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MARKET DRIVERS FOR THE ILLINOIS NUTRIENT LOSS REDUCTION STRATEGY

OCTOBER 2017

Part 1 of 3: Market Drivers Overview

This whitepaper provides an overview of various potential market drivers that could be leveraged in Illinois to advance the implementation of the Illinois Nutrient Loss Reduction Strategy (NLRS). These range from existing initiatives to new approaches that have not yet been implemented at a large scale or in the agricultural sector.

This document is one part of a series of three documents created by Delta Institute to illuminate opportunities for various stakeholders to support NLRS implementation.

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About Delta Institute

Established in 1998, Delta Institute is a Chicago-based nonprofit organization that collaborates with communities to solve complex environmental challenges across the Midwest. Delta Institute works to achieve landscape-level impacts through its agriculture and water quality programs by working in partnership with farmers, agricultural retailers, local and national nonprofits, conservation districts, and state and federal partners.
Visit online at www.delta-institute.org.

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ACPF – Agricultural Conservation Planning Framework
AFT – American Farmland Trust
AOI – Area of Interest
ARS – Agricultural Research Service
BMP – Best Management Practice
BOD – Biological Oxygen Demand
CC – Corn/Corn Rotation
CCS – Conservation Cropping System
CS – Corn/Soybean Rotation
CEAP – Conservation Effects Assessment Project
CWA – Clean Water Act
GHG – Greenhouse Gas
GIS – Geographic Information System
GMO – Genetically Modified Organism
HUC – Hydrologic Unit Code
LiDAR – Light Detection and Ranging
MAEAP - Michigan Agriculture Environmental Assurance Program
MLRA – Major Land Resource Area
MRCC – Midwest Row Crop Collaborative
MRTN – Maximum Return To Nitrogen
MWRD – Metropolitan Water Reclamation District of Greater Chicago
NASS – National Agricultural Statistics Service
NGO – Non Governmental Organization
NLRS – Nutrient Loss Reduction Strategy
NPS – Non Point Source
NRCS – Natural Resources Conservation Service
NTT – Nutrient Tracking Tool
POTW - Publicly Owned Treatment Works
PWSLP – Public Water Supply Loan Program
RMA – Risk Management Agency
SASB – Sustainability Accounting Standards Board
SEC – Securities and Exchange Commission
SRF – State Revolving Fund
STEPL – Spreadsheet Tool for Estimating Pollutant Load
T- Soil Loss Tolerance
US EPA – United States Environmental Protection Agency

INTRODUCTION

Water quality issues associated with excessive nutrient loads are globally pervasive. In the U.S., Gulf of Mexico eutrophication and hypoxia have received considerable attention from regulatory and legal perspectives, as well as from the media. To reduce nutrients flowing into the Gulf from the Mississippi River, which has the largest drainage in North America, US EPA developed the Gulf Hypoxia Action Plan in 2008, and Illinois completed the Nutrient Loss Reduction Strategy (NLRS) in 2015 for use as a roadmap to achieve the following necessary nutrient reductions in the state:

Nutrient	Interim Milestone (2025)	Target
Nitrate-nitrogen	15%	45%
Total phosphorus	25%	45%

Water quality data collected in Illinois rivers and streams over the past three decades suggests that annual loadings of nitrogen and phosphorus continue to rise despite efforts to implement more conservation practices and reduce pollution. Annual nitrogen and phosphorus loads average at approximately 412 million lbs and 35 million lbs, respectively, with fluctuations reflecting variability in annual flow conditions.[1] The NLRS estimates annualized costs over $800 million to achieve meaningful nutrient reductions in Illinois.[1] Agricultural conservation programs offered by USDA in Illinois between 2011 and 2014 provided approximately $150 million per year while US EPA's Section 319 Grant Program to address the full range of nonpoint source (NPS) pollution funded about $6.5 million for projects in the state.[2,3] Furthermore, facilities that discharge wastewater into Illinois waters are facing increased pressure to reduce their nutrient loads. To meet NLRS goals and obligations under the Clean Water Act, point sources are committing to significant infrastructure investments, novel governance structures, and technological innovations for resource recovery.

A potential gap of over $600 million a year to support NLRS implementation illustrates that current policies and voluntary conservation programs, both in terms of financial capacity and implementation levels, will not be sufficient to achieve the long term reduction targets. Implementation of conservation practices at much higher levels across the state, as well as diversification of crops and cropping systems that reduce nutrient losses, will be necessary to see impact. To close the gap, there is a need to leverage and develop new market based solutions that can disrupt the status of quo in ways that incentivize conservation innovation and unlock new funding streams to make agricultural food systems economically and ecologically sustainable. Market mechanisms vary greatly, though they have the potential to integrate and amplify actions across the value chain from producers to retailers to investors, driving changes in cropping systems more efficiently and providing financing for conservation practices.

This white paper provides an overview of existing and potential market drivers that can be leveraged to improve water quality and soil health given the ambitious nutrient reduction targets adopted by the state.

ILLINOIS NUTRIENT LOSS REDUCTION STRATEGY

While water quality has improved dramatically since the passage of the Clean Water Act, excessive nutrients in waterways continue to cause impairments in the Great Lakes, the Chesapeake Bay, and in the Gulf of Mexico. To address the water quality issues in the Gulf of Mexico, US EPA and states contributing to the loading of nutrients, nitrogen and phosphorus, into the Mississippi River have agreed upon aggressive reduction targets (45% reduction from baseline) and developed plans to achieve them. The Illinois NLRS synthesized decades of water quality data in Illinois and illustrated the pervasive nature of the problem - since the 1980s, nutrient loads have remained consistent despite significant investment in voluntary conservation measures (**Figure 1**). In order to be able to cut the amount of nitrogen and phosphorus entering Illinois waterways by nearly half, it is important to understand the existing land use and land management trends behind what ends up in the rivers and streams that ultimately drain into the Mississippi River Basin.

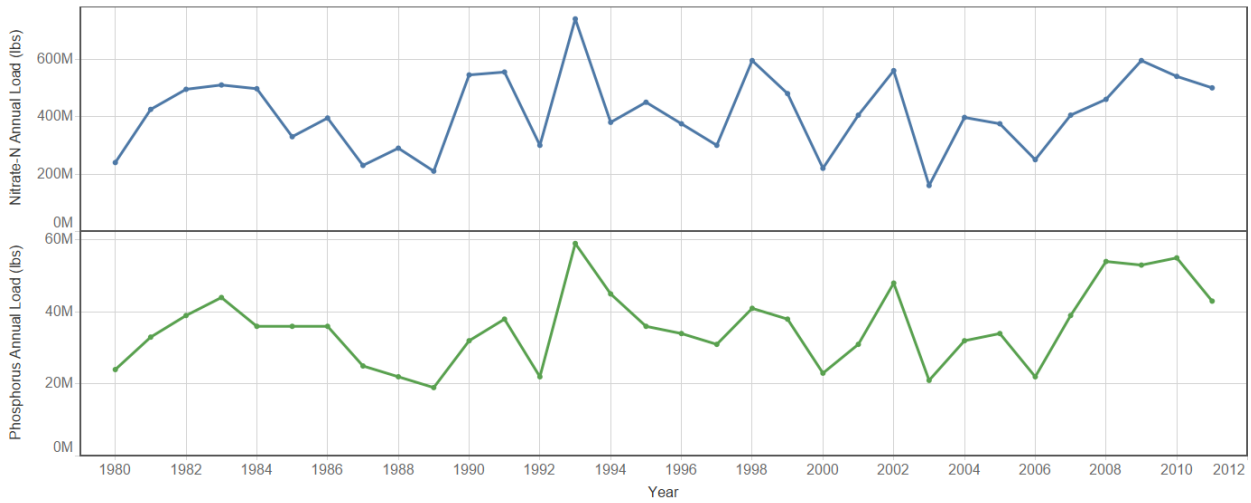


Figure 1 Annual Illinois nutrient loading from 1980 to 2011. Top panel: nitrate-nitrogen; Bottom panel: total phosphorus. Fluctuations correlate closely with riverine flow, see NLRS for primary data – Figure 3.3. Note: the values are approximate - reproduced from

Approximately 60% of Illinois land is in row crop agriculture, ranking 2nd in the US in corn and 1st in soybeans, as shown in **Figure 2**. According to the USDA-NASS Cropland Data Layer for Illinois in 2016 the major crops by acreage is: 11.5 million acres of corn, 9.6 million acres of soybeans, 324,000 acres of soybean /winter wheat (double-cropped), and 110,000 acres of winter wheat.[4]

Most of the remaining land use is made up of 5.7 million acres of forest, 3.2 million acres of grass and pasture, and 4.2 million acres of developed areas. Furthermore, there are 1,660 facilities that discharge into Illinois waters, with 263 facilities designed to handle at least 1 million gallons per day. This list also includes the 7 facilities operated by the Metropolitan Water Reclamation District of Greater Chicago, among them, the largest wastewater treatment plant in the world. As such, both,

agricultural nonpoint sources and permitted point source facilities are significant contributors to nutrient loading into the Mississippi River Basin, with the breakdown as follows:

Nutrient	Agricultural	Point Sources	Urban Runoff
Nitrogen	80%	18%	2%
Phosphorus	48%	48%	4%

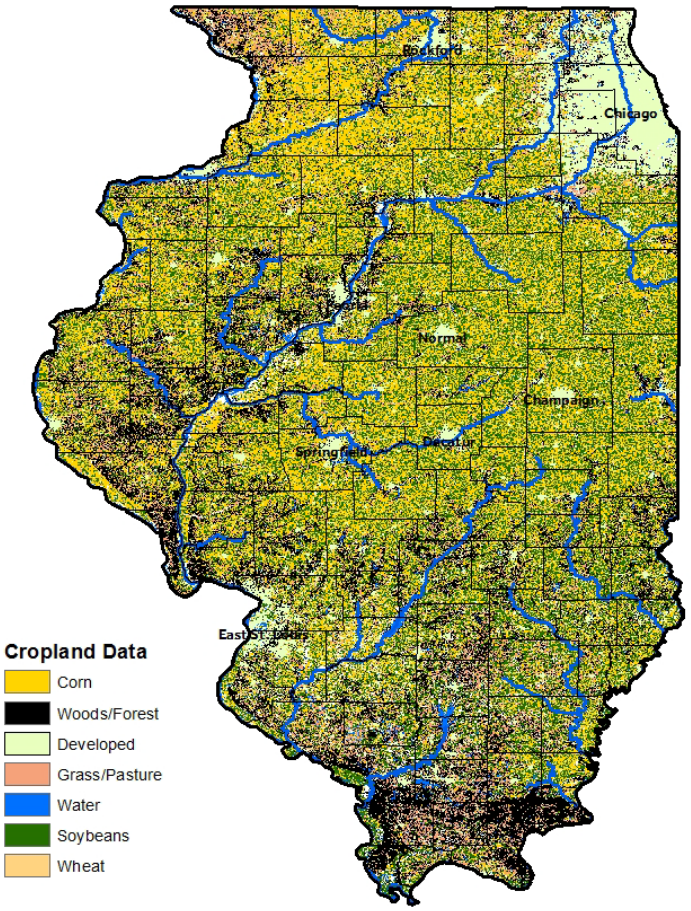


Figure 2 Illinois land use and crops for 2016.

In regard to achieving nitrogen reductions needed, it is important to recognize that average nitrogen application rates for most common crops in Illinois have remained steady (**Figure 3**), with corn consistently ranking highest for nitrogen intensity at about 160 lbs of fertilizer applied per acre. Historical trends for key crops planted and corn prices in Illinois can be found in the Appendix. In 2014, the most recent year for which data is available, USDA reported that over 1.9 billion lbs of nitrogen fertilizer was applied on Illinois corn acres. On average, Upper Midwest corn crops can expect to lose 22% of nitrogen applied through subsurface and surface flows (60% used by the crop, with the remaining 18% lost through volatilization and windborne sediment).[5] Comparing this to

documented nitrogen loads shown in **Figure 1**, nitrogen loading from corn would total roughly 422 million lbs (22% of 1.9 billion). It's apparent, then, that nitrogen application and loss associated with corn production dominates nitrogen dynamics in Illinois.

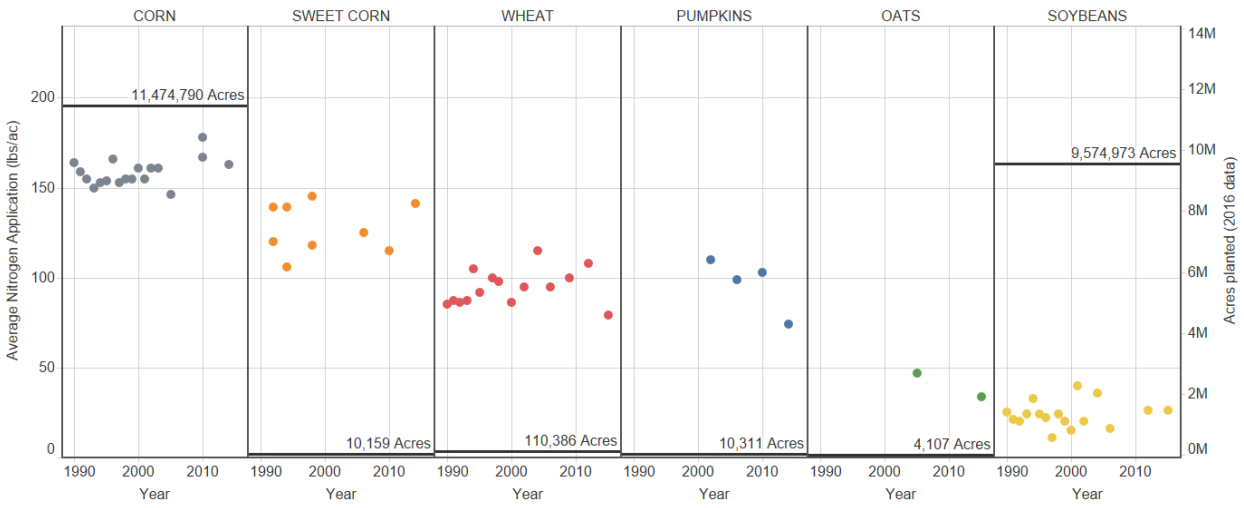


Figure 3 Average nitrogen application rates (lbs/ac) for common crops produced in Illinois between 1990 and 2015. The secondary axis shows the total crop acres planted for each commodity. Data Source: USDA National Agricultural Statistics Service.

Due to the significance of the nutrient contribution from agricultural sources, with row crops such as corn and soybeans in particular, the NLRS identifies a suite of agricultural conservation practices to serve as a roadmap for reaching the reduction targets. The strategy also models potential reductions associated with their implementation. The scenarios are based on Major Land Resource Areas (MLRAs) in the state and assess nitrogen and phosphorus reductions from a range of practices including edge-of-field, in-field, and land use changes. These practices include installation of bioreactors, buffers, conservation tillage, cover crops, nutrient management, perennial & energy crops, and wetlands (detailed in the Appendix). The Conservation Cropping System (CCS) strategy, which calls for a more holistic approach to conservation aimed at enhancing soil health and function alongside productivity and environmental protection, also includes practices such as employing extended crop rotations, drainage water management, and strip crops.[6]

Because these practices form the basis for the implementation of the NLRS, the discussion about the potential capacity of various market mechanisms will begin to establish linkages between the approaches proposed in NLRS and what could be feasible as part of employing a particular market strategy. The priority watersheds identified in the NLRS and categorized based on significance of the contribution from agricultural and point sources (see map in the Appendix) will inform which market mechanisms have the potential to be successful and areas to test and apply them.

There is no doubt that producers in Illinois respond to global market signals. Current corn prices are currently half of their peak value in 2012 (see Appendix for historical trends), leading to decreased returns for farmers. Already, USDA expects to see a large acreage shift from corn to soybeans in 2017 and projects that corn prices will remain near current levels through the next decade ($3.30 to $3.70 per bushel).[7,8] The low price regime for corn could lead to a system where market drivers can create tipping points for agricultural production in Illinois and beyond. Illinois decision makers, conservationists, producers, and other stakeholders seeking to improve water quality in Illinois should be prepared to harness and develop market mechanisms in the successful implementation of the NLRS.

MARKET DRIVERS

Defining Market Drivers

Nutrient loss in Illinois has been driven by market dynamics that have not fully taken into account the negative environmental externalities of production. While this can be viewed as a market failure, there are opportunities to use a suite of market drivers to reduce nutrient loss and improve the performance of Illinois agriculture. Local and regional water quality externalities are poorly constrained, and there has been limited uptake of technology, policy, or financial mechanisms to address this complex set of challenges. There are several market-oriented mechanisms that can be implemented to help to realign the public and private benefits from Illinois agriculture. Each of the example programs or initiatives described in this section is applicable in Illinois, and in broader geographies as well (**Table 1**). Specific programmatic examples are drawn from across policy, supply chain, land valuation and leasing, and supporting innovators. While each of these interventions could be piloted and scaled independently, there are synergistic opportunities between many of the programs that could be leveraged for greater ecosystem improvements. The programs highlighted here are designed for a range of stakeholders. They include capital markets, investors, supply chains, states and municipalities, and producers. There is always an interplay between market drivers in a globally connected marketplace, and the content here is focused on innovative market approaches that could have a measurable impact on Illinois nutrient loss.

Market Driver	Scale	Readiness/Feasibility	Barriers	Actions needed to overcome barriers
State revolving funds	Statewide implementa-tion, project scale	Established mechanism, but few ag NPS projects; Need to grow participation, and link with revenue generating activities	Illinois has a poor bond rating to grow fund; loan repayment; Higher priority of non-NPS projects	Incorporation of language in revised SRF rules that prioritize agricultural nutrient focused projects.
Watershed protection utility	Statewide implementa-tion	Conceptual; Need broad buy-in and likely legislative authorization	Non-conventional partnerships and new governance structure	Establishment of statewide governance structure as a Special Purpose District (via legislation) or a Public Utility (via petition to the Illinois Commerce Commission)
Pay for performance	Field to watershed scale	Piloting	High frequency & resolution data needed; Lack of numeric nutrient standards	Network of real time in-field and stream monitoring stations; Establishment of nutrient water quality standards
Supply chain partnerships	Field scale to statewide	In progress	Lack of financial/technical support to producers	Additional public and private support for technical assistance in CCS.
Consumer demand	Direct demand driver	In progress, opportunity for large growth	Need to create more demand; Consumer education	Dedicated marketing campaign around the food, health, and environmental benefits of CCS.
Land valuation	Field scale	Conceptual	Lack of explicit connection between soil health and land value; unanticipated negative outcomes	Research into soil health/land valuation connection and design of pilot framework.
Financing soil health	Field scale	Conceptual	Rigidity of government programs, unclear pathways to market-rate returns	Quantified financial risk/returns from CCS needed to change lender underwriting practices
Lease agreements	Field scale	Piloting	Increased complexity	Identification and outreach to landowners, development of template lease agreements
Risk mitigation innovation	Field scale	Conceptual	Limited replicability or data to support expansion of practices and programs	Incorporating new types of risk mitigation into USDA's FSA, RMA, and NRCS programs.
Investors and materiality	Supply chain with variable scaling	In development	Lack of adoption by regulatory agencies, long supply chains with distributed responsibility for negative externalities	Development of framework to distribute responsibility of nutrient pollution across the supply chain.
Continuous Living Cover	Field to landscape scale	In development	Adoption of practices by producers	Plant breeding, agronomic system development, markets for novel crops.

Table 1. Overview of market drivers that can be developed and implemented in Illinois.

Financing Innovations in Nutrient Reduction

Low-cost pollution control financing

The State Revolving Fund (SRF) is a permanent, independent source of low-cost financing for eligible recipients to control pollution and improve environmental quality. The SRF includes basic loans, purchase or refinancing of debt, guarantees and insurance, guaranteed SRF revenue debt, loan guarantees, or additional subsidization. Illinois EPA administers two SRF loan programs: the Public Water Supply Loan Program (PWSLP) addressing drinking water systems and the Water Pollution Control Loan Program (WPCLP) focusing on wastewater and stormwater infrastructure.

In Fiscal Year 2017, Illinois allocated approximately $386 million for the WPCLP.[9] While this may not be a financing strategy applicable to particular conservation practices, **the Clean Water Initiative expanded eligibility of the loan program to include nonpoint source pollution control projects related to agriculture and stormwater management.** The state agencies issue loans for conservation programs and local jurisdictions, and publicly owned treatment works (POTWs) apply and use loans for their conservation programs with direct linkages to water quality or protection. Examples of projects that can receive WPCLP loans include: "Publicly-owned septage receiving facilities, urban stormwater runoff, stream corridor restoration, forestry best management practices, development best management practices, agricultural runoff controls, 'green' infrastructure, and other nonpoint source pollution control projects as allowed under the Clean Water Act (CWA) Section 319(h) and Illinois EPA's NPS Management Program."[9]

The SRF provides a reliable source of funds to recipients who want to start conservation programs related to water quality or source protection with guarantees in place for repayment of the loans. Currently, the SRF is primarily utilized by point sources or municipalities to implement pollution control projects and programs, including nutrient reductions, due to their ability to generate revenue to pay back the loans.

For agricultural conservation programs to be able to utilize this financing mechanism, the conservation program needs to be economically beneficial and identify additional sources of revenue to pay back the loan. Pending approval of draft rules, private entities will also be eligible to apply for direct loans for NPS pollution controls. Illinois EPA will also be incorporating BMP rankings (related to environmental and economic effectiveness) into the WPCLP scoring system. Proposed rankings for the practices in the NLRS vary: constructed wetlands and bioreactors rank high, implementation of CCS as well as all but one other NLRS practice are ranked medium with the exception of perennial/energy crops, which are not included.[9] The expanded scope of the program will need to be coupled with additional outreach and administrative support to grow participation among producers. Iowa has developed and adopted a number of programs that expand the SRF for financing NPS projects. Local Water Protection and Livestock Water Quality Programs work with a

network of lenders and Soil and Water Conservation Districts to finance eligible projects complementing cost-sharing conservation programs, providing approximately $5 million in low interest loans in 2016. Iowa SRF also created a Sponsored Projects Program that allows for financing of restoration projects and NPS pollution control practices through an innovative approach that allows the borrowing utility to support a NPS project in the area. These sponsored projects are funded by a portion of the loan interest on the traditional infrastructure financing loan.

To expand capacity in the near-term, the SRF programs may issue bonds guaranteed by SRF funds. The revenue generated is used to provide assistance to borrowers. A green bond is designated for specific eligible projects addressing environmental issues. The green bonds may be issued by the government agencies and sold to investors for a set term. The entities that buy the bond expect a safe return on their investment. Organization and local jurisdictions use the proceeds from the sale of the green bond to fund conservation work. The green bond market has been expanding rapidly in the past several years with $81 billion issued in 2016 globally, with 14% of proceeds used for water projects and another 2% for agriculture and forestry projects.[10] Among government agencies in the Midwest, in 2016: the City of Cleveland issued its first green bond for wastewater management ($32.4 million); the City of Saint Paul issued green bonds for sustainable water ($7.7 million); and the Indiana Finance Authority and Iowa Finance Authority issued green bonds for wastewater and drinking water projects for $115.8 million and $163.3 million, respectively.[11,12]

While this is a good financing mechanism in certain states, this currently may not be feasible in Illinois due to its current bond rating. The use of green bonds may be more viable in local counties and municipalities with better bond ratings. Bonds also require a source of revenue for repayment, such as charges to water utility customers, and additional third party certification of the green bonds would ensure increased impact and transparency.

Watershed protection utility

During the Mississippi River Nutrient Dialogues of 2013 and 2014, a process led by the U.S. Water Alliance with contributors from across the Basin, the watershed protection utility emerged as one of four key strategies to address excess nutrients in a collaborative and long-term manner.[13] The resulting report describes this quasi-public utility as integrating efforts around watershed-based leadership, market mechanisms, and robust data infrastructure. This structure closely resembles the "water resources utility of the future" concept developed in a 2013 joint report by the National Association of Clean Water Agencies, Water Environment Research Foundation, and Water Environment Federation.[14] In both visions, the utility model shifts from centralized treatment of wastewater to strategic partnerships for reuse and recovery of valuable resources.

Illinois could establish a watershed protection utility as a novel institution to coordinate and distribute funding for the most cost-effective nutrient loss reduction projects across the state,

accelerating the pace of implementation through a more streamlined process. As a formal mechanism for linking point source demand to NPS supply of nutrient reductions, this concept would also be compatible with a pay-for-performance approach to rewarding farmers for their conservation efforts. Depending on its legal structure, the utility could be funded by a variety of sources ranging from grants to a new surcharge on water bills. Though the NLRS charged the Policy Working Group with further investigating this concept, no developments have been reported publicly beyond their initial meetings in late 2015. During that time, the Metropolitan Water Reclamation District of Greater Chicago (MWRD) announced the launch of a stakeholder steering committee and a white paper to demonstrate the feasibility of the concept. According to a discussion draft from February 2017, the utility is envisioned as a management company dedicated to meeting the objectives of NLRS by directing investment into the lowest-cost nutrient reductions across the state.

Leveraging Supply Chains

Supply chain partnerships

In recent years, the agricultural sector has launched numerous initiatives to educate and support voluntary nutrient loss reduction. These have ranged from N-WATCH, an on-farm soil testing program in Illinois, to the 4R Nutrient Stewardship Certification Program for agronomic service providers, to partnerships that establish goals for the entire supply chain. In August 2016, the Midwest Row Crop Collaborative (MRCC) was launched to support implementation of agricultural conservation practices in Illinois, Iowa, and Nebraska where row crop agriculture plays a significant role in excessive nutrient loading in the Upper Mississippi River Basin. In addition to addressing water quality impairments, MRCC will be working to address greenhouse gas emissions associated with fertilizer use and depletion of groundwater in the Ogallala Aquifer. The founding members of MRCC include Cargill, Environmental Defense Fund, General Mills, Kellogg Company, Monsanto, PepsiCo, The Nature Conservancy, Walmart, and World Wildlife Fund. The companies involved are key players in the food production (primarily corn, soy, and wheat) value chain from seeds to retail.

There is direct alignment between the targets set in the Gulf Hypoxia Task Force action plan, and the respective state nutrient reduction strategies, and MRCC's goals. Ultimately, by 2035, MRCC actions would lead to Illinois, Iowa, and Nebraska meeting the 45% nutrient loss reduction goal, and expanded partnerships and goals across the Upper Mississippi River Basin. As interim goals, MRCC aims to achieve the following by 2025:

- 75% of row crop acres in Illinois, Iowa, and Nebraska are engaged in sustainability measures utilizing Field to Markets Fieldprint Calculator to optimize water quality and soil health outcomes.

- 20% reduction of nitrogen and phosphorus loading from Illinois, Iowa, and Nebraska as a milestone to meet agreed upon Gulf of Mexico Hypoxia Task Force goals.
- 50% of all irrigation units used in Nebraska will maximize water conservation to reduce pressure on the Ogallala Aquifer

The MRCC strategies to achieve these goals include engaging farmers through the Soil Health Partnership and providing training and technical support to increase adoption of cover crops and fertilizer optimization practices. These practices align with several of the practices highlighted in the Illinois NLRS. In particular, a concerted effort to increase cover crop implementation in Illinois has the potential to reduce nitrogen and phosphorus losses by 30% (per acre), and 50% phosphorus reduction for extended rotations. Fertilizer optimization practices, such as nitrification inhibitor application, split applications, and rate optimization, could reduce nitrogen losses by 7.5-20%, depending on simulation parameters.

The MRCC will utilize Fieldprint Calculator as a tool to optimize for environmental outcomes, which is already integrated into the companies' responsible sourcing goals more broadly. Walmart also uses Adapt-N to support their fertilizer optimization goals in the sustainability index applied to their supply chain. Though these tools seem to be well aligned with the focus of the collaborative, their use by growers, crop advisors, and on-the-ground conservation professionals is currently limited. The Collaborative's ambitious targets have the potential to drive consequential changes in Illinois cropping systems. Kellogg, General Mills, and PepsiCo include corn, soybeans, wheat, and oats among the top 10 priority ingredients in their sustainable sourcing targets for 2020. General Mills' 2016 Sustainability Report indicates that only 26% of the corn in their production chain meets the standard.[21] Furthermore, Walmart's 2020 target is to ensure that its top food suppliers work with farmers to optimize their fertilizer use and reduce greenhouse gas emissions on 10 million acres of corn, wheat, and soybeans. Protecting soil, managing nutrients, and optimizing productivity for crops such as corn and soybeans are key components of Monsanto and Cargill sustainability goals as well. By building local capacity and offering producers and agricultural professionals in Illinois technical resources and support, MRCC can catalyze implementation of practices that will help them make progress toward nutrient reduction targets.

Continuous Living Cover

New agronomic approaches and plant breeding efforts have focused on creating or adapting varieties of plants that will not only develop novel cropping systems, but will create marketable products. One example of such a cropping system is a Continuous Living Cover (CLC) farming system.[22] The goal within CLC systems is to maintain living roots in the soil throughout the year, **leading to increased carbon sequestration, decreased erosion and nutrient loss, and improvements in soil health.** Strategies to maintain CLC systems can be achieved through the

combination of cover crops, perennial forages, agroforestry, perennial biomass, and perennial grains.

Although widespread adoption is limited as many elements of CLC systems are still being developed and the planted acreage of these crops are low, revenue-generating crops like Kernza®, pennycress, and winter camelina are beginning to enter the marketplace. Kernza® is the trade name of an intermediate wheatgrass developed by The Land Institute as part of their broader portfolio of perennial polyculture crops being developed.[23] While it has been in development for nearly 30 years, recently there has been significant excitement in the marketplace these sustainable crops. In 2016 Patagonia Provisions released a beer containing Kernza®,[24] and in 2017 General Mills announced that they would be incorporating the grain into their Cascadian Farms products.[25]

Pennycress and winter camelina are two other crops being developed for use in CLC systems. These crops are fall planted and harvested in early summer, producing greater revenue per acre than traditional cover crops. Camelina can be pressed into food-grade oil and presents an alternative to other cooking and baking oils. Pennycress can be used for biodiesel and is being commercialized by Arvegenix26.

These three crops are examples of market-driven solutions that provide revenue for farmers and reduce nutrient loss by maintaining living roots in the soil. Research, development, and market-building will continue for these crops and agronomic systems, hopefully demonstrating a viable and scalable approach that benefits producers and the environment. Implementing CLC systems and keeping the soil covered throughout the year can also provide additional opportunities to generate income to maximize the generation of saleable products.

Opportunities for consumers to drive agricultural conservation

Commodity crops and the systems that support their development are well understood, well developed, and create an efficient movement of goods from sellers to buyers. This creates a transparent transaction process that facilitates market success. In order for CCS to be more widely adopted, the same market efficiencies must exist that facilitate the development of a diverse production system of food, feed, fiber, and fuel.

Consumers hold a lot of untapped power in driving agricultural conservation. While sustainable agriculture encompasses more than just organic farming, organic farming serves as a good proxy to demonstrate that the market could support increased production levels of sustainable crops. While the USDA reported that organic sales reached $37 billion in 2015, the Organic Trade Association found that demand for organic dairy and grains could have supported a further increase in production.[27,28] Consumer demand for differentiated food products continues to grow the market

and drive further production.[29] However, according to USDA, in 2015, there were only 168 organic farms, roughly 0.3% of all operations in the state, with $35 million in total sales.

In addition to organic products, consumer demand in Illinois will likely continue to shift toward healthy, nutritious, locally produced food. Already there are 1,377 operations in Illinois that directly market their products, with $71 million in sales in 2015. Polling of residents in East Central Illinois counties conducted in 2015 by Illinois Environmental Council also indicated that 40% consider sourcing when buying food, and 67% report buying locally grown food some or most of the time (exceeding respective characteristics for organic food). Initiatives such as Regenerate Illinois and the Artisan Grain Collaborative are focused on addressing barriers to growing these markets. Regenerate Illinois, a consortium of stakeholders that is focused on restoring soil health in the state through regenerative agriculture, and the Artisan Grain Collaborative, a collective of practitioners interested in building and strengthening the value chain for diverse grains, have both formed in 2016 to support the markets for regenerative agricultural practices. Initiatives such as these are promoting distribution, processing, and marketing to move products to market and are helping grow the consumer base that will drive demand. Furthermore, they encourage adoption of agricultural systems that promote a holistic approach to land management which will result in reduction of erosion and nutrient losses. By supporting and growing these and similar initiatives, which demonstrate to value chain partners that demand exists, new markets will be created.

In addition to organic certification, there are other state based certification programs that indicate to environmental sustainability consumers. For example, the Michigan Department of Agriculture (MDA) currently operates the Michigan Agriculture Environmental Assurance Program (MAEAP) that assists farmers and operators on a voluntary basis to prevent or minimize agricultural pollution risks on all farms and all commodities. The program has a three-phase process that includes educational opportunities and workshops for interested parties, on-farm risk assessments conducted by certified MAEAP conservation technicians, and a third-party verification making sure that the risks that were identified were addressed and mitigated. The program's four systems - (1) Farmstead, (2) Cropping, (3) Livestock and Forest, (4) Wetlands and Habitats - examine different aspects of the farm. Once the proper systems are identified and the three-phase process has been completed, the farm will then be enrolled into the MAEAP program and can display a sign on their farmstead indicating their certification.

The MAEAP program was launched in 1998 with the first verification taking place in 2002. As of November 2016, 10,000 farmers have started the verification process and more than 3,300 farms have been verified. In 2013, an estimated 347,000 tons of sediment, 592,000 lbs of phosphorus and 1,353,000 lbs of nitrogen have been reduced through implementation of BMP's on certified MAEAP farms.

The 5 STAR (Saving Tomorrow's Agricultural Resources) program, created by the Champaign Soil and Water Conservation District (CSWCD) in Illinois, aims to work with all producers and landowners in Champaign County to assess agronomic practices on all tillable parcels. The landowner or producer will complete a survey regarding crop rotation, tillage practices, nutrient application practices, and best management practices that are currently implemented on their farm. Staff from the CSWCD will then assign a star rating to that particular farm based on the survey results. After a star rating has been assigned, staff will conduct an on-farm visit to assess and offer recommendations on best management practices for improved environmental outcomes.

Another example of a certification program that incentivizes conservation in response to consumer pressure is one developed by Louisiana State University. The Master Rice Grower Program provides incentives to qualified farmers for following sustainable production practices. There are four levels of participation in the program (bronze, silver, gold and platinum), all requiring different levels of participation ranging from attending educational workshops to implementing conservation plans. The farmer will also receive a financial incentive per barrel, depending on their current level.[31]

Similar efforts driving conservation cropping techniques could be implemented in Illinois to create the demand that will drive the establishment of market efficiencies within the value chain. A statute enacted by the Illinois General Assembly in 2000, called the Illinois Rivers-Friendly Farmer Program, was created to promote farming practices that benefit rivers while maintaining farm profitability and to inform the public about farmers' contributions to cleaning up the rivers of Illinois.[32] A farmer seeking the designation may submit a written application to the Department of Agriculture or any agency designated by the department. To receive the designation, farmers need to satisfy the following criteria: soil loss on cropland is at or below the tolerable soil loss level, an approved conservation plan is on file, and vegetative filter strips are implemented.[32] While the Illinois Rivers-Friendly Farmer program has been inactive since 2005 due to lack of staffing and resources, it can be amended in the future to include more aggressive standards coupled with financial incentives for implementation of conservation practices and advancing the NLRS.

Frontiers in Risk Mitigation

Agriculture is inherently risky. Changes in weather and markets can jeopardize farm revenues, and while the USDA supports crop insurance, there are limited incentives to reduce exposure to environmental risks and incentivize innovation in risk mitigating approaches to production. Further up the supply chain, new questions have emerged about the equitable distribution of responsibility from environmental damages from certain production practices between producers and consumers. **While there will always be some elements of risk, there is an emerging set of approaches that scale from the farms to capital markets that could be used to better account for and manage agricultural risk, providing new opportunities and incentives to reduce nutrient losses from Illinois.**

Exposure to water risk in Illinois was compiled using the Aqueduct water risk indicator tool (**Figure 4**), and characterized a majority of Illinois as "high risk" by using a comprehensive set of biophysical and socioeconomic indicators.[33] The high risk areas in Illinois could benefit from the implementation of CCS as a risk mitigation approach. Increasing soil organic matter, as a component of general soil health improvements would increase infiltration and water storage capacity and reduce run-off, reducing risks both locally and downstream. Even with the additional expected stressors from climate change, there are opportunities to mitigate risk from water and other types of environmental factors. These challenges can be addressed through several risk mitigation mechanisms detailed below.

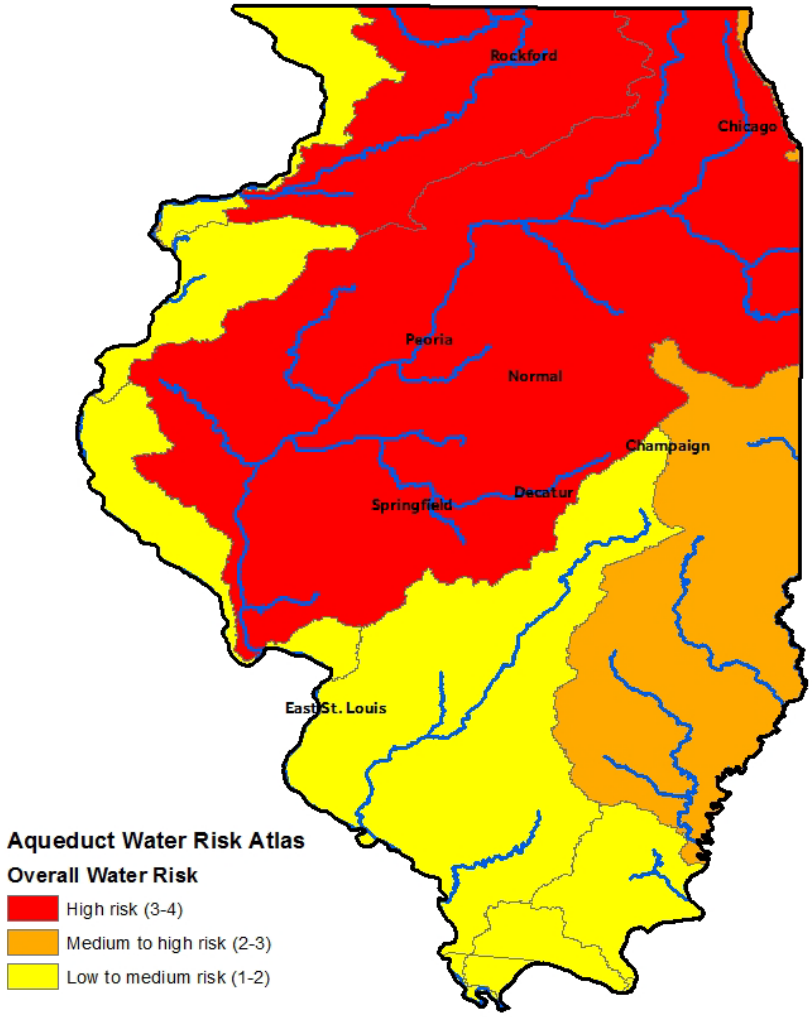


Figure 4 Water risk indicators for Illinois. As part of a global analysis, decision-relevant water risk indicators were calculated and are shown above for Illinois. The figure illustrates the overall water risk for Illinois, showing areas with higher exposure to

Reconnecting soil health to land value

The market value of agricultural land is determined by a mix of local and global economic, policy, and environmental characteristics. Currently, many of these factors are outside of the control of producers. In Illinois, one of the determinants of land value and cash rents is the productivity index, as defined by Bulletin 811.[34] Other states have devised similar mechanisms to connect productivity with land price or rents, like the Corn Suitability Rating 2 in Iowa.[35] Technology companies, like Granular, are also using complex data approaches to value land, as in their Acrevalue tool.[36] These approaches to land valuation discount the internal and external benefits provided by CCS, such as the ability of a healthy soil to facilitate nutrient cycling.

New approaches to land valuation and rental rate calculation are needed to differentiate management systems. While those that concentrate on maximizing productivity often have significant environmental externalities, CCS provides benefits to the producer in terms of carbon sequestration, water storage and drought risk reduction, nutrient cycling, and pest protection. There are few conceptual examples that are being developed, including the Australian based Soil Star.[37] Additional research and development is needed to better understand the trade-offs of modifying farmland valuation and the steps that would need to be taken to integrate this concept into practice. If land values for prime and healthy farmland were to increase, the ability for new and beginning farmers to access that land would decrease. Rental rates would also increase, decreasing producer profitability, unless a market premium was available for products produced on healthy soils. Specific communities that may be interested in this approach would be operator landowners, non-operator landowners, and investors. Each one of those communities has different interests in the short-term and long-term revenue generated by agricultural production that would need to be taken into consideration. In order to begin testing out this concept, the methodologies of professional communities, such as lenders, assessors, and appraisers who concentrate on farmland will need to be assessed. In Illinois, many of these professionals are represented in the Illinois Society of Professional Farm Managers and Rural Appraisers. While soil health may be an implicit component of land valuation, determining the appropriate ways to explicitly connect soil health to land value will help to determine the suite of market drivers that need to change in order to implement this potentially transformational market shift.

Innovations in financing for soil health

Agricultural production is tightly coupled with the financial sector, and innovations are necessary to leverage the power of capital to shift toward CCS and reducing risks for producers and value chains alike. Stranded assets are assets that are written-off, devalued, or converted to liabilities because of their exposure to environmental risks and changes in the market.[38] While this concept has mostly been applied to fossil fuels, it also has applicability to agriculture. For instance, management regimes that result in degraded soils might be more prone to extreme events; synthetic nitrogen fertilizer

could become more costly under climate policy; phosphate availability might be more limited in the future; and heavy tillage equipment might be seen as too risky in the future. Accounting for these risks within underwriting guidelines and other lending criteria might alter the way credit is distributed in agricultural systems. This presents an opportunity to work with investors, lenders, insurance companies, USDA, and companies in the agricultural value chain to better understand the current and future risks, and better align future capital formation with resource conserving and risk reducing agricultural management systems. While the underwriting / lending / insuring criteria and mechanisms differ across the financial supply chain, moving this concept toward implementation would need a thorough survey of the currently used financing criteria coupled with a roadmap for how each type of financing mechanism could be adapted to better support soil health and CCS.

Another example of innovative financing for CCS and soil health outcomes is being piloted by The Nature Conservancy as part of a USDA Conservation Innovation Grant.[39] The project works with commercial lenders and impact investors to reduce the rates of operating loans for producers that implement specific conservation practices that results is both public and private conservation and natural resource benefits. If successful, this approach could be scaled to other agricultural lenders, specifically in the farm credit system.

Leveraging lease agreements to improve conservation outcomes

Average lease terms for farmland in the state are between one and three years.[40] Leases of this length prioritize short-term yield over the adoption of long-term best management practices. One way to encourage more sustainable farming practices is to lengthen these leases or to execute ground leases which allows for increased security and planning on the part of the farmer. Longer term leases allow farmers to capture the investment they make in their fields and may allow them to increase their borrowing capacity.[41] Beyond lengthening leases, similar incentives include leasing with option to purchase, which allows farmers to recoup the investments they make. This strategy is employed by some sustainable farmland investment groups such as Iroquois Valley Farms. Long-term leases can also include rights of transfer and renewal which reassures farmers that the investment they make in sustainable practices and any benefits they receive can be passed on to the next generation.[42] Long-term leases, however, are often more complex, may make securing a loan more difficult, and may just as easily reduce net income in the long run for the farmer as well as the landowner depending on the market trends. Illinois agencies can play a role in guiding management decisions on cropland leased to farmers by the Department of Natural Resources, Department of Transportation, and Department of Agriculture. In 2017, the Department of Natural Resources held nearly 34,000 acres of land under farm leases, 8% of those acres are locked into 10 year terms under the federal Conservation Reserve Program. Most lease rates are at or below market rates.

The Sustainable Agricultural Land Tenure Initiative, a collaboration between Drake University and Iowa State University are exploring programs and policies that lead to agricultural sustainability and stewardship through lease agreements. The initiative aims to provide learning opportunities for

farmers, landowners, attorneys, educators, and public officials, with organizations such as Women Food and Ag Network making it a priority to utilize such resources. Furthermore, American Farmland Trust launched a three-year project in 2017 in two Great Lakes watersheds (Ohio's Portage and Toussaint Rivers and New York's Genesee River) to expand adoption of conservation practices on leased land particularly among women non-operating landowners. The project team also includes research institutions, on-the-ground technical assistance, and agronomic retail sector to enhance outreach and education on this issue. Lessons learned from such projects can help reform leasing agreements in Illinois, where 60% of cropland is leased, as well as other parts of the Midwest. Supporting the implementation of more long-term leases will support on-field and practice-based conservation. This will help achieve the scale up in practices needed to reach the agricultural nutrient reduction goals of the Illinois NLRS.

Opportunities to support innovation in risk mitigation

Crop insurance is an important tool to protect producers from many natural hazards. While the USDA supported programs have evolved since their inception in the 1930s to protect producers' livelihoods against the twinned threats from the Great Depression and the dust bowl, there is need for further reformation to encourage natural resource stewardship and reduction in nutrient losses. Insurance products are not directly tied to natural resource risk, or the use of CCS. There are early efforts[43] to demonstrate the correlations between conservation practices, like cover cropping and reducing risk. Innovators in this space, including representatives of the Soil Health Champions Network, have shown that using practices that increased soil organic matter have made them more resilient to droughts and less likely to require insurance payouts. More data are needed to better understand the relationship between CCS and risk mitigation, in order to formalize these relationships under existing USDA Risk Management Agency (RMA) programs, or other avenues outside of USDA.

Beyond government programs to help mitigate risks, there are limited mechanisms to incentivize producers to innovate in ways that have positive environmental and economic outcomes. **New programs are needed that either financially protect producers that implement novel conservation practices or provide upfront funding to test innovative practices.** Within these conservation innovation programs and across the broader agricultural system, efforts are needed to spread and scale the lessons learned from implementing conservation cropping systems. NRCS could collect agronomic and financial data from recipients of Farm Bill programs, and those data and others could be used to further document the internal and external costs of conservation measures.

Emerging mechanisms for investors

The U.S. Securities and Exchange Commission (SEC) is tasked with protecting investors, maintaining fair, orderly, and efficient markets, and facilitating capital formation. In an age of increasing transparency around the social and environmental impacts of economic activity, new

initiatives, like the Sustainability Accounting Standards Board (SASB), have begun to develop standards for the disclosure of material sustainability information that could be incorporated into SEC filings. SASB has developed standards for 79 industries, including both agricultural products and meat, poultry, and dairy. Inputs to agricultural production are included in the Resource Transformation and Non-Renewable Resource categories covered by SASB.

While producers themselves would not be impacted by regulatory disclosures, many elements of the supply chain could be affected if their activities could be shown to have material impacts on the financial health of the company. For instance, companies might need to disclose information on water withdrawals, greenhouse gas emissions, tillage practices, fertilizer consumption, animal welfare, and use of GMOs. There remains challenges in connecting farmer actions (e.g. fertilizer application and tillage) back to the companies that manufacture the equipment or the inputs. Metrics related to those disclosures may not have been material in the past, but investors are more likely to consider sustainability related returns on their investments in addition to financial returns. Sustainability related disclosures from publicly traded companies that operate in the Illinois agricultural sector may be impacted if their services or products result in negative impacts that were material to the performance of the company.

TOOLS FOR QUANTIFICATION AND IMPLEMENTATION

Economic markets rely on good information to function. Similarly, management decisions should be guided by a robust assessment of economic and environmental benefits associated with those decisions. The variability inherent in ecological systems (hydrology, climate, soils, etc.) as well as cropping systems (rotations, drainage, nutrient application, and uptake) requires intensive monitoring efforts as well as development of models that capture a complex set of interactions and predict relevant environmental parameters. In recent years, many tools and advanced models have been developed. This section provides a brief overview of the tools and their suitability in guiding selection of practices relevant to the Illinois NLRS and evaluate their effectiveness (see Appendix for details about the tools).

	NTT	Adapt-N	Fieldprint	STEPL	ACPF	Practice type
Practices recognized in the IL NLRS						
Buffers			■	■	■	edge-of-field
Bioreactors					■	edge-of-field
Conservation Tillage	■		■	■		in-field
Cover Crops	■		■			in-field
N Rate Reduction	■	■	■			in-field
N Inhibitor Product		■	■			in-field
N Application Timing	■	■	■			in-field
Perennial/Energy Crops						in-field
Wetlands	■				■	edge-of-field
Practices recognized by AFT in the CCS strategy						
Crop Rotation	■		■			in-field
Drainage Water Management	■		■		■	edge-of-field
Strip Crops	■		■			in-field

Figure 5 The relationship between planning tools capabilities and agricultural conservation practices recommended for implementation in Illinois.

The tools highlighted represent a selection of publicly available platforms that are also commonly used by corporate sustainable sourcing initiatives or preferred by government agencies for evaluation and verification. Their capabilities range from estimating nutrient loads to prioritizing areas for siting specific practices to making optimizing fertilizer application regimes. **Figure 5** shows the overlap and gap between NLRS/CCS practices and the tools' abilities to model and estimate the resulting changes. For example, the Fieldprint Calculator can model most of the practices featured in the NLRS (plus several other practices), however nutrient reductions associated with planting perennial or energy crops are not directly addressed by any of the tools highlighted here. **The need**

for multiple tools to quantify results creates a barrier for producers and an inefficiency in synthesizing information in decision making and markets.

While this section provides a brief overview of a subset of publicly available tools, it's important to acknowledge that there are also numerous commercial agronomic tools in use that incorporate yet another set of different parameters and assumptions. Most of them focus on yield rather than attaining soil health and stewardship outcomes, but several are being evaluated through the Environmental Defense Fund's NutrientStar program. There are ample opportunities for better alignment and integration of these tools overall to support land management decisions and link to market signals.

CONCLUSION

The agricultural ecosystem in Illinois is continuously evolving. While the current system is very efficient in producing caloric output, there are many externalities of production, including the extensive loss of nutrients from the system. Looking forward, this white paper presents strategies to adapt, adopt, and invent mechanisms to revive rural landscapes and ecosystems, both in Illinois and in the geographies downstream. While there are a variety of interventions that could mitigate some of the existing challenges, there is a multitude of local and global forces at play involving policy, science, technology, culture, and market dynamics. The challenge in the decade ahead will be that we need to address all of these components of the Illinois agricultural system, realizing that they are embedded in regional, national, and global contexts.

While there are many drivers of change, this report focuses on market drivers that could be used to reduce nutrient loss in Illinois. Many of the market mechanisms explored herein are in need of additional development and support to help the Illinois agricultural community better meet (and exceed) the targets laid out in the Illinois NLRS. For instance, there is little consumer knowledge about the environmental impacts of production systems in Illinois, and the opportunities to improve them. Strategies borrowed from other agricultural sectors could be used to help bridge the gap between producers and consumers to improve the outputs and outcomes of the system in a more synchronous and transparent way. In addition to creating stronger connections between producers and consumers, there are opportunities to create partnerships between producers in different geographies to highlight the human and ecological impacts of nutrient loss. An example of this type of relationship is forming between a farmer-led watershed group in Wisconsin and fishermen from the Louisiana Bayou.[44] These types of interactions help to tell the human story of agriculture, which is a natural complement to the market component highlighted here.

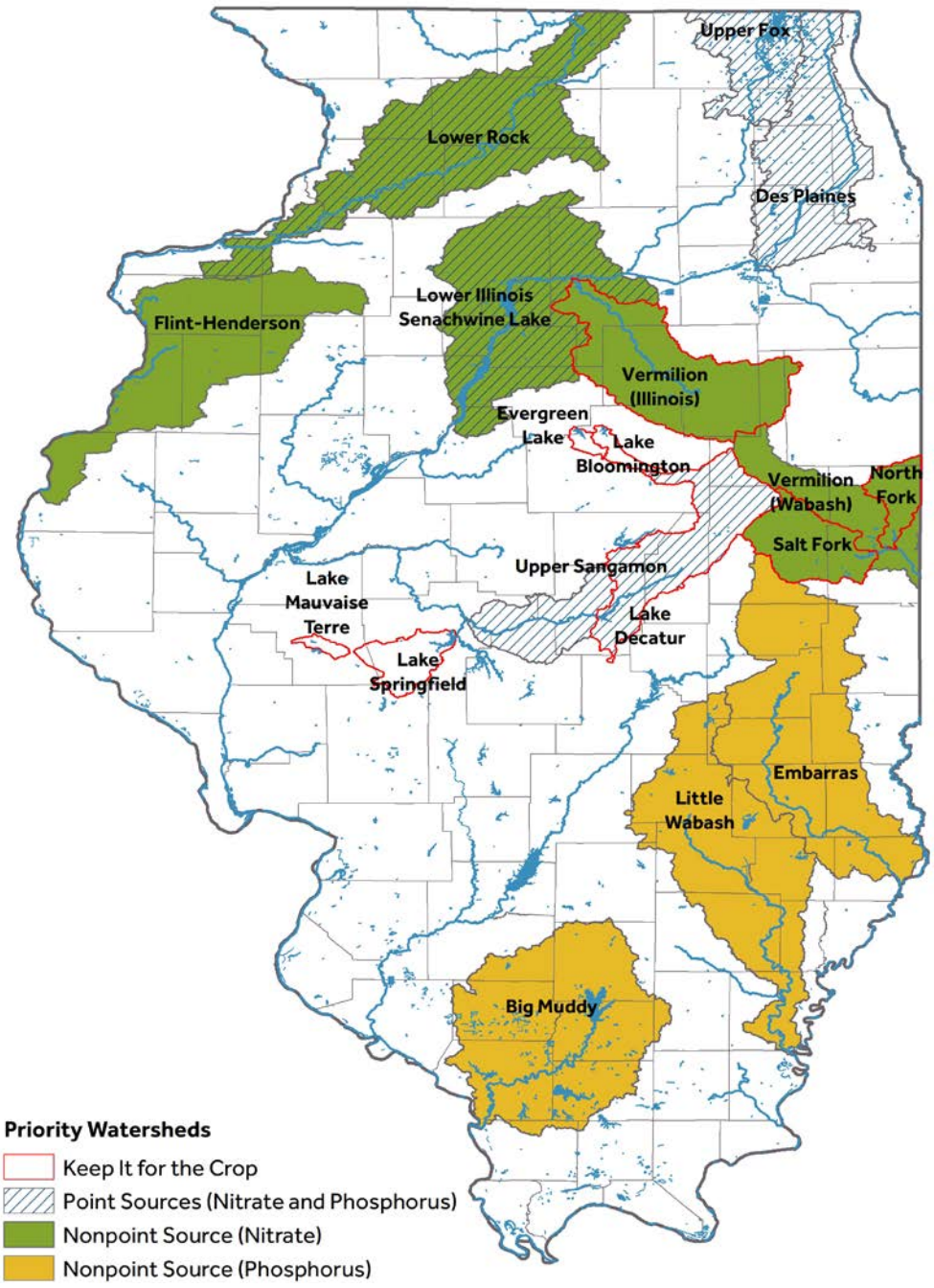
The challenges in reducing Illinois' nutrient loss will not be solved by one organization, policy or market intervention, but will require collaborative, forward looking, and solutions-based approaches to these complex challenges. There are no one-size-fits-all or turn-key solutions, but there are a number of opportunity spaces where the components needed to build the enabling infrastructure for new markets are ready to be deployed. Some of these components are familiar and ready, such as existing crop insurance mechanisms, that if tweaked could help promote CCS. Other components, such as agronomic tools and models have been developed for specific purposes, but could be refined to better meet challenges faced by producers and consumers alike, such as by increasing interoperability, portability, and adaptability to different production systems and end uses. Existing initiatives led by aligned value chain partners can push their boundaries in the pre-competitive space to accelerate the adoption of CCS while making their producers more profitable and their supply chains more resilient. The market driven elements of a more conservation oriented and nutrient conserving food system are all around us, the hard part is weaving them together in ways that work for producers, consumers, and the planet.

APPENDIX

Illinois NLRS implementation scenarios

Practices in the NLRS	NLRS implementation scenarios	Nitrate-N reduction per acre (%)	Nitrate-N reduced (million lbs)	Total P reduction per acre (%)	Total P reduced (million lbs)
Bioreactors	Bioreactors on 50% of tile-drained land	25	35	NA	NA
Buffers	Buffers on all applicable cropland	90	36	25-50	4.8
Conservation Tillage	1.8 million acres of conventional till eroding >T converted to reduced, mulch, or no-till	NA	NA	50	1.8
Cover Crops	Cover crops on all corn/soybean tile-drained acres	30	84	30	4.8
Cover Crops	Cover crops on all corn/soybean non-tiled acres	30	33	NA	NA
Cover Crops	Cover crops on 1.6 million acres eroding >T converted to reduced, mulch, or no-till	NA	NA	50	1.9
N Rate Reduction	Reducing N rate from background to MRTN on 10% of acres	10	2.3	NA	NA
N Application Timing	Spring-only application on tile-drained corn acres	15-20	26	NA	NA
N Inhibitor Product	Nitrification inhibitor with all fall applied fertilizer on tile-drained corn	10	4.3	NA	NA
N Application Timing	Split application of 40% fall, 10% preplant, and 50% side dress	15-20	26	NA	NA
N Application Timing	Split application on 50% fall and 50% spring on tile-drained corn acres	7.5-10	13	NA	NA
Perennial/Energy Crops	Perennial/energy crops equal to pasture/hay acreage from 1987	90	10	90	0.3
Perennial/Energy Crops	Perennial/energy crops on 10% of tile-drained land	90	25	50	0.3
Wetlands	Wetlands on 35% of tile-drained land	50	49	0	0

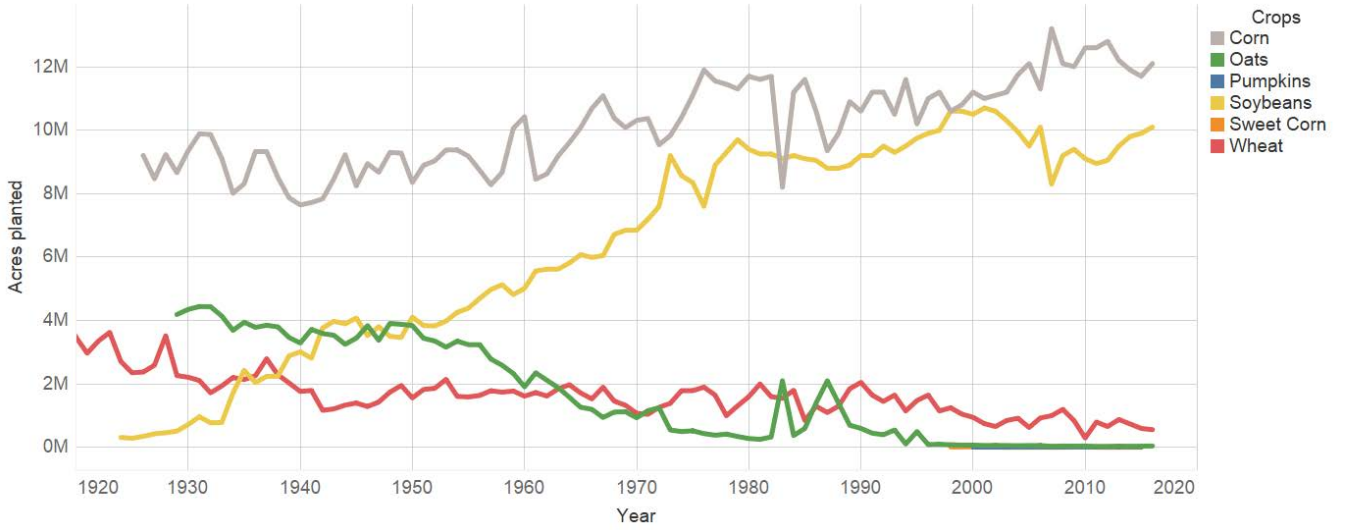
NLRS Priority Watersheds

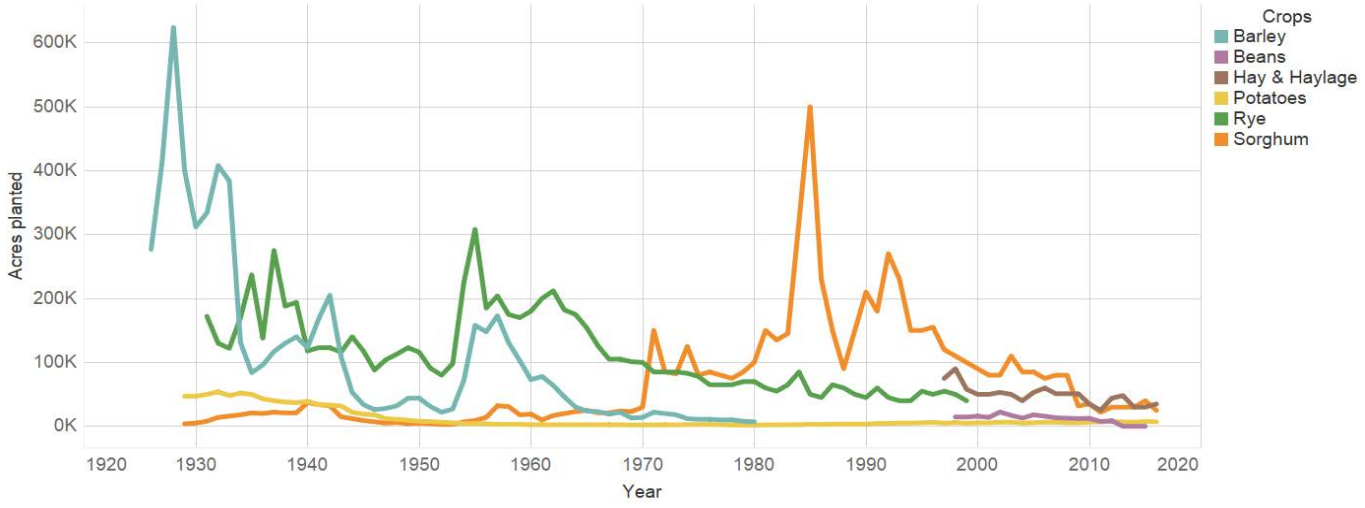


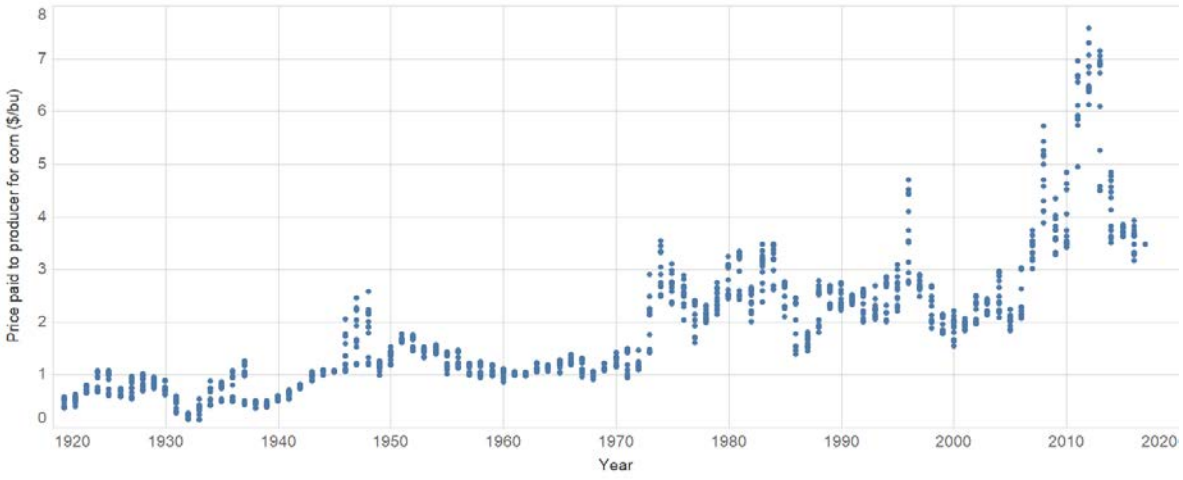
Tools Overview

Model/ Tool Name	Description	Data Inputs	Data Outputs	Spatial/ Temporal Extent	Developer	Intended Audiences
Nutrient Tracking Tool	The Nutrient Tracking Tool (NTT) compares agricultural management systems to calculate a change in nitrogen, phosphorous, sediment loss potential, and crop yield. GHG emissions evaluation to be incorporated in late 2017. http://nn.tarleton.edu/ntt/	AOI, soil type and characteristics, BMP type, fertilizer rate and source	Baseline and alternative conditions, reduction of Total N and P, % reduction and estimated crop yield	Field level scale, edge-of-field	University/ USDA ARS	Conservation Organizations, NGOs
Adapt-N	The Adapt-N tool provides precise nitrogen (N) fertilizer recommendations that account for the effects of seasonal conditions using high-resolution climate data, a dynamic computer model, and field-specific information on crop and soil management. http://www.adapt-n.com/	AOI, soil type and characteristics, drainage class and characteristics, tillage practices, organic matter content, fertilizer rate and source, cropping history and tillage practices	Nitrogen fertilizer recommendations based on input data	Field level scale	For-Profit/ University	NGOs, Farmers/ Operators
Fieldprint Calculator	The Fieldprint Platform is an assessment framework that empowers brands, retailers, suppliers and farmers at every stage in their sustainability journey, to measure the environmental impacts of commodity crop production and identify opportunities for continuous improvement. https://calculator.fieldtomarket.org/fieldprint-calculator/	AOI, soil type and characteristics, fertilizer rate and source, cropping history and tillage practices	sustainability indicators: Biodiversity, energy use, GHG emissions, irrigated water use, land use, soil carbon, soil conservation, water quality	Field level scale	NGO	Corporations, NGOs
STEPL	STEPL (Spreadsheet Tool for Estimating Pollutant Load is a customizable spreadsheet-based model for use in Excel. Using simple algorithms, it calculates nutrient and sediment loads from different land uses and the load reductions from the implementation of best management practices (BMPs). http://it.tetratech-ffx.com/steplweb/	AOI, climate history and information, livestock information, State and County, BMP practices and area applied	nitrogen, phosphorus, BOD and sediment loads with and without BMPs applied	Watershed level scale	For-Profit/ EPA	Conservation Organizations, NGOs
ACPF	The ACPF watershed planning toolbox is intended to leverage modern data sources and help local farming communities better address soil and water conservation needs. The ACPF toolbox can be used within the ArcGIS® environment to analyze soils, land use, and high-resolution topographic data to identify a broad range of opportunities to install conservation practices in fields and in watersheds. http://northcentralwater.org/acpf/	AOI, LiDAR data, soil type and characteristics, land use data, cropping history	Runoff risk assessment, controlled drainage opportunities, riparian analysis, nutrient removal wetlands opportunities, specific BMP implementation opportunities	Watershed and Field Level Scale	USDA ARS	Conservation Organizations, NGOs

Historical Cropping Data and Costs







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