflected in RCPP and CIG are necessary to implement EoF at the scale that will result in watershed-level improvement.

COMMUNICATIONS AND OUTREACH

While the soil health movement has been successful in expanding in-field conservation practice adoption, EoF practices remain the "black sheep" of agricultural conservation. In order to craft a more resilient, equitable, and profitable agricultural system, it is important to reframe our perception of agricultural landscapes as producing a suite of ecosystem services, not just crops and livestock. Creating and socializing this new narrative for a more holistic, regenerative American agriculture requires coordinated communications and outreach. Efforts to share this vision of agriculture should engage producers and technical assistance providers to make the case for adoption and also inform society at large to make the case that producers should be compensated for the environmental benefits they produce. Only by supporting this culture shift – in combination with commensurate financial incentives – will we see the large-scale transformation of the agricultural landscape we need to meet our shared water quality goals. The Roadmap's call to action makes this need clear; we have to focus on communicating about EoF practice adoption if we want to see measurable changes in water quality.

▲ *A blue heron explores a saturated buffer on a Midwest farm. © NRCS/SWCS photo by Lynn Betts*

RECOMMENDATIONS SYNTHESIS

As we developed the Roadmap with the Partners, the recommendations evolved as a set of interrelated imperatives. Importantly, **the synthesis recommendations largely focus on addressing structural barriers to scaling EoF**—including cultural mindsets, technical capacity, financial incentives, administrative barriers, and policy misalignment. These structural barriers constitute a system that serves as a fundamental roadblock to scaling EoF by perpetuating the status quo. Shifting how we value and perceive the role of working lands to include an array of services, such as providing clean water, air, and habitat is fundamental to dismantling these structural barriers and incentivizing adoption.

The process to develop recommendations consisted of first identifying short- and long-term actions and strategies to achieve each pillar's goal (see Appendix B). After considering what is needed to accomplish each Roadmap goal, the full landscape of action items was analyzed. This analysis resulted in the nine synthesized recommendations presented below. In combination, these broad-scope recommendations and granular action items form a comprehensive set of recommendations that can be used by stakeholders, such as producers, policymakers, technical assistance providers, NGOs, and companies, to advance transformational change across the agricultural landscape.

The recommendations below are cross-cutting in nature and encompass multiple pillars – reflecting the foundational issues needed to ensure adoption at a meaningful scale. As a consequence, they generally address multiple goals identified by the Partners as key to practice adoption. Where this occurs, it may also reflect the potential power of such a recommendation to facilitate EoF practices.

Table 5. Summary of the Roadmap recommendations (see also page 7)

RECOMMENDATIONS
1. **Elevate and replicate** successful or promising local, state, and regional policies and initiatives.
2. **Remove administrative barriers** to conservation practice implementation.
3. **Increase technical assistance** by supporting the multiple sources of conservation expertise.
4. **Integrate EoF** as a nature-based water management policy solution.
5. **Increase funding** and better target conservation programs to achieve watershed-scale impacts.
6. **Expand i**nnovative funding approaches, like ecosystem services markets.
7. **Accelerate** sustainable supply chains and corporate commitments to water and biodiversity.
8. **Harness and extend efforts t**o rebuild soil health to recognize the vital role of EoF in working landscapes.
9. **Harmonize and coordinate** national agriculture policy.

RECOMMENDATION 1: ELEVATE AND REPLICATE SUCCESSFUL OR PROMISING LOCAL, STATE, AND REGIONAL POLICIES AND INITIATIVES.

Local, state, and regional programs and initiatives that show promise or have been successful in increasing EoF implementation should be replicated in other geographies. Understanding why some approaches are successful, while others are not, are key in scaling local efforts.

For example, in 2008, Minnesota passed the Legacy Amendment to its Constitution approving additional tax revenue for a period of 25 years to address clean water and preserve natural resources, including funding for parks and trails. The dedicated revenue source funds several trust fund accounts, including the Clean Water Fund. Through the Clean Water Fund, the state supports projects that improve drinking water quality and restore and protect water quality in wetlands, rivers, and lakes. To guide its actions and investments under the fund, Minnesota developed a clean water roadmap and a sustainability framework. Minnesota's efforts provide a template for a comprehensive state-wide approach to water quality improvement by having:

- Clear legal authority and a mandate for clean water;
- Dedicated funding source independent of annual budgeting process;
- Roadmap to guide implementation; and
- Periodic reporting.

Another state approach to address water quality is H2Ohio. The Ohio General Assembly has dedicated $172 million to its H2Ohio initiative to improve water quality in the region by upgrading and establishing water management infrastructure. Because Ohio's goal is "long-term, cost-effective, and permanent water quality solutions," EoF practices are featured prominently, with a major component of the funding dedicated to wetlands creation as well as drainage water management, two-stage ditch construction, and EoF buffers.

An exemplar of a successful, regional approach to improving drinking water quality through expanding conservation practices is the Middle Cedar Partnership Project (MCPP) in Iowa. MCPP addresses the increasing concentrations of nitrates and extreme flood events in the Cedar River. Led by the City of Cedar Rapids, MCPP focuses on working with local conservation partners, farmers, and landowners to install best management practices such as cover crops, nutrient management, wetlands, and saturated buffers to help improve water quality, water quantity, and soil health in the Cedar River watershed. This project will lay the foundation for needed improvements and bring together a diverse group of conservation partners. The project leverages multiple public and private sector partners and funding sources, an essential strategy to expand investment sources beyond public dollars.

Southfork Watershed Alliance, Iowa: A Farmer Driven Partnership

The Southfork Watershed Alliance formed in the 1990s when a group of interested residents and business leaders united around the goal of establishing a comprehensive watershed program. Propelled by the U.S. Geological Survey stream monitoring that identified high loads of nitrate nitrogen in their watershed, the Alliance became the first farmer-led watershed group in Iowa and remains the longest running. The watershed now has over 1,500 acres of restored wetlands, over 1,700 acres of grassed waterways, and numerous other in-field practices (Moorman et al. 2020). The USDA Agricultural Research Service extended stream and tile monitoring efforts in the early 2000s, leading to its designation as a Conservation Effects Assessment Project (CEAP) watershed in 2004. Since then, the watershed has become a test bed for watershed-scale research and implementation.

How the cross-cutting themes relate:

- **Science, technology, and data** are needed to improve understanding of the benefits and impacts of EoF practices, how they interact with in-field conservation practices, and how they stack-up against traditional water infrastructure projects to inform the development of innovative local, state, and regional conservation programs. Developing performance metrics to measure the outcomes of these initiatives is essential to measure and document successes that can be replicated elsewhere.
- **Aligned policies and programs** are essential to direct federal conservation dollars in support of successful local, state, and regional conservation models.
- **Communications and outreach** are needed to encourage more EoF projects. As adoption accelerates, EoF proponents should identify and amplify examples of successful local, state, and regional initiatives to generate positive momentum and facilitate replication in other geographies.

RECOMMENDATION 2: REMOVE ADMINISTRATIVE BARRIERS TO CONSERVATION PRACTICE IMPLEMENTATION.

Addressing administrative barriers to conservation practice implementation is low hanging fruit of the Roadmap. Improvements in program delivery and effectiveness are a building block to increase EoF practice implementation. Stakeholders consistently note administrative challenges, especially involving the farm bill conservation programs, that impede and disincentivize practice adoption. These challenges include rules that hinder stacking of practices, a need for increased training of conservation professionals, understaffing of NRCS field offices and conservation districts, the complexity and number of farm bill programs, and burdensome program sign-up requirements (R. Christianson et al. 2018). Some of these barriers may be resolved by working with government officials to simplify program implementation through administrative changes, such as permitting the stacking of practices and streamlining program sign-ups. Other programmatic issues require regulatory changes that must be accomplished at the national level.

Other changes require legislative amendment. For example, the profusion of farm bill programs, each with their own implementing regulations, would benefit from restructuring—without a diminution in funding—to simplify their administration and improve producer access to technical and financial assistance. This would ease program administration for NRCS and the Farm Service Agency and, importantly, remove barriers to program access for producers and landowners. Likewise, turnover and declines in staffing at NRCS have impacted conservation program and technical assistance delivery and would also require legislative changes and an increase in funding (see Recommendation 3).

How the cross-cutting themes relate:

- **Aligned policies and programs** are needed to strengthen the existing conservation delivery infrastructure by simplifying and streamlining conservation program administration and removing unnecessary barriers to stacking practices.

RECOMMENDATION 3: INCREASE TECHNICAL ASSISTANCE BY SUPPORTING THE MULTIPLE SOURCES OF CONSERVATION EXPERTISE.

Technical assistance is the backbone of implementing and scaling EoF practices. Conservation successes to date are due to the 1:1 technical assistance that has been provided to producers by NRCS, state and local governments, and the private sector. An important step in increasing the application of EoF practices is to create enabling conditions that strengthen the capacity of conservation professionals to administer, advise on, and implement these practices. The lack of technical capacity, support, and connectivity between different parts of our conservation delivery system to link producers to the services they need to adopt EoF is a fundamental challenge.

Polk County, Iowa Saturated Buffer Project

The Polk County Saturated Buffer Project formed a partnership between the county, Soil and Water Conservation District, Iowa Department of Agriculture and Land Stewardship, Natural Resource Conservation Service, and Agricultural Drainage Management Coalition to create a new framework to install EoF practices at a significant pace with lower costs and landowner hassle. The ongoing pilot has been successful—over 135 tile outlets in four watersheds have been investigated for installation, with an initial installation of 50+ saturated buffers and bioreactors scheduled to take place in 2021. This will nearly double the amount of statewide EoF practices installed to date.

Polk County Saturated Buffer Project leadership developed a systematic approach that included the following elements to ensure the highest likelihood of success:

- **Prioritizing watersheds with a high occurrence of Agricultural Conservation Planning Framework (ACPF) identified saturated buffer sites**
- **Incentivizing landowner participation by securing matching funding sources to provide 100% cost share plus a temporary construction easement**
- **Recruiting landowners/farmers to install multiple sites**
- **Relying on leadership to streamline the process for landowners**
- **Bundling sites for design and construction to create multiple landowner bid-packages for contractors to deliver more efficiently and cost effectively**

The project is designed to be replicable. Polk County SWCD welcomes additional interest.

Our conservation delivery infrastructure is comprised of several components, including USDA field offices, conservation districts, agriculture extension offices, NGOs (e.g., commodity organizations, conservation organizations, etc.), and Certified Crop Advisors (CCAs). In addition to working with farmers directly to implement practices, capacity includes the ability to engage in outreach and communications to raise awareness regarding program and funding availability and relationship building with producers to develop mutual trust. Supporting and strengthening within and across organizations providing agronomic and conservation advice to producers is key. Policy strategies include empowering stakeholders to better utilize resources and build capacity by providing greater flexibility and technical resources to help producers embrace EoF practices.

For example, as NRCS has noted, filling vacant positions at the agency is critically important in order to reach full performance (Nalley 2020). While NRCS has been given some direct hire authority, the agency would benefit from expanded direct hire authority to fill this need. This capacity shortfall is particularly detrimental to EoF practice adoption because these practices require, among other things, significant engineering and construction expertise to implement. Streamlining NRCS's workload, increasing funding and authorities for critical hires, and reaffirming the agency's key role as technical assistance providers are necessary to address technical assistance needs.

To **address this lack of capacity and technical assistance while maintaining flexibility** and filling capacity gaps as appropriate given on-the-ground circumstances, a multi-pronged strategy should be pursued that:

- Supports and recognizes the importance of the multiple sources of technical assistance, e.g., certified crop advisors, contractors, NGOs and conservation districts;
- Increases technical assistance funding and engineering job authority and supports more NRCS field personnel;
- Enhances NRCS's ability to work with partners to meet technical assistance needs on the ground; and
- Integrates EoF education (including outreach to help remove barriers for people of color, women, and new farmers) into training for NRCS, CCAs, watershed coordinators, and all other conservation professionals, including engineers, technicians, and contractors that design and build EoF practices.

Streamlining and strengthening conservation delivery infrastructure and technical capacity in a way that more fully frames the economic value of conservation will also facilitate a cultural shift toward recognizing the ecosystem service functions of working lands as intrinsic to its value.

How the cross-cutting themes relate:

- **Science, technology, and data** are essential to improve our understanding of the economic costs and landscape benefits of EoF practices. This is imperative to equip technical assistance providers with the information they need to effectively make the economic case to producers about how EoF practices can be integrated into a successful farming operation.
- **Aligned policies and programs** are needed to strengthen our existing conservation delivery infrastructure by simplifying and streamlining conservation program administration and increasing NRCS's workforce.
- **Communications and outreach** are essential to elevate a culture of conservation and innovation that supports investment in technical assistance. An integrated communications and outreach strategy is needed to create and socialize a new narrative that EoF practices are part of a whole-farm approach that produces a suite of environmental benefits on a landscape scale, in addition to traditional crops and livestock.

RECOMMENDATION 4: INTEGRATE EOF AS A NATURE-BASED WATER MANAGEMENT POLICY SOLUTION.

Use of nature-based solutions such as EoF practices to improve water management, address flood risk, and build overall resilience is gaining traction in a range of applications such as municipal water quality and risk management with the attendant potential to unlock new sources of funding. Adopting policies that recognize the importance of nature-based solutions by funding watershed-based projects would accelerate this trend and could be accomplished by explicitly including nature-based solutions in stimulus, infrastructure/disaster, climate bills, and the farm bill. In addition, several policy and funding silos that may be currently used for nature-based solutions should be harmonized so that they work together to prioritize this approach. These programs include the revolving funds for the Clean Water Act and Safe Drinking Water Act, Army Corps of Engineers infrastructure projects, Federal Emergency Management Agency (FEMA) disaster mitigation funding, farm bill conservation programs, and traditional watershed development and planning programs such as those implemented by NRCS.

Minnesota Model for Private Sector Technical Assistance

In 2018, Natural Resources Conservation Service formed a three-year cooperative project with Ecosystem Services Exchange (ESE), a private sector technical service provider, to develop drainage water management plans and the designs for saturated buffers and bioreactors in southern Minnesota. This agreement with NRCS enables ESE to provide plans to landowners and farmers at no cost to them to strengthen their case when applying for NRCS financial assistance funds through the Environmental Quality Incentives Program (EQIP). The project calls for 10 technical training sessions, 210 site reviews, 70 drainage water management plans, and designs for 50 saturated buffers and 40 bioreactors.

This public-private partnership is ongoing and will increase the adoption rate of conservation drainage practices in Minnesota by easing the workload burden on local staff as well as providing training opportunities for conservation practices that not all NRCS staff are familiar with. Other states can replicate this model to show how private sector technical assistance is key to advancing innovation and delivering widespread adoption of edge-of-field and drainage water management practices.

Nature-Based Solutions

The terms "nature-based solutions," "green infrastructure," and "natural infrastructure" mean different things to engineers, landscape architects, urban planners, and conservation practitioners.

For the purposes of this Roadmap, we use the following definitions, as provided by the Environmental and Energy Study Institute (Luedke 2019).

- **Nature-based solution:** Restoring and/or emulating nature in order to increase human, ecosystem, and infrastructure resilience to climate impacts. These solutions often result in environmental, economic, and social co-benefits, including carbon sequestration—a key tool in mitigating greenhouse gas emissions. Nature-based solutions include both green and natural infrastructure.
- **Green infrastructure:** Projects that combine gray infrastructure with nature-based solutions to create hybrid systems that improve resilience to climate impacts, while also often resulting in environmental, economic, and social co-benefits. Generally, green infrastructure is a built or engineered solution such as a green roof or bioswale.
- **Natural infrastructure:** Projects that use existing or rebuilt natural landscapes (e.g., forests, floodplains, and wetlands) to increase resilience to climate impacts, often resulting in environmental, economic, and social co-benefits.

At the state level, nature-based solution legislation and rulemaking to incentivize "greening" the management of water control structures and water supplies is a critical strategy to counter extreme weather events. An example of this proactive approach is the George Shannon Wetland Reuse Project, which created 2,200 acres of wetlands to treat wastewater in drought-prone North Texas. The $75 million dollar project increased the drinking water supplies for 2.3 million people by 30% and avoided a $1 billion dollar expense to build a new reservoir.

Federal programs should be designed to encourage local and regional innovation and identify best practices so that they may be replicated elsewhere. Identifying and amplifying successes such as the George Shannon project and providing technical assistance to transfer successful approaches for multiple communities' benefit leverages public investment and helps build shared understanding among producers and stakeholders regarding the role and value of EoF practices.

Nature-based solution policies and programs should also be designed to align with and support emerging ecosystem service markets and/or payments for ecosystem services. Because EoF practices can provide multiple benefits, supporting the growth of ecosystem service markets will accomplish several interrelated goals: drive EoF adoption by providing producers with a revenue stream, foster EoF durability by incentivizing farmers to maintain practices, and shift cultural norms around EoF adoption and the role of such practices on working lands.

How cross-cutting themes relate:

- **Science, technology, and data** are essential to better understand how nature-based solutions including EoF practices can support water and climate goals and complement in-field practices.
- **Aligned policies and programs** are needed to advance conservation goals through infrastructure and water management legislation and emerging ecosystem service markets.
- **Communications and outreach** are needed to identify, share, and promote further adoption of local and regional successes in advancing nature-based solutions legislation that integrates EoF practices. This is a component of creating and socializing a new narrative that EoF practices are part of an integrated farming approach that can produce a suite of environmental benefits on a landscape scale, in addition to traditional crops and livestock.

RECOMMENDATION 5: INCREASE FUNDING AND BETTER TARGET CONSERVATION PROGRAMS TO ACHIEVE WATERSHED-SCALE IMPACTS.

Most conservation funding is designed to address producers' priority resource concerns on their operations. This farm-level implementation is not designed to aggregate conservation benefits at the watershed and/or landscape-level. In order to achieve ecological and economic benefits at scale, a watershed and landscape approach with measured outcomes is necessary. The solution is not to reduce traditional conservation cost-share funding, given the need for such funding and the widespread support these programs enjoy. Rather, federal conservation programs should increase collaborative, watershed-level funding while emphasizing this approach in policy.

For example, in recent farm bills, collaborative conservation approaches through the Resource Conservation Partnership Program (RCPP) and the Conservation Innovation Grants (CIG) program have been introduced to better achieve landscape- and watershed-level conservation impacts, encourage conservation innovation, and leverage a broader range of stakeholder investment. These programs should be expanded and simplified to increase EoF implementation, innovation, and regional collaborations that prioritize impaired watersheds and shift metrics from number of practices funded to outcomes of practices funded. Inherent in this recommendation is that successfully targeting and measuring practice outcomes will require addressing science-based knowledge gaps and developing affordable, deployable technologies, including robust predictive models.

Increasing investment in conservation programs to embrace collaborative, regional approaches is consistent with the evolution of the farm bill conservation title to meet evolving environmental challenges. By the early 2000s, the farm bill conservation title shifted emphasis to conservation practice implementation to improve soil and water quality outcomes on working lands (EQIP and CSP). RCPP and CIG represent next generation policy designed to address persistent watershed and landscape environmental concerns.

Evolving conservation programs to emphasize collaborative approaches has several benefits, including leveraging NGO, state, and corporate funding, encouraging technical innovation, and facilitating projects that span multiple jurisdictions. Moreover, collaborative approaches can often provide "one stop shopping" for producers with trusted conservation intermediaries, thereby avoiding delays and administrative complexity that producers may face when they sign up for individual farm bill conservation programs.

In addition to the farm bill programs, increasing support for programs that leverage federal and state funding, such as section 319 of the Clean Water Act is key to fostering creative approaches to clean water, including jumpstarting market-based investments in nature-based solutions by providing initial investment dollars. In sum, we need to envision future programmatic and funding sources at all levels of government that invest in collaborative, regional approaches. Moreover, an emphasis on watershed- or landscape-scale implementation contributes to the shift to a culture of conservation and innovation.

How the cross-cutting themes relate:

- **Science, technology, and data** are essential to improve our understanding of the benefits of EoF practices on a landscape scale and support the shift of conservation programs to focus on collaborative, regional approaches.
- **Aligned policies and programs** are needed to advance these collaborative, regional approaches and expand the success of our existing farm bill conservation programs.
- **Communications and outreach** are needed to create and socialize a new narrative that EoF practices are part of an integrated farming approach that can produce a suite of environmental benefits on a landscape scale, in addition to traditional crops and livestock.

RECOMMENDATION 6: EXPAND INNOVATIVE FUNDING APPROACHES LIKE ECOSYSTEM SERVICES MARKETS.

Decades of conservation practice implementation have shown that relying solely on voluntary conservation adoption is insufficient to achieve necessary scale of EoF adoption, as well as other conservation practices. Social science research indicates that several structural barriers – both economic and social – play a role in why a large percentage of producers do not adopt conservation practices. Making the economic case to producers, downstream beneficiaries, and technical assistance providers is key to overcoming adoption challenges. For producers, EoF practices have the potential to be part of a comprehensive whole-farm approach to risk management and profitability. For downstream beneficiaries, strategically installed EoF practices can improve water quality and reduce flood risk.

Innovative financing methods that seek to improve environmental outcomes while providing new revenue streams for producers and landowners are receiving renewed interest. For example, new energy around ecosystem market development offers an opportunity to apply lessons learned from carbon and other ecosystem market initiatives that first gained traction in the early 2000s. In particular, the soil health "movement" is helping spur the redevelopment of markets, including a recent bipartisan bill that was introduced in the U.S. Senate to support carbon markets through USDA.

Ecosystem approaches have been successful in providing clean water in large markets such as in the New York City watershed through payments and conservation incentives to upstream farmers and forestland owners. Other financing mechanisms like green bonds have been used to fund green infrastructure projects from Lawrence, Kansas, to Washington, DC. These loans allow cities and utilities to proactively manage and treat water before it reaches municipal systems, thereby reducing environmental and economic risk in the long run. Looking to the future, measuring EoF performance, monetizing benefits, and developing multiple market payers (municipal water, insurers, etc.) for a mix of services can make EoF a cost-competitive alternative to gray infrastructure investments.

Innovative Financing and Private Sector Engagement in North Carolina's Restoration Economy

On July 1, 2020, North Carolina's Governor Roy Cooper signed into law HB 1087, a bill that establishes the nation's first flood reduction marketplace and reduces barriers to private sector involvement in restoration project. The law establishes guidelines relevant to North Carolina's Division of Mitigation Services (DMS), a program that awards contracts to private businesses to complete mitigation and ecological restoration projects. HB 1087 allows DMS to enhance or restore watershed flood capacity by:

1. **Authorizing DMS to accept appropriations and grants to support projects that enhance flood storage capacity and mitigate flood risks.**
2. **Allowing DMS to quickly contract with private restoration companies to install natural infrastructure projects to increase flood storage capacity.**
3. **Creating the nation's first flood reduction marketplace that will create and sell flood reduction credits based on the acre-feet of flood storage capacity created by the project.**
4. **Establishing an advisory board to develop project criteria, maintain an inventory of projects, and annually report the increased flood storage capacity created by DMS.**

As various organizations continue to develop innovative market approaches, companies, government agencies, and NGOs should consider both overall ecological function and social equity in how these instruments are designed to avoid unintended negative consequences such as farm aggregation and exclusion of small farmers. For example, in response to criticisms and protests that the United Nations' Reducing Emissions from Deforestation and Forest Degradation program (REDD+) could negatively impact land ownership and resource access in indigenous communities, the United Nations decided that reporting on social safeguards is a prerequisite for countries to participate in the REDD+ market. Designing ecosystem services markets to prioritize resource allocation among smaller farms, historically disadvantaged farmers, and areas with higher rates of rural poverty would help ensure that these markets do not reinforce trends of farm aggregation already in progress. Balancing equity considerations with economic efficiency is a challenge but should be carefully considered in the design of ecosystem services markets. A failure to consider equity in the management of these markets and programs may result in equity risks, including reduced stakeholder participation, that could jeopardize success.

Federal policy can accelerate development and adoption of green financing mechanisms and ecosystem service markets by providing critical enabling conditions. Moreover, not only must federal policy be aligned with these efforts, it must **also ensure meaningful financial returns for producers and landowners.**

How the cross-cutting themes relate:

- **Science, technology, and data** are essential to determine what standardized performance metrics can be used to monitor and verify the environmental benefits of EoF practices and support programs or markets to compensate farmers for producing ecosystem services (e.g., clean water, habitat).
- **Aligned policies and programs** are needed to ensure that federal, state, and local conservation policy efforts support emerging ecosystem service markets.
- **Communications and outreach** are needed to make the economic case for farmers to participate in ecosystem service markets and adopt an integrated farming approach that can produce a suite of environmental benefits on a landscape scale, in addition to traditional crops and livestock.

RECOMMENDATION 7: ACCELERATE SUSTAINABLE SUPPLY CHAINS AND CORPORATE COMMITMENTS TO WATER AND BIODIVERSITY.

In addition to payment for ecosystem services, the expansion of sustainable supply chain and corporate sustainability efforts, in general, provide another important market mechanism to grow EoF implementation by ensuring conservation is profitable for farmers. Sustainable supply chain efforts have supported in-field practices such as cover cropping to improve nutrient management and soil health. For example, the Midwest Row Crop Collaborative was formed in 2016 by companies and nonprofits to expand adoption of soil health practices on row crop agriculture in order to achieve the goals of the Mississippi River Hypoxia Task Force. Similarly, corporate sustainable supply chain initiatives could support EoF as key to improving water quality. In fact, growing sustainable supply chains is part of a three-legged stool that supports a fundamental shift toward valuing ecosystem services as part and parcel of what working lands produce, which should look like:

- **Align farm safety net and conservation with environmental and risk mitigation benefits;**
- **Pay for ecosystem benefits; and**
- **Foster sustainable supply chains.**

Again, ensuring that the supply chain value generated by EoF practice implementation is meaningfully shared with producers is critical both as a matter of fairness and to ensure sufficient financial incentives for installation in the first place.

This recommendation is related to Recommendation 6 because it seeks to value the ecosystem services working lands by providing and compensating producers for verified performance, not for simply installing conservation practices. This approach more fully recognizes the multiple benefits of EoF and is foundational to shifting cultural mindsets among producers, technical assistance providers, downstream beneficiaries, the supply chain, and policymakers. In order to fully develop sustainable supply chains that could benefit water quality, a strong lever is needed such as the scope 3 climate commitments that are gaining traction. The emergence of Science Based National Targets Network to guide corporate efforts to operate sustainably is one avenue to facilitate science-based corporate commitments for water quality.

Finally, like Recommendation 6, data-driven policy and implementation are key to optimizing and quantifying real and measurable ecosystem improvement, economic value, and undergirding robust markets.

How the cross-cutting themes relate:

- **Science, technology, and data** are essential to better understand, monitor, and verify the environmental benefits of EoF practices and improve supply chain traceability to track environmental performance and translate its value throughout the supply chain.
- **Aligned policies and programs** are needed to ensure that federal, state, and local conservation policy efforts support and enhance corporate sustainability efforts.
- **Communications and outreach** are needed to educate consumers about the societal benefits of EoF practices and make a value proposition for why they should pay for agricultural products produced with EoF practices. Communications and outreach are also needed to make the economic case for farmers to participate in corporate sustainability programs and adopt an integrated farming approach that can produce a suite of environmental benefits on a landscape scale, in addition to traditional crops and livestock.

Innovative Finance Model: Sustainable Water Impact Fund

The Sustainable Water Impact Fund is a partnership between The Nature Conservancy and Renewable Resources Group, a global investment and asset-management firm, to demonstrate how an investment product can deliver environmental benefits while providing competitive financial returns. The fund aims to achieve direct conservation outcomes including terrestrial and wetland habitat restoration, land protection, instream flow enhancement, sustainable groundwater management, and other environmental benefits by acquiring and improving land, water, and agricultural management. While traditional investment models have assumed that prioritizing environmental and social impact compromises profitability, this fund is an opportunity to demonstrate an investment model that removes this tradeoff.

RECOMMENDATION 8: HARNESS AND EXTEND EFFORTS TO REBUILD SOIL HEALTH TO RECOGNIZE THE VITAL ROLE OF EOF IN WORKING LANDSCAPES.

Burgeoning interest in and broad-based support of soil health provides a platform to raise the profile of EoF practices as a vital element of working landscapes that safeguard water quality and provide other benefits. Most states now have policy activity related to improving soil health. Some states have adopted detailed policies to improve soil health such as Nebraska's Healthy Soils Taskforce, which is charged with developing a comprehensive statewide plan. EoF advocates should engage with soil health stakeholders to include broader recognition of the role of EoF practices in the vitality of working landscapes. Fundamental to these legislative initiatives is support for the ecosystem benefits that improved soil health provide, including carbon sequestration, climate resilience, and water filtration. EoF is highly complementary to in-field practices and, in many cases, necessary to optimize ecosystem services on farms and across the landscape. Relatedly, soil health legislative initiatives that seek to facilitate multiple ecosystem benefits and quantify them can help grow ecosystem services markets.

EoF advocates can learn from the success of the soil health movement, which enjoys broad support across the political spectrum. Although soil conservation has been policy since the Dust Bowl, only recently have the multiple benefits of soil health been more widely appreciated and recognized. Understanding how soil health has gained traction is helpful to grow recognition of EoF practices, their key role in conservation, and how to scale adoption. Notably, several states acknowledge the essential role of EoF in reaching state nutrient reduction goals, and more broadly, mitigating the hypoxic zone in the Gulf of Mexico. Twelve states in the Mississippi River Basin have developed these strategies as part of the EPA's Hypoxia Taskforce. Iowa's strategy states plainly that even if all corn and soybean-producing acres adopted cover crops, nutrient reduction goals would not be met; a combination of in-field and EoF is necessary to reach that goal.

A confluence of factors occurred that likely pushed support for soil health practice adoption over a tipping point. These factors include:

- **Federal agency champion** in NRCS that over the last decade redoubled its public efforts to communicate the benefits of healthy soils to farmers and society;
- **Farmer interest and motivation** to take a proactive approach to conservation that allows them to improve and strengthen the land they farm;

Chesapeake Bay: Utilizing Integrated Nutrient Management Plans and Partnership Programs to Accelerate EoF Adoption

The Chesapeake Bay watershed, the largest estuary in North America, encompasses 64,000 square miles of streams and rivers, forests, farms, and cities across six states and the District of Columbia. Excess nutrients and sediment from degradation of this watershed have led to poor water quality that harm the Bay's biodiversity and those who depend on it. In 2010, a Total Maximum Daily Load (TMDL) was established under the Clean Water Act to improve the Bay's water quality. The TMDL outlines a framework to reduce nutrients and sediments to the Bay from multiple sectors across the watershed, with the intent to achieve a 25% reduction in nitrogen, 24 % in phosphorus and 20% reduction in sediment. Each state in the watershed has developed a Watershed Implementation Plan (WIP) which details how reductions will be achieved to meet this goal. The ambition of the TMDL demands implementation of a broad suite of management practices, particularly in the agricultural sector, which delivers the most excess nutrients and sediments to the Chesapeake. In total, WIPs from across the states vow reductions from agriculture sources through implementation of more than 7 million acres of in field nutrient management and more than 500,000 acres of edge of field practices.

One example of how partners have collaborated to accelerate progress to meet the WIP goals in Delaware and Maryland is the Delmarva Conservation Partnership (DCP). The DCP, created in 2014, initiated one of the first Regional Conservation Partnership Program (RCPP) projects that supported farmers and landowners to improve water quality and wildlife habitat. Led by The Nature Conservancy and the DE-MD Agribusiness Association, over 30 organizations engaged in the five year program to implement nutrient reductions in priority watersheds using a mix of both in field practices such as 4R nutrient management and edge of field practices like wetland restoration. The Pocomoke River watershed was identified as a priority, and the partnership worked there with landowners to reconnect the river's floodplains and restore headwater wetlands using practices such as ditch plugs and two stage ditches. The annual reduction from this effort is estimated to be 71,000 pounds of total nitrogen, 7,600 pounds of total phosphorus, and 47,500 pounds of total suspended sediment or about 20% of the total reduction goals set by the Chesapeake Bay Program for the Pocomoke River watershed.

- **Broader societal interest in healthy food systems** and growing understanding of the connection between agriculture and environmental impacts;
- **Renewed interest in soil carbon markets** and greenhouse gas offsetting; and
- **Emergence of informal coalitions,** collaborations, and information sharing among NGOs, philanthropies, and individuals.

How the cross-cutting themes relate:

- **Science, technology, and data** are needed to develop evidence on performance and cost-effectiveness of various combinations of practices as well as to better understand why there is a remaining disconnect between producers and adoption of EoF practices. Behavioral science to study barriers to adoption and conduct research about what messaging and incentives farmers will respond to will help craft and inform effective communications and outreach strategies. In addition, improved understanding of the benefits of EoF practices and how they can complement in-field practices is essential to make the case to farmers and assist them in determining what combination of practices would work best on specific farms.
- **Aligned policies and programs** are needed to support successful state soil health policies and state nutrient reduction strategies and expand these efforts to encourage EoF practice adoption.
- **Communications and outreach** are needed to leverage interest in soil health to expand farm management decisions to embrace EoF practice adoption. Communicating how both EoF and in-field practices are components of a larger, landscape-scale approach to conservation is key to elevating a new narrative that agriculture can produce a suite of environmental benefits for society, in addition to crops and livestock.

RECOMMENDATION 9: HARMONIZE AND COORDINATE NATIONAL AGRICULTURE POLICY.

The efficacy of current agriculture programs that serve a range of important functions, including the farm safety net, conservation, and research, is seriously undercut by a lack of coordination and performance metrics. The farm bill is our de facto policy, but the omnibus legislation is an accretion of programs without an overarching purpose and set of policy goals. At the same time, other agencies and laws can play a role in how working lands are managed, including the EPA and its implementation of the Clean Water Act. Harmonizing and better coordinating these national polices is critical to ensuring the efficacy of our public investment in working lands and the economic and ecological viability of the agricultural sector into the future.

One key example of how federal agriculture policy sometimes works at cross-purposes is the federal crop insurance program (FCIP). Federal crop insurance is a primary farm "safety net," and as such, a key policy lever to influence producer behavior. The federal government subsidizes crop insurance premiums at more than 60%, on average. The vast majority of commodity crops are covered by crop insurance. Research shows that crop insurance can undercut a producer's incentives to adopt conservation practices to mitigate risk and can encourage cultivation of flood-prone and other risky lands that could be well-suited for EoF practices. Further, producers who enroll in FCIP are more likely to rely heavily on commercial inputs, such as nitrogen fertilizer as a hedge against risk (Plastina 2019). In addition, FCIP administrative rules can sometimes serve as a barrier to conservation practice adoption as was the case, until recently, with cover cropping. Federal crop insurance should be reformed to take a holistic approach to risk mitigation and reward producers who mitigate risk through conservation and sustainable farming practices, including the adoption of EoF practices. Re-imagining the farm safety net should be part of an overarching coordinated national agriculture plan so that USDA programs work together to ensure the long term resilience and productivity of working lands.

A coordinated policy with clear purpose to ensure resilient, productive, and equitable agriculture systems could, for example:

- Align farm safety net and conservation programs so that they work in concert;
- Incentivize production of crops that encourage crop diversity and environmental and nutritional health;
- Embrace a data-drive, results-based approach to programmatic implementation;
- Elevate local, statewide, and regional EoF practice successes and leverage local resources;
- Value the full suite of working lands benefits; and
- Address climate impacts and challenges to agricultural productivity and producers' economic well-being.

This recommendation is a significant legislative lift. However, if well-crafted and adequately funded, a coordinated agriculture policy could be a gamechanger, as it would provide the mandate and funding to manage existing programs and infrastructure more systematically, as well as guide future regulatory implementation and legislative efforts. In the interim, an executive order could improve coordination and, in turn, agriculture and environmental outcomes.

How the cross-cutting themes relate:

- **Science, technology, and data** are essential to better understand the impacts of EoF practices and establish standardized performance metrics in order to support coordination across agriculture programs.
- **Communications and outreach** are needed to advance a shared vision for a more resilient, equitable, and productive agricultural system. Outreach to coordinate agriculture stakeholders can build support around a national agriculture policy that advances these goals.

▲ *Aerial view of a stream and a saturated buffer. © NRCS/SWCS photo by Lynn Betts*

Table 6. Relationship of Recommendations to Roadmap Pillars and Goals

	PILLAR ONE: BUILD THE ECONOMIC CASE			PILLAR TWO: BUILD CAPACITY TO IMPLEMENT			PILLAR THREE: ELEVATE A CULTURE OF CONSERVATION & INNOVATION		
RECOMMENDATIONS	**Develop market-based solutions.**	**Increase & better target public investments.**	**Integrate EoF practices within whole-farm operations as a tool to diversify farm income & enhance financial risk management.**	**Develop a coordinated, national plan for agriculture policy.**	**Promote & enable watershed-level & regional planning & leadership.**	**Invest in diverse & flexible technical assistance.**	**Build a shared understanding among farmers & their partners of the role of EoF practices as part of a systems approach to improving conservation and water management.**	**Harness the momentum & capacity of groups already working with producers on in-field practices.**	**Activate farmers, stakeholder groups, & other leaders who can influence & overcome barriers to adoption.**
Elevate and replicate successful or promising local, state, and regional policies and initiatives.		☑			☑		☑		
Remove administrative barriers to conservation practice implementation.				☑				☑	☑
Grow technical assistance by supporting multiple sources of conservation expertise.		☑		☑	☑	☑			
Integrate EoF as a nature-based water management policy solution.	☑	☑	☑		☑		☑		☑
Increase funding and better target conservation programs to achieve watershed-scale impacts.	☑	☑	☑		☑				☑
Expand innovative funding approaches like ecosystem services markets.	☑	☑	☑		☑		☑	☑	☑
Accelerate sustainable supply chains and corporate commitments to water and biodiversity.	☑	☑	☑		☑		☑	☑	☑
Harness and extend the soil health momentum to recognize the vital role of EoF on the working landscape.	☑				☑		☑	☑	☑
Harmonize and coordinate national agriculture policy.	☑	☑	☑	☑	☑	☑	☑	☑	☑

CALL TO ACTION

The growing public awareness of the importance of soil health and resulting policy successes at the state and federal levels are attributable to coalescing of efforts from an array of various stakeholders and groups. Similarly, developing public awareness of and support for the value of EoF is necessary to gain policy traction and achieve on-the-ground successes. The Roadmap serves as a blueprint for stakeholders that, if followed, can result in EoF adoption at scale, a key ingredient to achieve improved water quality and resilient communities. The Partners and other stakeholders can turn the Roadmap into an action plan and kick-start such momentum by:

- Coalescing stakeholders around the Roadmap and developing an implementation plan;
- Sharing resources and information;
- Developing shared communications around EoF; and
- Growing opportunities for collaborations from on-the-ground projects to legislative proposals.

▲ *The installation of a wood chip bioreactor. Wood chips remove nitrates from tile water as the water flows through the bioreactor. © SWCS/IDALS Photo by Lynn Betts*

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▲ *Wetland on a South Dakota farm. © Don Poggensee, USDA-NRCS*

APPENDIX A: POLICY MATRIX

This matrix identifies at what level and how policies and programs relate to EoF practices. Understanding the policy landscape is key to developing solutions that scale EoF practices by better utilizing existing policy tools, improving alignment with sustainable supply chain efforts, and identifying gaps and areas where improvement is needed. Where possible, programs or examples are hyperlinked for ease of reference.

SCALE	REGULATORY	QUASI-REGULATORY	VOLUNTARY	MARKET	RESEARCH	TECHNOLOGY
Federal/ National	Clean Water Act 303(d) (TMDLs) Wetland Mitigation Banking under CWA section 404 Safe Drinking Water Act Water Resources Development Act (USACE) Endangered Species Act Habitat Conservation Plans)	Conservation compliance (farm bill) Coastal Zone Management Act (and grants) Great Lakes Water Quality Agreement Annex 4	Ag Innovation Agenda (USDA) Farm bill conservation programs: EQIP, CSP, RCCP, CRP, CIG, conservation easements, esp. wetland restoration NRCS Watershed Program USDA Conservation loans Federal Crop Insurance CWA Section 319 FEMA Hazard Mitigation grants North American Wetland Conservation Act (NAWCA) grants HUD grants for state watershed approaches (grant program has been spent down) Land and Water Conservation Fund (e.g., riparian acquisitions)	CIG grants supporting Ecosystem services markets Section 2709 2008 Farm Bill (16 USC 3845) USDA Organic Certification	USDA: (intermural and extramural) NIFA, NRCS CEAP, ARS, Extension, SARE CIG Grants FFAR (like NFWF chartered by Congress) National Institute of Water Resources (NIWR) (funding comes from USGS) USGS National Science Foundation NOAA USFWS	Federal grant opportunities: NIFA (various grant opportunities), CIG grants supporting tech development NSF engineering grants EPA Great Lakes Funding) FFAR (Seeding Solutions Grants, Sustainable Water Management) Performance measurement innovation USGS (MI, WI, MN) Technology accelerators (Techstars; Aglaunch) NRCS Conservation Tech Assistance (CTA) National Center for Appropriate Technology (NCAT) USDA Extension (supported through NIFA) ARS Office of Technology Transfer
State	MN Buffer Law CWA TMDLs (WI) WI P Rule/adaptive management FL BMPs (mandatory, presumption of compliance) CA Right to Clean Water/ Water Board authority State drainage laws (e.g., OH; IL) Clean Water State Revolving Funds (Fed/State under CWA) Drinking Water State Revolving Funds (Fed/State under SDWA) Groundwater management acts (Nebraska, Arizona, California) Wetland mitigation banking (under CWA) (WA)	Taxation (FL Ag Privilege Tax) “Assurance” and “Ag Certainty” Programs (MI, VA) Minnesota Drinking water supply management areas (mapped by Department of Health)	State MS Nutrient Reduction Strategies Iowa Watershed Approach Colorado Water Plan Ag certification programs (MN MAWQP) State BMP cost share (often though soil and water conservation districts (VA, WA) State grants and loans for water management (CA Dept Water Resources) State funds for research, demonstration practices, education, etc. (e.g., MN Clean Water Fund) Tax credits (WI, AK, PA) MN One watershed, One Plan, Multipurpose Drainage Management Plan H2Ohio	NY Watershed (headwaters ag/forest planning)	Iowa State STRIPS Project; Demonstration Projects (Farmer to Farmer) various (e.g., IA) MN Clean Water Fund (constitutional amendment and lottery funds) Land grant university research (combination of extension and grants) Iowa Leopold Center (funding now goes to nutrient research center—interesting funding mechanism through tax on fertilizer industry) Illinois- tax on fertilizer goes to Nutrient Research and Education Council (NREC)	Peer Learning exchange (SWCS Specialty Conferences) Recognition programs (e.g., Water Prize, IA)
Regional/ Watershed	CWA TMDLs (e.g., Chesapeake Bay, Lake Champlain) Water quality pollution trading (under CWA) (ID)	HB1422 Chesapeake Bay – voluntary adoption initial phase (VA)	Gulf Hypoxia Taskforce RCPP and CIG (USDA & NGO partnerships) NFWF grants (various) Multistate Conservation Grants Program (USFWS & Association of Fish and Wildlife Agencies)		SARE North Central Region Water Network (consortium of extension with funding for research, education, and outreach) NRCS collaboration between AK, MS, and LA	GLRI Edge of Field watershed monitoring project (NY)

APPENDIX B: RECOMMENDATIONS – DETAILED ACTION ITEMS

The following matrix outlines both immediate and long-term action items that can be implemented to accomplish each pillar's goals, both legislatively and otherwise, on federal, state, and local scales. "Immediate" means those policy or other actions that can be carried out now, especially those actions that could provide "wins" galvanizing further progress and/or serve as proof of concept. "Longer Range" means those recommendations that have a longer horizon in terms of laying the policy groundwork, mobilizing constituents, and/or generating on-the-ground results. Although these action items do not comprise the full scope of strategies that could be implemented to advance each goal, we believe these actions have the greatest potential for scaling adoption of Edge of Field practices. This analysis of immediate and longer range action items to accomplish each goal informed the development of the synthesized recommendations described above.

CATEGORY	IMMEDIATE	LONGER RANGE
Pillar One: Build the Economic Case **A) Develop market-based solutions** **B) Increase & better target public investments** **C) Integrate EoF practices within whole-farm operations as a tool to diversify farm income & enhance financial risk management**	• Leverage federal funding opportunities and programs to grow regional and local ecosystem markets through climate change and stimulus/infrastructure legislative proposals that support ecosystem market development (especially with participation of downstream beneficiaries) and payment to producers for such services with a focus on priority resource concerns at the landscape, watershed, and sub-watershed levels. (e.g., through clean water market development transform drainage ditch governance) Market-based solutions should be designed to focus on resource priorities and be outcome based (Drinking Water State Revolving Fund, Clean Water State Revolving Fund, stimulus/green infrastructure—engages states). (Goals A, B, C) • Make use of yield data and input data to demonstrate where farmers are losing money and where EoF installation would be ideal a standard practice by linking voluntary adoption to farm bill subsidies such as preferential crop insurance rates, allowing farmers to claim APH even for land taken out of production, etc. (Goals A, B) • Remove administrative barriers to conservation practice adoption (e.g., conflicting policies between crop insurance and conservation programs, barriers to "stacking" conservation practices)—in many cases does not require legislative change. (Goals B, C) • Support disaster/FEMA appropriations and programs that fund green infrastructure projects and installation of EoF practices, including funding tech expertise like engineering. Tie green infrastructure to downstream beneficiaries as part of the financial incentive for installation (risk reduction + revenue) (Goals A, B, C) • Coordinate RCPP or CIG grant applications among partners to achieve proof of concept (EoF as revenue and risk mgmt.) and drive larger scale change on the ground. (Goal C)	• Farm Bill 2022—include policies to grow ecosystem markets, e.g., amend section 2709 and fund it, and sustainable supply chains with added value captured by producers. Revamp the Federal Crop Insurance Program to encourage and reward adoption of conservation practices that reduce crop risk and generate ecosystem services; authorize CCC to serve as an ecosystem credit backstop to encourage market development and maintain market prices above a certain level. (Goals A, B, C) • Increase funding for regional, collaborative approaches such as CIG and RCPP, pilot block grant approaches, reduce administrative burden (i.e., do not reduce funds for farmer contracts under CSP, EQIP, but shift emphasis to regional approaches through increased funding in programs like RCPP/CIG). Goal B) • Support state leg funding mechanisms like MN tax water fund. Tax source provides dedicated funding not reliant on annual appropriations. (Goal B)
Pillar Two: Build Capacity to Implement **A) Develop a coordinated, national plan for agriculture policy** **B) Promote & enable watershed-level & regional planning & leadership** **C) Invest in technical assistance**	• Establish an office of ecosystem services, nature-based solutions, and climate resilience to coordinate regional efforts and align with national policies (Goals B, C) • Include improvements to NRCS technical assistance capacity in annual appropriations, climate or stimulus legislation. (Goal C)	• Include national ag policy language in the 2022 Farm Bill. (Goal A) • See Pillar One, Goal B above, shift conservation funding emphasis to regional, landscape programs such as CIG/RCPP without reducing EQIP/CSP funding. (Goal B) • In the farm bill, fund increased Extension and NRCS technical capacity, including recruiting from colleges with an emphasis on growing diversity/fully fund extension. Fund a new program to train CCAs and NGOs in EoF and other practices that improve resilience, reduce nutrient losses and create revenue. (Goal C)
Pillar Three: Elevate a Culture of Stewardship Innovation **A) Build a shared understanding among farmers & their partners of the role of EoF practices as part of a systems approach to improving conservation and water management** **B) Harness the momentum & capacity of groups already working with producers on in-field practices** **C) Activate farmers, stakeholder groups, and other leaders who can influence and overcome barriers to adoption**	• Develop affinity groups among corporate sustainability efforts, municipal water/US water, NGOs and philanthropy to increase awareness, develop shared EoF understanding, legislative proposals and project collaborations. (Goals A, B, C) • Leverage state action in areas like soil health to bootstrap in EoF practices. Map spheres of influences. (Goal B) • Host (NRCS, conservation partners, NGOs, conservation districts, etc.) farmer and community conversations, peer-to-peer learning re: EoF benefits. (Goal C)	• Align policies so that financial assistance, tech assistance, and the safety net work together to reduce risk and improve outcomes by shaping producer behavior through federal benefits. (Goal A) • Create certification programs, training, and/or financial incentives for technical assistance providers (including CCA) to help promote EoF practices in the 2022 Farm Bill. (Goal B)
Cross-cutting **A) Science, Tech, Data** **B) Aligned Policy and Programs** **C) Communications & Outreach**	See recommendation synthesis.	See recommendation synthesis.

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