Farmers for Sustainable Food

Pilot Milkshed Sustainability Project

Year One Report on Environmental Sustainability, Local Resources, and Financial Benchmarking

August 2021

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1 EXECUTIVE SUMMARY

Farmers for Sustainable Food (FSF), the Lafayette Ag Stewardship Alliance (LASA), and key stakeholders in the dairy supply chain partnered to create a replicable framework for farmer-led sustainability projects. The framework created by these groups provides a pathway for establishing sustainability projects that address financial and environmental outcomes driven by on-farm conservation.

Year one results indicate that project farms demonstrated that their farming practices contribute to significant reductions in environmental pollutants to streams in the project area.

Founded in 2017, LASA is a farmer-led watershed conservation group formed to identify and promote conservation practices (CPs) throughout southwestern Wisconsin. This report summarizes the first year of a pilot effort with 12 LASA farmers primarily from Lafayette County, WI, to demonstrate the efficacy and impact of local conservation on sustainability and local resource outcomes through FSF's Framework for Farm-Level Sustainability Projects. This report focuses on environmental outcomes from the framework, specifically on-farm sustainability and local resource issues.

Our environmental assessment used nationally recognized sustainability metrics developed by Field to Market: The Alliance for Sustainable Agriculture to address on-farm sustainability. It also used a local water quality resources evaluation tool commonly referred to as the Prioritize, Target, and Measure Application (PTMApp) to address local resource issues. Year one results indicate that the project farms' farming practices contribute to above-average sustainability metric scores and significant reductions in environmental pollutants to streams in the project area.

In year one, the Southwest Wisconsin Technical College Farm Business and Production Management program has worked with the FSF and other key stakeholders in the dairy industry to begin assessing a farmer's return on investment when implementing CPs on their farms. Financial analyses were completed for 2019 and included a breakdown for corn grain, corn silage, and alfalfa enterprises. The first year of the project was focused on establishing a baseline of data for each participating farm that can be built upon to create trendlines and conclusions of the farm's return on investment with implemented CPs.

1.1 ON-FARM SUSTAINABILITY

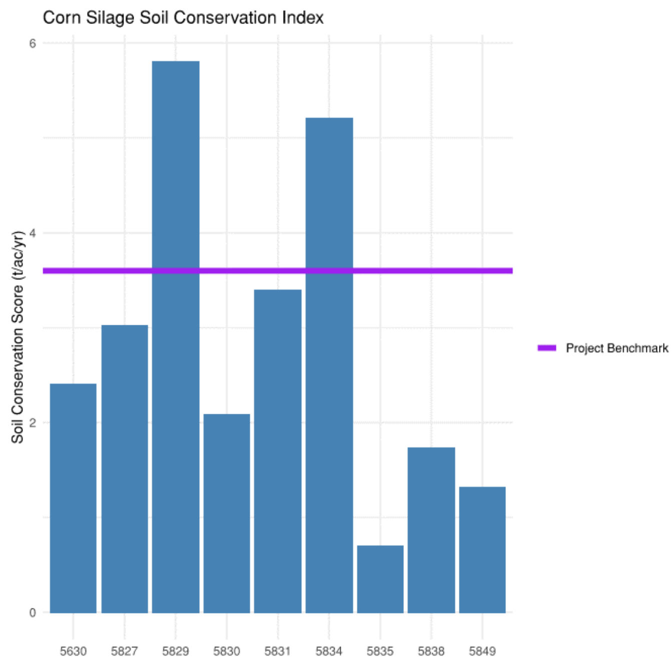


Figure 1. LASA Project Benchmark for Soil Conservation for Corn Silage

On-farm sustainability was assessed using farm and project-level sustainability metrics. These metrics were calculated for each farm and crop type via Field to Market's Fieldprint® Platform. Year one of the project focused on collecting data to establish a baseline for participating farms and the project as a whole. In year 1 we collected data from 142 fields managed by the 12 project farms to create project benchmarks and document current conservation practices and management systems. On average, farms participating in the pilot project have adopted five conservation practices per field, which Field to Market's Fieldprint Platform recognizes as having a positive impact on sustainability scores. Sustainability metric scores for corn grain, corn silage, alfalfa, and soybean production were calculated. An example of a calculated project benchmark metric for corn silage is shown in **Figure 1**. Project benchmarks created for the pilot project within the Fieldprint® Platform are useful as they allow a farmer and local project to:

1. compare anonymized scores between farms and to identify areas where improvements can be made,
2. project farms can compare themselves to other farms looking at historic state and national benchmarks,
3. serve as a baseline from which to demonstrate improvement over the life of the project, and
4. make sustainability claims through Field to Market.

Specific to greenhouse gas emission and energy use metric scores, we found that farms with livestock and that derive most of their crop nutrient needs from manure, on average, scored better than the project benchmark. This is the direct result of the use of manure for crop nutrient needs, which replaces the use of inorganic forms of nitrogen that have a higher energy (fossil fuel) cost to produce and ship.

The Field to Market's Fieldprint Platform documented the adoption of conservation practices which the Fieldprint® Platform recognizes as having a positive impact on sustainability metric scores. Conservation practices documented included contour farming, contour strip cropping, grassed waterways, cover crops, reduced tillage, no-till, and comprehensive nutrient management.

A very valuable aspect of the project was the creation of farm average benchmarks which allows the project farmers to compare themselves with project benchmarks and to begin a conversation to investigate ways to improve scores which is ingrained in Field to Market's philosophy of continuous improvement. Project benchmarks have been established for alfalfa, corn grain, and corn silage. (**Figure 2**).

Figure 2: Example of farm-level summary of sustainability metric scores for alfalfa (value on the left) shown against average project scores (value on the right).

1.2 LOCAL RESOURCES

The local water resource component of the environmental assessment looked at the water quality impact to local rivers and lakes from implemented CPs and best management practices (BMPs). This assessment is used to evaluate the impacts of implemented CPs as well as scenarios for potential future CPs against established baseline conditions in the project area. We used the PTMApp tool to evaluate the effectiveness of local conservation projects for reducing sediment, nitrogen, and phosphorus delivered to local rivers and lakes. This information can help create better dialogue around agriculture and water quality issues as well as target outreach, technical assistance, and financial assistance to those farms and fields where adoption of CPs and BMPs will produce cost-effective land treatment.

> ***This information can help create better dialogue around agriculture and water quality issues and to target outreach, technical assistance, and financial assistance to those farms and fields where adoption of conservation practices and land management systems will produce cost-effective land treatment.***

In a small watershed evaluation area, PTMApp was used to characterize the benefit to water quality (sediment, nitrogen, and phosphorus reduction) from the CPs that have been implemented by project participants. **Figure 3** shows sediment loss from non-project participant fields (benchmark) compared to fields of project participants assuming no CP implementation (stewardship baseline) and with the benefit of existing CPs (stewardship existing). A future implementation scenario was also analyzed to estimate the water quality benefit of implementing cover crops on 50% of all suitable fields within the evaluation watershed. This evaluation showed that existing conservation is reducing sediment yields by approximately 28% in local streams and rivers (**Figure 3**). The future implementation scenario shows the potential to further reduce sediment and nutrient yields. Estimates suggest yield reductions of 40% (sediment), 28% (nitrogen), and 23% (phosphorus) could be achieved beyond existing stewardship conditions.

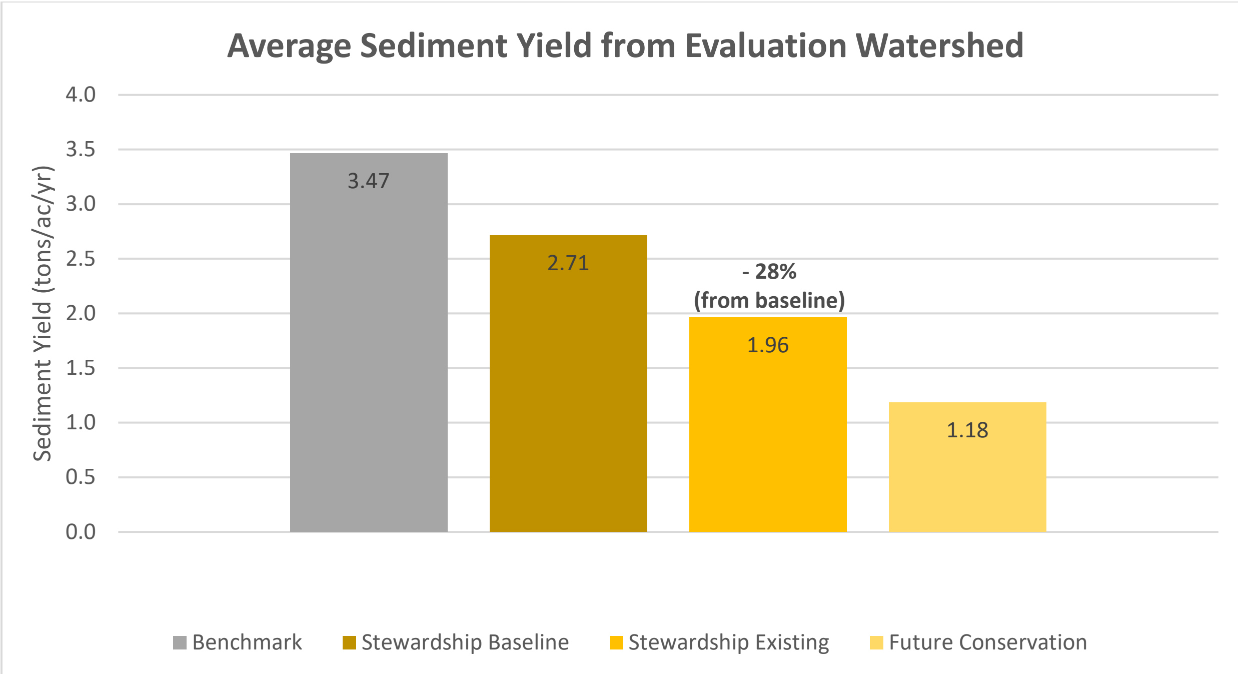


Figure 3: A comparison of the sediment yields between the project stewardship fields and the benchmark fields in the evaluation area watershed.

These results demonstrate, in measurable terms, the benefit to local water resources from CPs already adopted by project farms, and the benefit of scaling up CPs in watersheds of the LASA project area. With PTMApp data products and the desktop tool available to the LASA project and Lafayette County, information from PTMApp can be used to:

1. enhance the communication of the water quality benefit of CPs to local water resources;
2. capture and report the benefits of existing conservation in small watersheds or the entire project area;
3. target communication for programs, technical assistance, and financial assistance to areas where CP implementation will achieve the greatest benefit to local resources; and
4. assist in seeking competitive grants to support the conservation agenda of LASA farmers.

1.3 FINANCIAL BENCHMARKING

The Southwest Wisconsin Technical College Farm Business and Production Management program has worked in cooperation with the FSF and other key stakeholders in the dairy industry to begin assessing a farmer's return on investment when implementing CPs on their farms. Financial analyses were completed for 2019 and included a breakdown for corn grain, corn silage, and alfalfa enterprises. This first year of the project was focused on establishing a baseline of data for each participating farm that can be built upon to create trendlines and conclusions of the farm's return on investment with conversation practices implemented.

All three project farms are located in southern Wisconsin, milking nearly 6,000 cows and farming over 9,000 acres combined. Each farm's information is uniquely their own and held in strict confidentiality. Only average financial numbers of the three project farms are used in this report (**Appendix A**).

Each of the three farms also participated in an assessment of on-farm environmental sustainability using Field to Market's Fieldprint Platform. This analysis identified that all three farms had:

1. comprehensive nutrient management plans and were following university recommended fertilizer rates,
2. use of fall cover crops after corn silage,
3. high crop residue management, and
4. implemented a variety of structural CPs—most notably grassed waterways and farming on the contour.

These practices resulted in above average sustainability metric scores when compared to historic state and national averages. Over time, one of the goals of the project is to demonstrate a positive relationship between achieving high on-farm environmental sustainability with positive financial performance.

Financial data collected in this report is recorded from the actual financial records kept on each farm. FINPACK software, a product of the Center for Farm Financial Management at the University of Minnesota, is the premier farm financial management program used by educators to help producers better understand and manage their farm finances. FINPACK is not an accounting system, but instead provides tools to evaluate farm records and better understand farm financial position and sustainability.

1.4 LOOKING FORWARD

Our project partners are actively preparing year two data results and have plans to collect and analyze a third year of data that should provide opportunities to verify year one results. Combining data from Field to Market's Fieldprint Platform with the Farmers Assuring Responsible Management (FARM) environmental stewardship (ES) analysis increased the value of this project by producing a more complete, whole-farm review of greenhouse gas emissions and energy use intensity. The addition of PTMApp data to estimate water quality benefits of implemented or future CPs further highlights the effort that participating farmers are putting toward environmental sustainability.

FSF and LASA plan to show continued progress toward on-farm sustainability outcomes as well as improvements to local water resources through CPs used in the project area. After each year of data collection, FSF and LASA plan to report updates to the continued progress being made by farmers within our project.

2 PROJECT OVERVIEW

Houston Engineering Inc. (HEI), under a contract with Farmers for Sustainable Food (FSF), supported a project designed to pilot a new framework for establishing and conducting local farmer and industry-led agricultural sustainability projects. The project is registered as an Innovation project within the **Field to Market's Continuous Improvement Accelerator framework.**

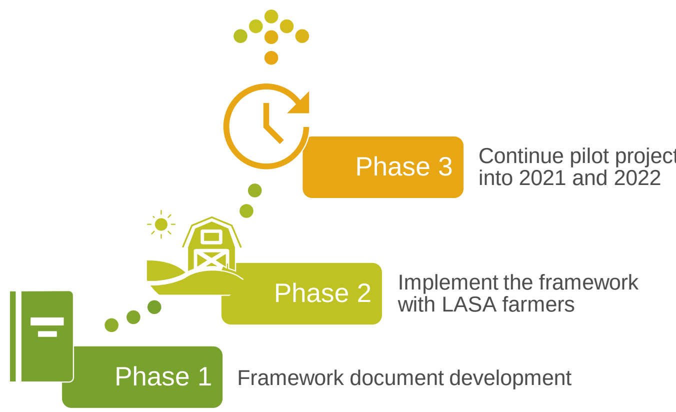
FSF is a collaborative, non-profit organization that provides resources, advocacy, support, and empowerment for farmers who are innovating and demonstrating sustainable farming practices. FSF connects farmers, processors, environmental groups, scientists, food companies, community leaders, and agricultural businesses to share ideas and collaborate on projects.

FSF, the Lafayette Ag Stewardship Alliance (LASA), and key stakeholders in the dairy supply chain partnered to create a replicable framework for farmer-led sustainability projects to demonstrate the efficacy and impact of local conservation through a pilot project with 12 local farmers. This report provides a summary of the environmental assessment phase of the framework document (**Appendix B**).

The overall desired outcomes for the project were to:

1. Create a positive and meaningful experience for participating farmers regarding engaging public and private entities in conservation.
2. Assess if current farming practices in conservation-conscious areas are having a positive impact on sustainability and water quality.
3. Demonstrate the financial benefits of CPs on farms.
4. Increase the use of sustainability measurement platforms by farmers to inform land and water management decisions, leading to increased adoption of conservation measures.
5. Provide public and private support and assistance to farmers pursuing conservation on their land.
6. Increase the effectiveness of local, state, and federal conservation programs by using tools that can assist in prioritizing, targeting, and measuring performance of CPs.
7. Increase engagement and landowner involvement in conservation groups and studies.

The pilot project was built around three phases. Phase 1 was the development of a framework document for establishing and conducting local farmer and industry-led sustainability projects. The framework, completed in 2020, is an easy-to-use handbook for documenting impacts of conservation. It consists of assessments and methods for establishing and implementing a farmer-led agricultural sustainability project involving on-farm sustainability outcomes, documenting the impact of on-farm CPs on local water resources, and a corresponding financial analysis.



Phase 2 was to implement the framework with farmers in the LASA organization. This phase includes environmental and financial analyses of participating farms and had several components. The environmental analysis portion, supported by HEI, includes on-farm metrics through Field to Market's Fieldprint® Platform and a local water resources assessment using Prioritize, Target, and Measure Application (PTMApp). A financial analysis for three of the 12 farms was done by Farm Business Management experts at Southwest Wisconsin Technical College. Additionally, this project incorporated the FARM Environmental Stewardship (ES) evaluation for three of the project dairy farms that ship milk to Grande Cheese. A separate technical memo has been prepared for this component. Phase 3 is the continuation of the project for two additional years (2021 and 2022).

Project stakeholders include: Dairy Farmers of Wisconsin; FSF; Grande Cheese; Innovation Center for U.S. Dairy; LASA; The Nature Conservancy; Nestlé; Southwest Wisconsin Technical College; University of Wisconsin-Division of Extension; Wisconsin Corn Growers Association; and Wisconsin Department of Agriculture, Trade and Consumer Protection.

3 PROJECT PURPOSE

3.1 ON-FARM SUSTAINABILITY: FIELDPRINT® PLATFORM

The purpose of the on-farm sustainability portion of the environmental assessment was to show the environmental impact of participating farms using nationally recognized sustainability metrics. To do this, the project used Field to Market's Fieldprint Platform, a web-based sustainability assessment framework that enables farmers and the value chain to measure the environmental impacts of commodity crop production and identify opportunities for continuous improvement. **Backed by the sustainability metrics embedded in the Platform, Field to Market's Continuous Improvement Accelerator provides pathways for member organizations to educate farmers, fosters an awareness of farm impacts on broad environmental categories, and supports ongoing conservation planning and implementation with farmers.** The Platform is being used in more than 72 Continuous Improvement Projects throughout the US. The eight sustainability metrics developed by Field to Market's multi-stakeholder process and included in the Platform are biodiversity, energy use, greenhouse gas emissions, irrigation water use, land use, soil carbon, soil conservation, and water quality.

3.2 LOCAL RESOURCES: PTMAPP

The purpose of the local resource portion of the environmental assessment was to show the environmental impact of participating farms on local water resources, the water quality impact of implemented CPs, and scenarios for potential future CPs against the established baseline condition in the project area. To do this, HEI used PTMApp developed by the Minnesota Board of Water and Soil Resources. PTMApp is a geographic information system (GIS) desktop and web application designed to evaluate the effectiveness of local conservation projects and improve watershed planning through its ability to show the estimated pollution reductions of sediment, nitrogen, and phosphorus to local water resources.

4 BACKGROUND

4.1 FIELDPRINT® PLATFORM

4.1.1 PROJECT PATHWAYS

Launched in 2019, Field to Market's Continuous Improvement Accelerator harnesses the power of collaboration across the agricultural value chain to implement locally led conservation solutions and deliver sustainable outcomes through member-led continuous improvement projects.

The Continuous Improvement Accelerator enables member organizations to design and implement projects in one of three Project Pathways, allowing for maximum flexibility and impact in delivering sustainable outcomes. Pathways are designed and implemented around a range of conservation goals, meeting farmers and organizations at any stage in the conservation process (**Figure 4**). The LASA project was established as an Innovation Project with Field to Market in 2020. The project focuses on addressing the natural resource concerns of soil health and water quality and will use the metrics for soil conservation and water quality to show progress in addressing project resource concerns.

Figure 4: Field to Market project pathway descriptions.

4.1.2 CLAIMS

Another advantage of registering a project in Field to Market's Continuous Improvement Accelerator is that it enables member organizations to make credible claims about advancing progress and impact. Claims are available to Continuous Improvement Projects that are meeting the requirements of the Process-Based Standard, are in good standing, and are enabled for projects at various stages of operation in the field. These claims can be used by organizations and industry to support their needs for reporting on the sustainability and continuous improvement of growers. To be able to report claims, at least 10% of the managed (planted) acreage for each crop, year, and farm must be enrolled. For example, if a farmer managed/planted 500 acres of corn grain in 2019, then representative fields totaling at least 50 acres must be set up in the Fieldprint® Platform. Claims can be made under one or more of the following categories:

Participation Claims	A participation claim is a statement or assertation of participation in a Field to Market Continuous Improvement Project by a Field to Market member organization or licensee, which may also include the number of acres and growers enrolled in the project. Projects are eligible for participation claims from year one.
Adoption Claims	An adoption claim is a claim related to the uptake of a specific practice or intervention in the context of a Continuous Improvement Project that has a public-facing Continuous Improvement Plan. These claims allow projects to report on progress that is being made in increasing the adoption of practices or technologies that are proven through independent scientific research to be effective in improving environmental outcomes.
Measurement Claims	A measurement claim is a static, one-year snapshot of aggregated annual metric performance. A measurement claim may be made when a Continuous Improvement Project has been in place for one or more years and project participants are benchmarking performance on an annual basis, using all Field to Market's metrics and algorithms.
Trends Claims	A trends claim may be made when a Continuous Improvement Project has been in place for more than one year and project participants are benchmarking performance on an annual basis, using all Field to Market's metrics and algorithms. Projects can use this claim category to demonstrate that metric results generated by a project are showing interim directional improvement before reaching the five years of data required for an impact claim.
Impact Claims	An impact claim is a claim of sustained improvement in environmental outcomes within a Continuous Improvement Project. This type of claim must meet the data requirements for multi-year projects and receive third-party verification from an entity approved by Field to Market.

4.1.3 METRICS

The Fieldprint Platform was used for the on-farm sustainability metrics portion of the project. It was chosen because it was developed at the national level.

The Fieldprint Platform is a confidential tool used to explore the relationships between a farmer's management systems and natural resource impacts. The tool provides estimates of the operational efficiency of the farming operation and helps to highlight areas of potential improvement.

The Fieldprint Platform measures a field's sustainability footprint based on eight sustainability metrics (**Figure 5**). Each Field to Market metric measures a specific environmental outcome that is important for environmental sustainability, calculated and measured at the scale of a farm, responsive to changes in farm management, and uses robust science to support accurate modeling of environmental impact. This information is documented in the Field to Market report titled "Harnessing Sustainability Insights and Unleashing Opportunity" in **Appendix C**.

Figure 5: The eight Field to Market sustainability metrics evaluated with the Fieldprint® Platform.

The following is a description of each of Field to Market's eight sustainability metrics:

Biodiversity	Supporting diverse species and ecosystems by conserving and enhancing habitats across US agricultural landscapes (unit:% realized total habitat potential index on a scale of 0-100%, a higher score is more desirable)
Energy Use	Increasing energy use efficiency on US cropland (unit: BTU/unit of production, a lower score is more desirable)
Greenhouse Gases	Reducing greenhouse gas emissions from US cropland per unit of output and sustained contribution to reducing the overall greenhouse gas emissions from agricultural landscapes (pounds of CO_2 equivalent/unit or production [CO_2 equivalent or CO_2e includes CO_2 emissions plus N_2O and CH_4 emissions converted to the equivalent amount of CO_2], a lower score is more desirable).
Irrigation Water Use	Improving irrigation water use efficiency and conservation on US cropland (unit: acre-inch per units of crop production, a lower score is more desirable).
Land Use	Improving productivity on US cropland (unit: acre/unit of production, a lower score is more desirable).
Soil Carbon	Increasing soil carbon sequestration on US cropland (unit: unitless scale from -1 to 1, a higher score is more desirable).
Soil Conservation	Reducing soil erosion on US cropland (unit: tons/ac/yr, a lower score is more desirable).
Water Quality	Improving regional water quality through reduction in sediment, nutrient, and pesticide loss from US cropland (unit: unitless scale from 1-10, a higher score is better)[1]

[1] Unit of production is tons for corn silage and alfalfa; unit of production is bushels for soybean, wheat, and corn grain

Calculation of sustainability metrics is done at the field level. The number of fields to collect data for and to analyze is established by Field to Market protocols. Data collected and entered into the Fieldprint® Platform includes the following:

- Location of fields
- Soils
- Crop rotations
- Farm management and operations
  - Tillage
  - Nutrient and pesticides
  - Harvest
  - Irrigation
- CPs

An example crop rotation is available in **Appendix D**.

To gain a full picture of a field's sustainability performance, the Fieldprint Analysis visualizes results in a spider diagram that uses relative indices on a scale of 1-100 to represent metric outcomes in comparison to state benchmarks, national benchmarks, and project benchmarks, where available. (**Figure 6**). The Platform also generates specific numeric scores for each sustainability metric, including how the metric is calculated and what management and operations affect the score (**Table 1**). For more information on how metric scores are calculated, what influences each metric, and areas where changes can be made that would improve a score, we have included Field to Market's "Harnessing Sustainability Insights and Unleashing Opportunity" document in **Appendix C**.

You can think of the spidergram as your sustainability footprint. A smaller footprint is more desirable.

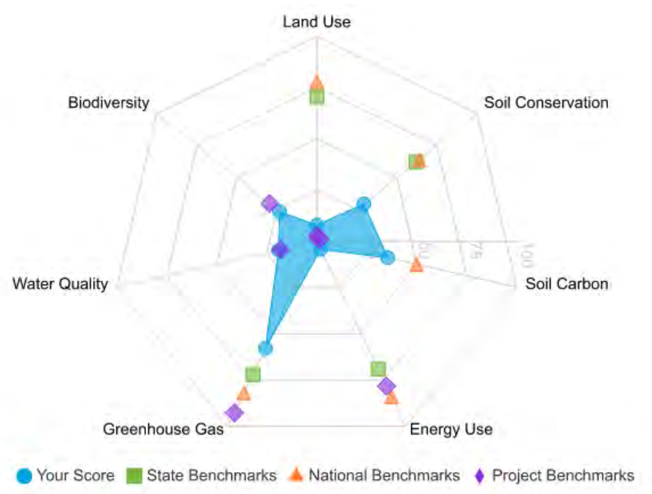


Figure 6: Example spidergram for a corn grain field with the field score, state benchmarks, national benchmarks, and project benchmarks.

Table 1: Example of Numeric Fieldprint® Platform data for corn grain field with field score, state benchmarks, national benchmarks, and project benchmarks.

Metric	Your Result	Project Benchmark	State Benchmark	National Benchmark
Land Use (acre / bushel)	0.0045	0.0041	0.0069	0.0074
Soil Conservation (ton / acre / year)	3.0	1.0	3.5	3.6
Soil Carbon	0.17	N/A	N/A	0.00
Energy Use (btu / bushel)	9303	28857	25291	35312
Greenhouse Gas (lbs_co2e / bushel)	8.8	15.0	9.3	11.4
Water Quality	8.35	8.20	N/A	N/A
Biodiversity	71%	70%	N/A	N/A

4.1.4 BENCHMARKS

4.1.4.1 STATE AND NATIONAL BENCHMARKS

When possible, state and national benchmarks are created using standard calculations of sustainability performance for a fixed period of time based on publicly available, statistically robust data of agricultural production systems. They are calculated by region and crop, using algorithms and models that are similar to Field to Market metrics, with some adjustment necessary to account for data availability. Benchmarks are important points of comparison for five of our metrics – Land Use, Energy Use, Greenhouse Gas Emissions, Irrigation Water Use, and Soil Conservation. They are presented to Platform users as reference points alongside their individual field results. In the Fieldprint Platform, they are displayed on the spidergram and slider bar graphics as a starting point for a user to compare their sustainability performance to a known, static marker of sustainability for their region. The other three Field to Market metrics—Biodiversity, Soil Carbon, and Water Quality—are represented by qualitative index models for which it is not currently possible to calculate benchmarks from publicly available data.

With benchmarks, projects can:

- *Compare scores between farms to identify potential areas of improvement*
- *Demonstrate improvement over the course of the project*
- *Establish sustainability claims*

4.1.4.2 PROJECT BENCHMARKS

Field to Market can calculate project benchmarks when there is a minimum of 10 unique growers for a crop, as was the case with alfalfa of this project. Field to Market was also able to create project benchmarks for corn grain although it had fewer than 10 growers. For corn silage HEI created the project benchmarks based on average metric values across project farms and fields. Project benchmarks were created for seven of the eight metrics, excluding irrigation water efficiency. Project benchmarks are useful as they allow a project to:

1. compare anonymized scores between farms and to identify areas where improvements can be made,
2. demonstrate improvement over the life of the project, and
3. make sustainability claims through Field to Market.

4.2 PTMAPP

PTMApp can be used in rural settings to:

1. identify the sources and amount of sediment, nitrogen, and phosphorus that leaves the landscape and enters a downstream lake or river;
2. target specific fields on the landscape (based upon Natural Resources Conservation Service [NRCS] design standards, landscape characteristics, land productivity, and/or landowner preference) for the implementation of nonpoint source BMPs and CPs; and
3. estimate the benefits of single or multiple BMPs and CPs within a watershed where the benefits are expressed as the downstream load reduction reaching a lake or river and the estimated cost/load reduction.

For single practices, an optimization curve showing the relationship between the estimated implementation cost and the reduction in annual load for a watershed can be obtained. These tools allow anyone to target solutions to the identified priorities and develop tailor-made solutions rather than one-size-fits-all approaches. The application has desktop (PTMApp-Desktop) and Web (PTMApp-Web) components. PTMApp-Desktop consists of a toolbar for use within ESRI's ArcGIS technology. Once created, data can be shared using the PTMApp-Web component.

Data used by PTMApp includes hydro-conditioned topographic data, rainfall frequency/duration data, land use/land cover, soils, rainfall-runoff (r-factor) values, and study boundary and priority resource points. The science and theory used to process data in PTMApp-Desktop are well documented through a series of peer-reviewed technical memorandums. This documentation is available at http://www.rrbdin.org/prioritize-target-and-measure-application-ptmapp-theory. These documents describe all the technical aspects of the processing performed to generate the output products for this study.

4.2.1 PTMAPP PROCESS

PTMApp is based on watershed areas and surface flow principals. It is dictated by flowlines, or areas of concentrated water flow, that either drain to an outlet to continue a path downstream or flow to a nearby basin or waterbody. Scales for assessment range from the smallest unit at ~40 acres (a catchment) up to the largest unit of ~500 miles^2 for an 8-digit Hydrologic Unit Code (HUC 8) watershed (**Figure 7**). Assessments can be conducted at the catchment outlet or at any point on a flowline that is considered a priority resource point (PRP). PRPs are user-designated and represent a point on the landscape that is an important location, whether it is a lake inlet or outlet, a river convergence, or some other location.

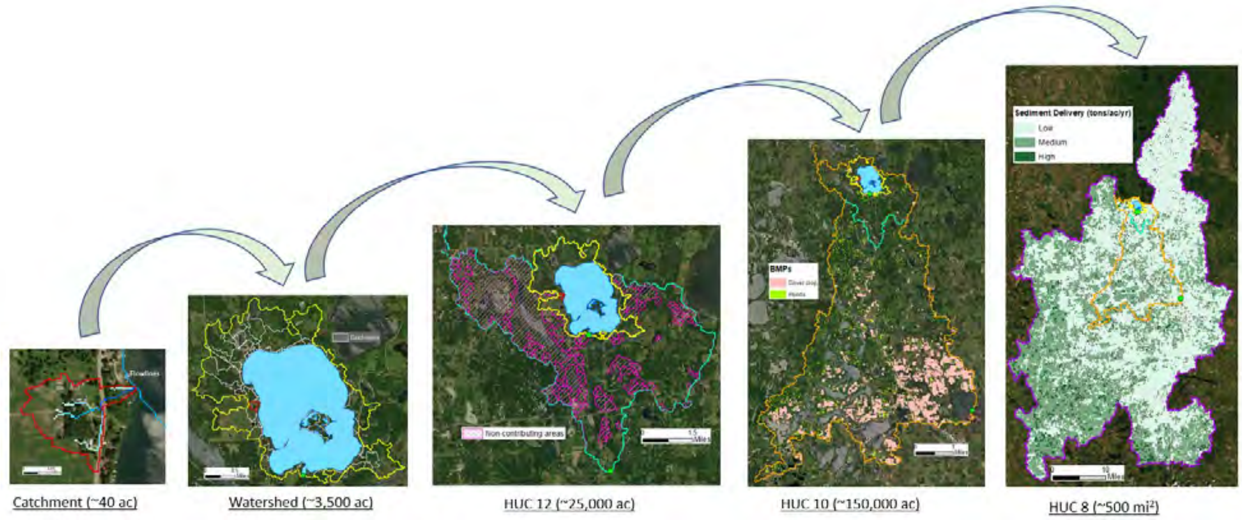


Figure 7: A series of images showing the various scales for PTMApp analysis with some example data for each scale (flowlines, catchments, non-contributing areas, BMPs, and sediment delivery).

Once input data is created, PTMApp-Desktop generates source loads (total phosphorous [TP], total nitrogen [TN], and sediment). These loads are then routed to downstream locations along concentrated flow paths to priority resource points using a sediment delivery ratio for sediment and first order decay equations for TP and TN. Potential locations for BMPs and CPs are identified based on NRCS design standards. The BMP and CP locations are then integrated with the source load data and surface hydrology calculations to estimate the BMP and CP efficiency and source load reductions. Finally, the cost of potential BMPs and CPs are estimated based on 2019 Minnesota Environmental Quality Incentives Programs (EQIP) payment schedules. It is important to note that this is a desktop analysis to help target and measure locations for on-the-ground BMP and CP implementation.

Using PTMApp, the project was able to quantify the estimated benefits from both current and potential future CPs to local water resources, which cannot be done without the use of sophisticated water quality models. Once completed, the PTMApp data products and desktop toolbar will be accessible to LASA, its local supporters, and other natural resource managers. PTMApp provides the ability to target outreach, technical assistance, and financial assistance to farms and fields where adoption of CPs and land management systems will produce cost-effective land treatment.

4.2.2 WATERSHED CONDITIONS

There are three main types of watershed conditions that can be evaluated in PTMApp. The baseline condition assesses sediment and nutrient loading when there are no CPs or BMPs present on the landscape. If there have been BMPs implemented in the project area and the locations of these practices are known, this information can be ingested into the PTMApp toolbar to estimate the sediment and nutrient load reductions for the existing CPs. If some areas of the landscape have existing CPs while other areas do not, a comparison can be made between stewardship fields (have CPs or BMPs) and benchmark fields (do not have CPs or BMPs). Lastly, PTMApp uses landscape characteristics as well as BMP implementation requirements to show BMP suitability and feasible practices for a potential future condition. A subset of these feasible practices can be selected to form a conservation implementation scenario. The future scenario can be assessed at multiple scales within the project area (e.g., catchment, subwatershed, etc.). Both the existing and future conditions that account for existing or future CPs and BMPs can be compared against the baseline conditions to demonstrate the effectiveness of conservation.

4.2.3 ADDITIONAL USES OF PTMAPP

Nitrogen delivery to groundwater was also a local resource concern in the pilot study area, so PTMApp was enhanced to assess nitrogen groundwater risk. Overall, groundwater nitrogen risk is based off the total estimated nitrogen input from fertilizer by crop type or land use, and potential denitrification occurring in the soil (by soil type). Addition and loss terms are then calculated based on the potential annual groundwater recharge rate. The difference between these terms is the relative nitrogen risk (high, medium, and low) and is mapped across the landscape. Areas shown to be particularly vulnerable can be targeted for nitrogen source reduction or loss mitigation.

5 ASSESSMENT AND FINDINGS

5.1 ON-FARM SUSTAINABILITY: FIELDPRINT® PLATFORM

The LASA project is registered within Field to Market's Continuous Improvement Accelerator as an Innovation Project. A total of 12 farms were enrolled in the Fieldprint® Platform, 11 of which were in Lafayette County and one in Rock County, located two counties east of Lafayette County (**Figure 8**). Within the 12 farms, 142 fields at 3,357 acres were assessed, representing 10% of managed acres (29,500 acres). Crops grown in 2019 that were evaluated include alfalfa, corn grain, corn silage, soybeans, and winter wheat. This report includes 2019 crop year data, with results from the 142 individual farm fields.

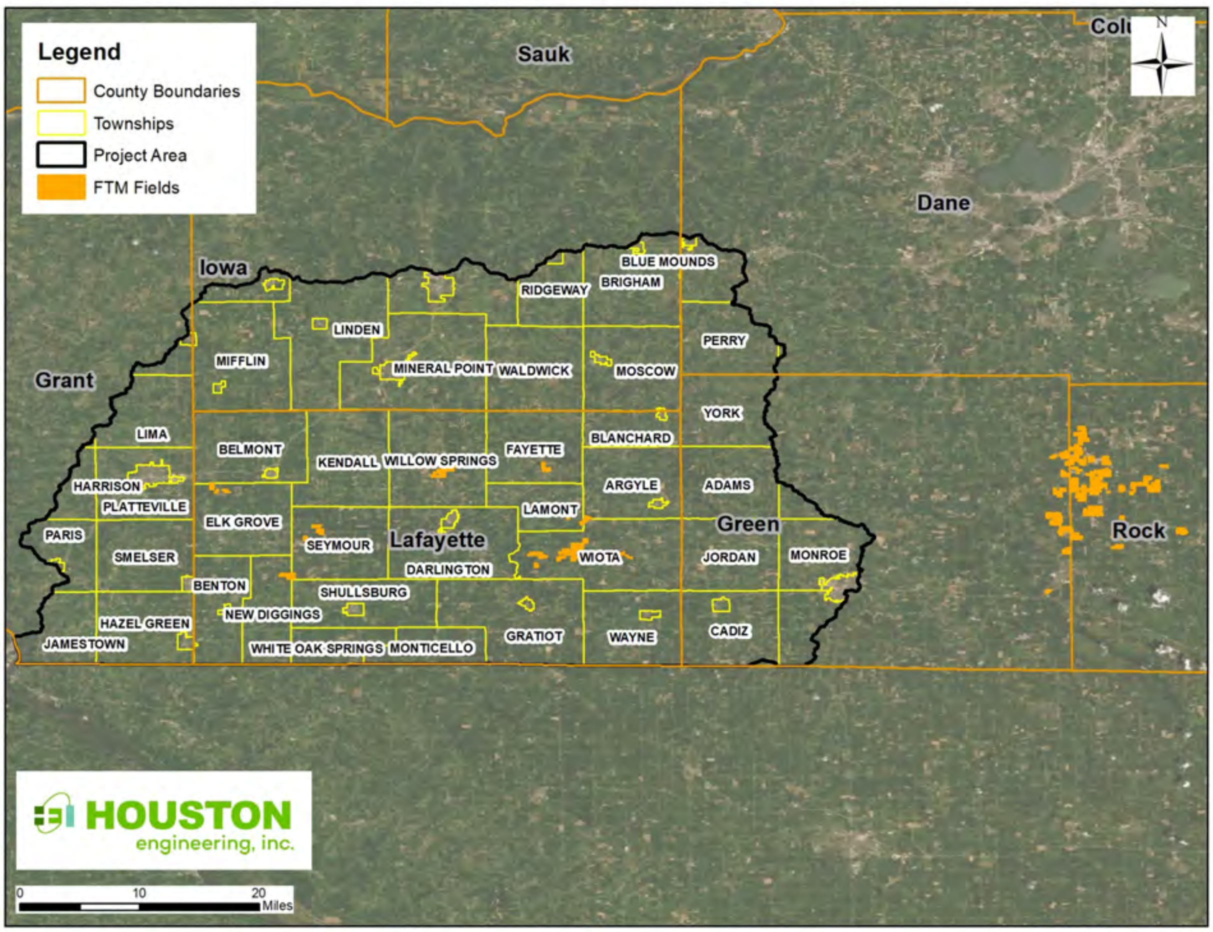


Figure 8: Project area boundary with counties, townships, and Field to Market fields.

5.1.1 RESULTS

5.1.1.1 FIELD-LEVEL RESULTS

Participating farms and fields were evaluated for seven of the eight sustainability metrics. The spatial location of each field is determined either inside of the Fieldprint® Platform or externally using ArcGIS. The following map is an example of the fields included in the Fieldprint® Analysis for one participating farm (**Figure 9**). Below is an example of four Fieldprint® Platform metric scores by field for alfalfa grown on one participating farm in 2019 (**Table 2**). This table shows the amount of variability that can occur from one field to the next, depending on the values associated to the inputs and the physical features of the field, such as soil type and slope.

Figure 9: Example farm and field identification symbolized by 2019 crop.

Table 2. Example field results for land use, energy use, greenhouse gas, and soil conservation for the 2019 alfalfa fields in the image above.

Field	Planted Acres	Production (ton)	Land Use (ac/ton)	Energy Use (BTU/ac)	Greenhouse Gas (lbs/ton)	Soil Conservation (tons/ac/yr)
103	24.11	98.63	0.2444	5,346,841	3,947	2.2
17	3.83	15.67	0.2444	5,068,115	3,936	2.9
43 and 105	20.51	47.20	0.4346	5,904,977	43,097	2.9
57 and 93	11.52	47.13	0.2444	4,933,278	3,930	2.5
66	4.65	19.02	0.2444	5,032,495	3,934	2.9
68	16.84	68.89	0.2444	4,913,338	3,929	2.5
69	7.74	31.66	0.2444	4,966,075	3,932	1.1
72	6.02	24.63	0.2444	4,994,632	3,933	2.5
73	5.62	22.99	0.2444	5,003,779	3,933	1.1
81	4.55	18.61	0.2444	5,036,151	3,934	2.6
83	5.61	22.95	0.2444	5,004,024	3,933	2.5

Field	Planted Acres	Production (ton)	Land Use (ac/ton)	Energy Use (BTU/ac)	Greenhouse Gas (lbs/ton)	Soil Conservation (tons/ac/yr)
84	7.33	29.99	0.2444	4,971,665	3,932	2.9
86	3.17	7.29	0.4346	6,059,723	43,108	2.9
87	3.46	7.96	0.4346	6,044,382	34,097	2.5
88	8.31	34.00	0.2444	4,959,219	3,931	2.9
98	6	13.81	0.4346	5,973,391	34,092	2.9

5.1.1.2 REPORTING

Below is an excerpt from the Fieldprint® Report for one metric (greenhouse gas) within the Fieldprint® Platform. It includes information on the metric, the field score, benchmark scores, and a breakdown of score components.

GREENHOUSE GAS

The Greenhouse Gas (GHG) Emissions metric calculates the total emissions from four main sources – energy use, nitrous oxide emissions from soils, methane emissions (rice only) and emissions from residue burning. It is an efficiency metric calculated using a series of complex algorithms to determine the total GHG emissions per unit of crop production.

Your Score

Greenhouse gas emissions are reported in the Fieldprint® Platform as pounds of carbon dioxide equivalent (CO_2e) per crop unit produced (e.g., bushels or pounds). "CO_2e" simply means the N_2O and CH_4 emissions are converted to the equivalent amount of CO_2, to provide a common unit of all emissions in one measure, which is comparable over time and influenced by all the actions a farmer takes.
The Fieldprint® Platform uses standard US government assumptions regarding fuel use, such as the 22.3 pounds of CO_2e that are emitted per gallon of diesel combusted. Emissions also result from electricity and fuel usage as well as from burning crop residues.
Low scores are desirable and indicate less greenhouse gas emitted per unit of crop produced.

GREENHOUSE GAS

2019 Corn (grain)

8.8 LBS CO_2E / BUSHEL

COMPARISON TO BENCHMARKS

Greenhouse Gas score in comparison to available benchmarks (**Table 3**). Benchmarks are an average of USDA statistical data for the period 2008-2012, to provide context for your scores. Benchmarks should not be interpreted as a specific level of sustainability or a performance target. State and national benchmarks that are not shown in the table or on the spidergram are not available for the applicable metric.

Table 3. Comparison of field score, project benchmark (Wisconsin) and national benchmark for one, 2019 corn grain field (inside Field to Market excerpt).

SCORE	RESULT
Your Score	8.8 lbs CO_2e / bushel
Project Benchmarks	15.0 lbs CO_2e / bushel
State Benchmarks	9.3 lbs CO_2e / bushel
National Benchmarks	11.4 lbs CO_2e / bushel

Breakdown of Greenhouse Gas Score Components

Breakdown of Greenhouse Gas Emission components (**Table 4**). Values are shown on both a per acre and per bushel basis.

Nitrous oxide emissions from a field are taken from results of a detailed crop model based on crop type, region of the country and soil texture to determine how much N_2O results from additions of nitrogen (N) from fertilizer and manure.

Table 4. Breakdown of greenhouse gas emissions for one, 2019 corn grain field by lbs CO2e/acre and lbs/CO2e/bushel (inside Field to Market excerpt).

Component	GHG Emissions (lbs co2e / acre)	GHG Emissions (lbs co2e / bushel)
Emissions associated with energy used on the farm		
Management Energy Emissions	118.7	0.5
Application Energy Emissions	51.7	0.2
Manure Loading Energy Emissions	165.6	0.7

Component	GHG Emissions (lbs co2e / acre)	GHG Emissions (lbs co2e / bushel)
Seed Energy Emissions	6.3	0
Irrigation Energy Emissions	0	0
Post-Harvest Energy Emissions	0	0
Transportation Energy Emissions	1.6	0
Subtotal Energy Emissions	343.9	1.4
Soil N_2O emissions	1,608.8	7.2
Methane emissions (rice only)	0	0
Residue burning emissions	0	0
Total GHG Emissions	1,952.7	8.8

5.1.1.3 FARM LEVEL SUMMARY

This level of analysis combined each unique farmer's fields for each crop reported to generate a farm-level sustainability score for each metric. This farm-level summary provides each farmer with an easy way to graphically see all metrics averaged across fields and crops with comparison to benchmarks (project, state, and national). Figure (10) provides an illustration of the four sustainability metrics that LASA is most interested in (soil conservation, soil carbon, land use efficiency, and water quality) . Each farm-level summary report included a representative Fieldprint® Platform spidergram for one of the farmers' fields and a section that described how each metric is calculated, what management and operations influence each score, and opportunities to improve scores. An example farm-level report is included in **Appendix E** and a Fieldprint® analysis summary can be found in **Appendix F**.

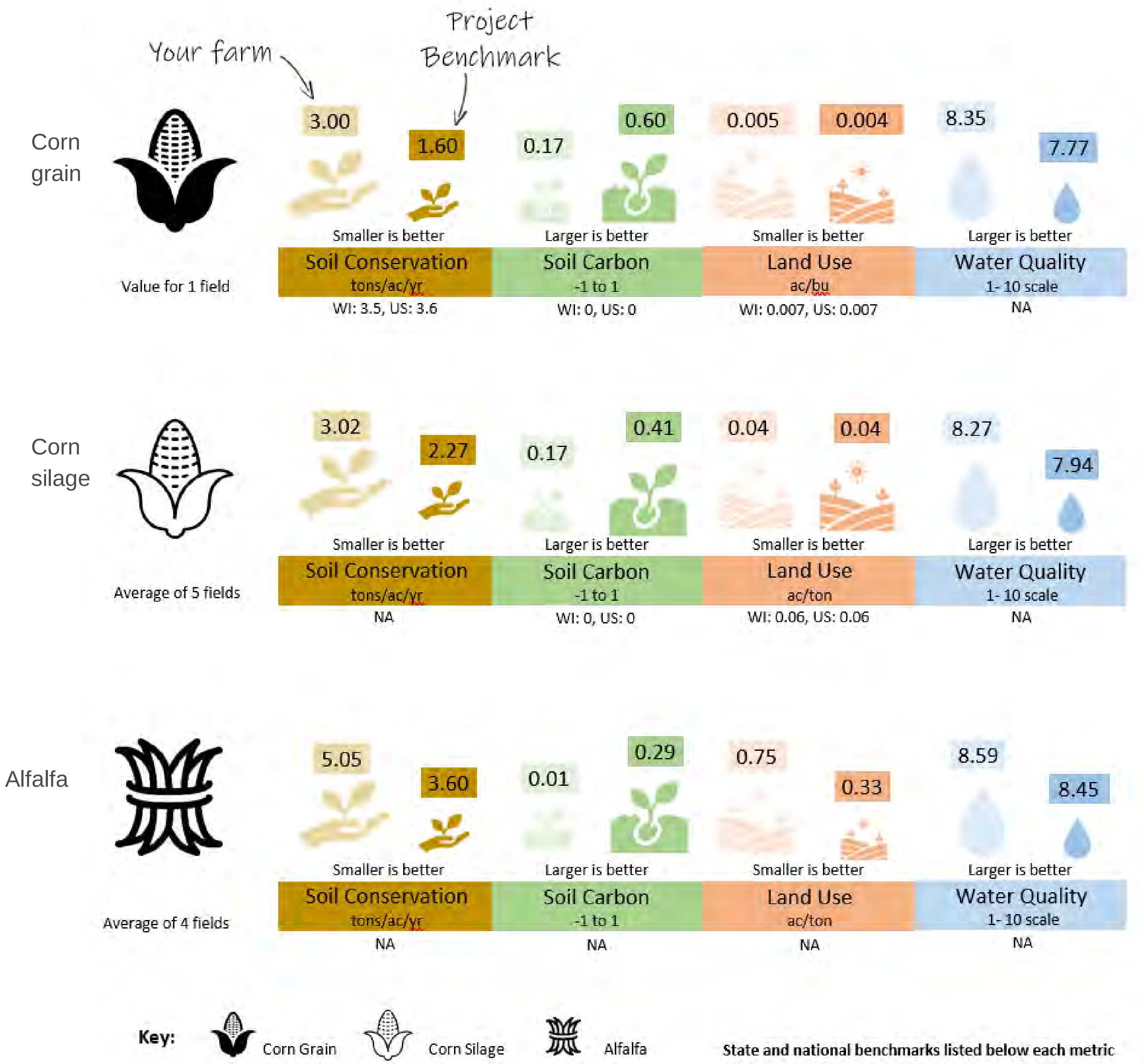


Figure 10: Illustrative farm-level summary showing soil conservation, soil carbon, land use and water quality metric values along with project, state and national benchmarks for corn grain, corn silage and alfalfa.

5.1.1.4 PROJECT-LEVEL SUMMARY

This level of analysis combined all farm summary information together by crop and metric to display each farm's scores against other farms in the project along with the project benchmark. **Figure 11** shows a project-level graph created for one crop (corn grain) and one metric (land use). Additionally, **Figure 11** shows the 2019 crop year project data and project benchmark comparison for corn silage. This figure shows the participant farms' metrics against the project benchmark. Three crops (corn grain, corn silage, and alfalfa) were assessed at the project level for seven of the eight metrics (excluding irrigation water).

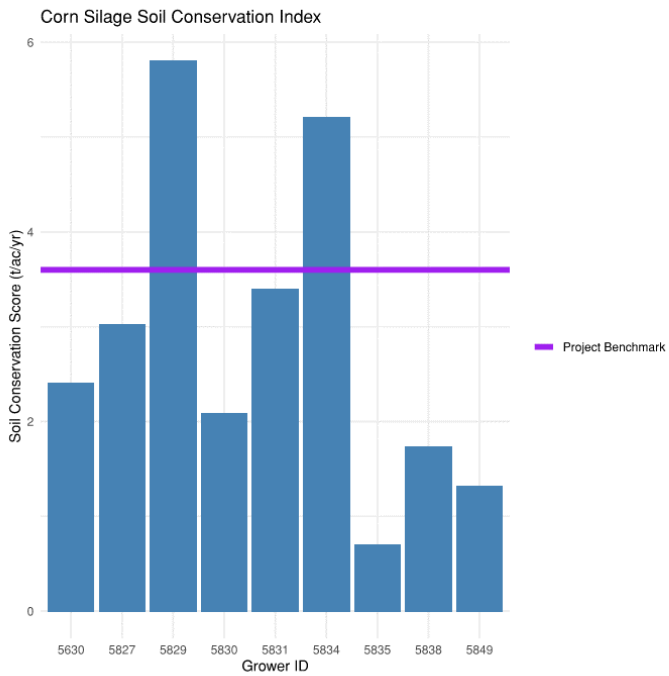


Figure 11: Graphical project level summary for the average corn silage soil conservation index values for each farm along with project benchmark.

5.2 LOCAL RESOURCES: PTMAPP

The PTMApp process follows a pathway that starts with:

1. establishing priority resource points, local water resources, and/or watershed outlets where local resource evaluations can be performed,
2. characterizing baseline conditions in the project area by performing source assessments for estimating sediment and nutrient (nitrogen and phosphorus) loss, and evaluating areas of highest risk for groundwater nitrogen infiltration, and
3. running the PTMApp toolbar and evaluating the data to understand changes in sediment and nutrient loading from existing or future CPs.

For this project, the PTMApp project area can generally be described as Lafayette County, WI, with some adjacent areas in the surrounding eastern, western, and northern counties (**Figure 12**). The participating farm in eastern Rock County was excluded from the PTMApp analysis. This was primarily because the area in Rock County drains to a different major watershed and would have significantly increased the scope of the watershed data collection and PTMApp processing effort, which could not be accommodated by the project resources.

5.2.1 PRIORITY RESOURCE POINTS

Priority resource points (PRPs) were placed in a nested fashion to provide broad and fine levels of detail within the project area. There are a total of 75 PRPs covering the project area, five of which represent the project area boundary in full without overlap (i.e., priority resource outlets). Four of those five priority resource outlets are located along the south edge of the project area at the Wisconsin-Illinois state boundary and the fifth is located on the western edge in Grant County near the outlet to the Mississippi River. Additional PRPs were placed within the project area at locations of local water resources or areas where estimating sediment and nutrient loads was desired.

For this project, PTMApp was used to complete a general analysis of sediment and nutrient loading for the entire project area, and also for a focused evaluation of a small watershed in the east-central portion of the project area (teal boundary in **Figure 12**). The evaluation area watershed was assessed in detail because it includes several Fieldprint® Platform fields. This focused evaluation will be expanded upon in years two and three of the project after getting input from the LASA Board of Directors and project advisory team.

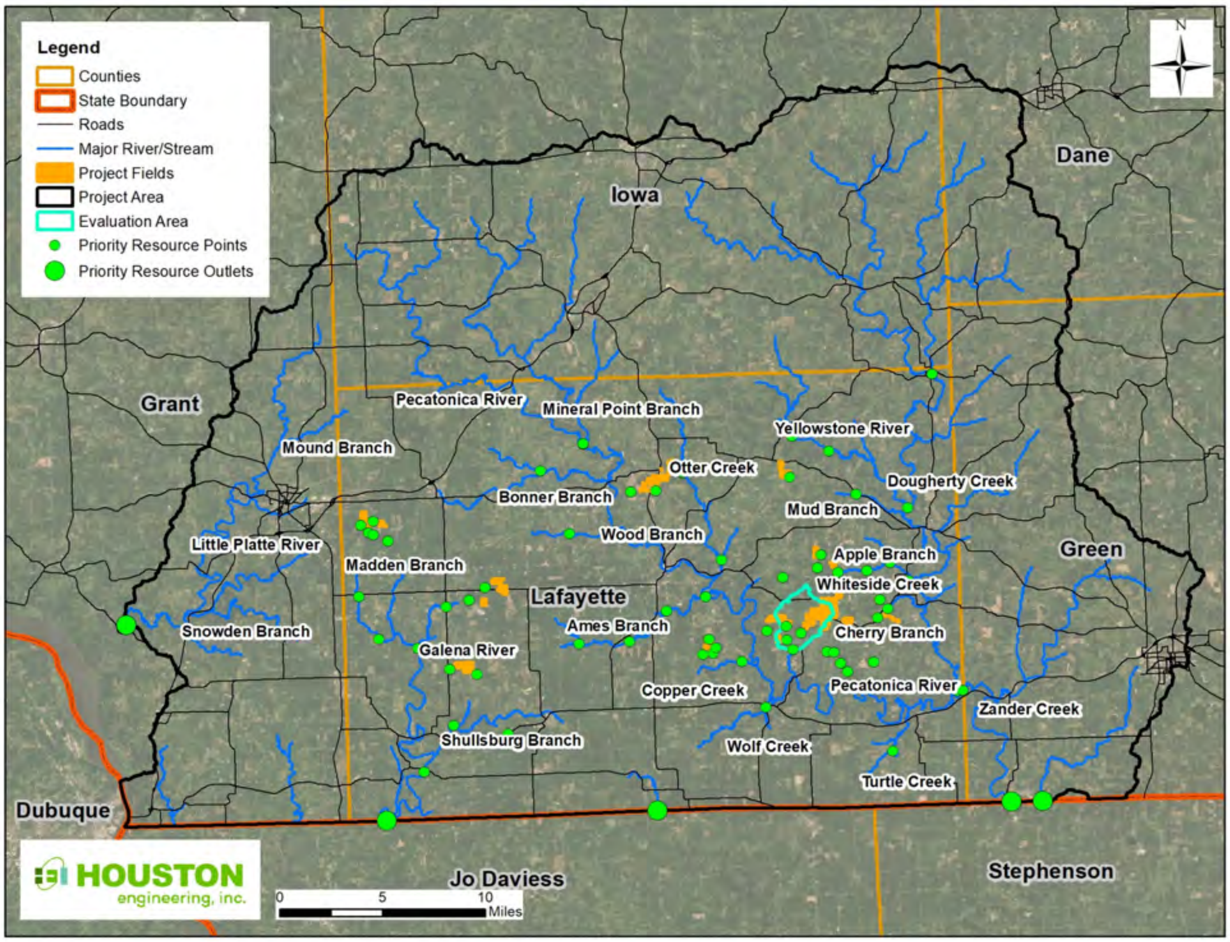
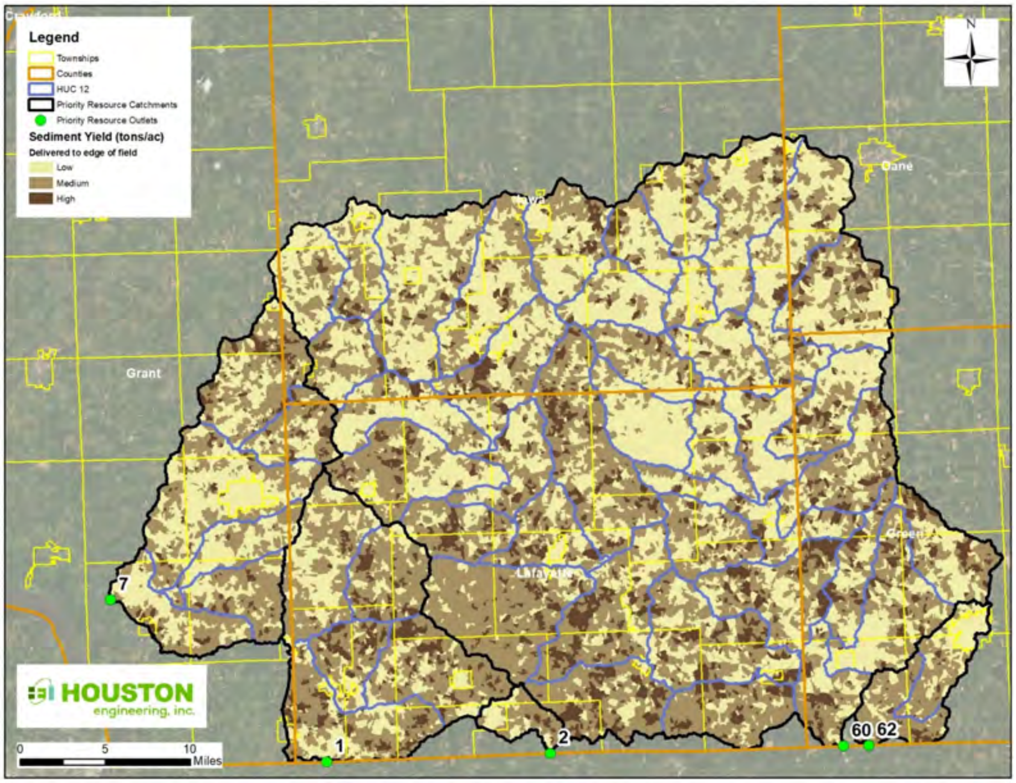


Figure 12: Lafayette and adjacent counties with major waterways, roads, project fields, PRPs, priority resource outlets, and the PTMApp evaluation area.

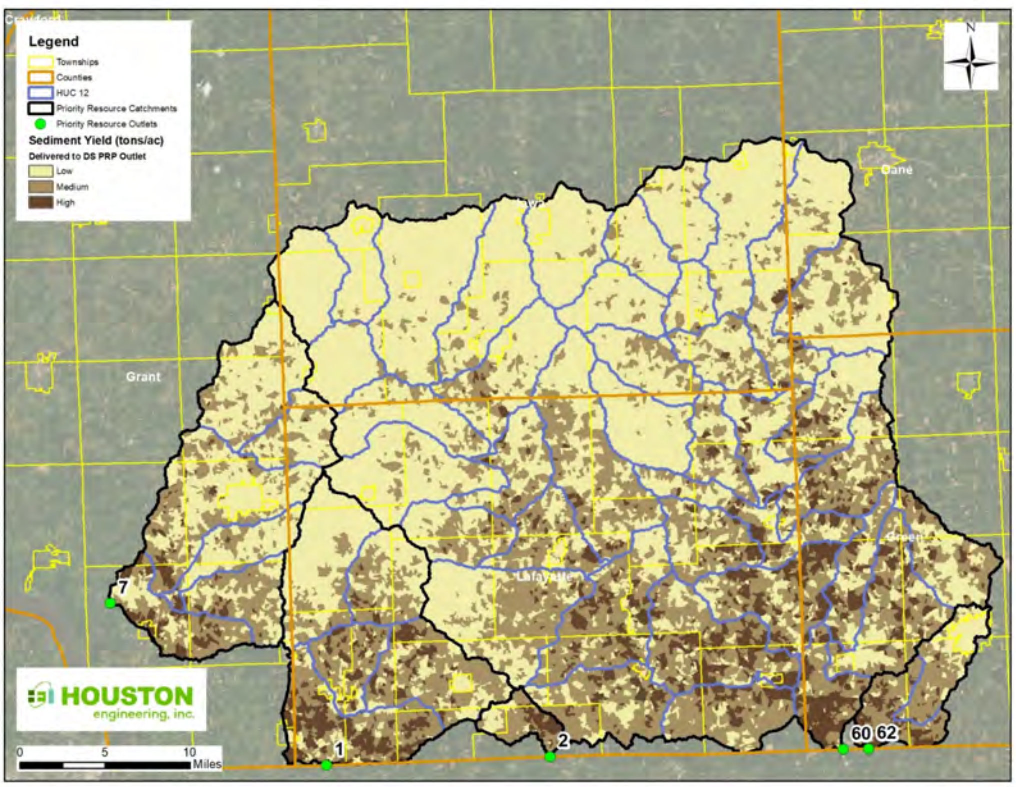
5.2.2 SOURCE ASSESSMENTS

Sediment and nutrient source assessments largely reveal those fields/catchments that have the highest potential source loading to the downstream resources or priority resource outlet. **Figures 13, 14,** and **15** show the relative potential for sediment, nitrogen, and phosphorus loss under baseline conditions.

Each figure presents two maps. The top map shows average yield from each PTMApp field/catchment, as measured at the catchment outlet. Values are calculated using the revised universal soil loss equation (RUSLE) for sediment yields, and land use-based estimates from literature values for nitrogen and phosphorus yields. The bottom map of each figure shows the yield from catchments as measured at the priority resource outlet, but accounts for in-stream losses during transport between the catchment and the priority resource outlet. The decay or loss of sediment, nitrogen, and/or phosphorus mass after leaving the field is used to represent the reduction in mass from physical, chemical, and biological processes. This is evident in the lower maps of each figure as smaller yield values from the catchments that are located further upstream from the priority resource outlet (more in-stream reduction).

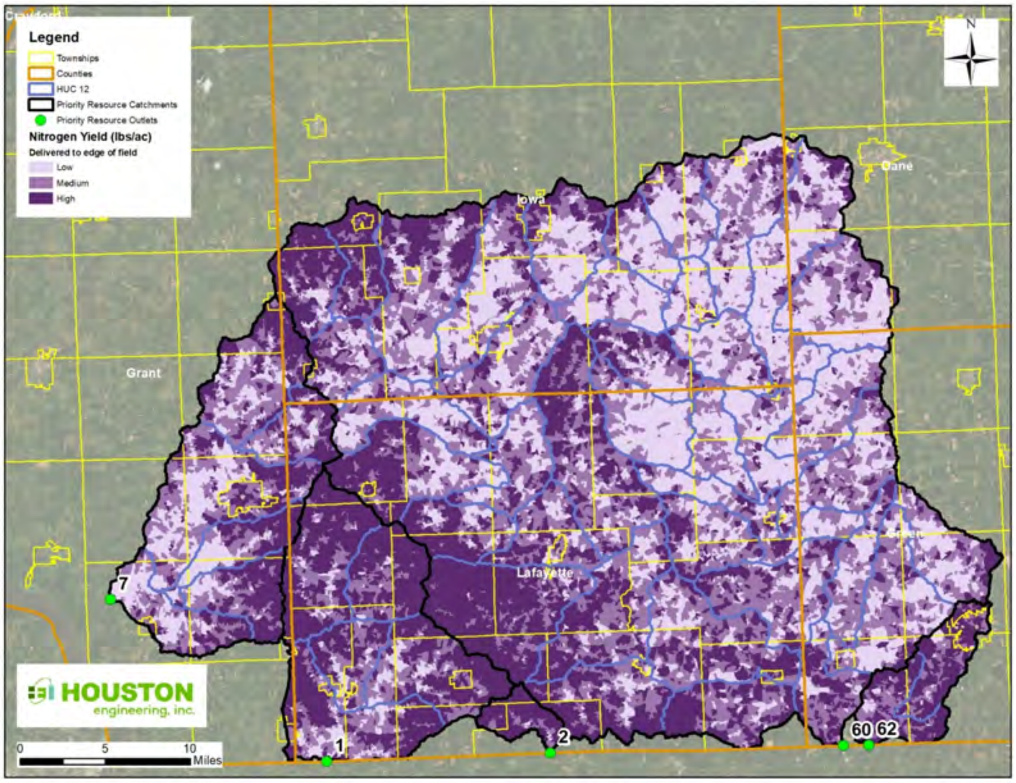


Sediment yield to the field edge

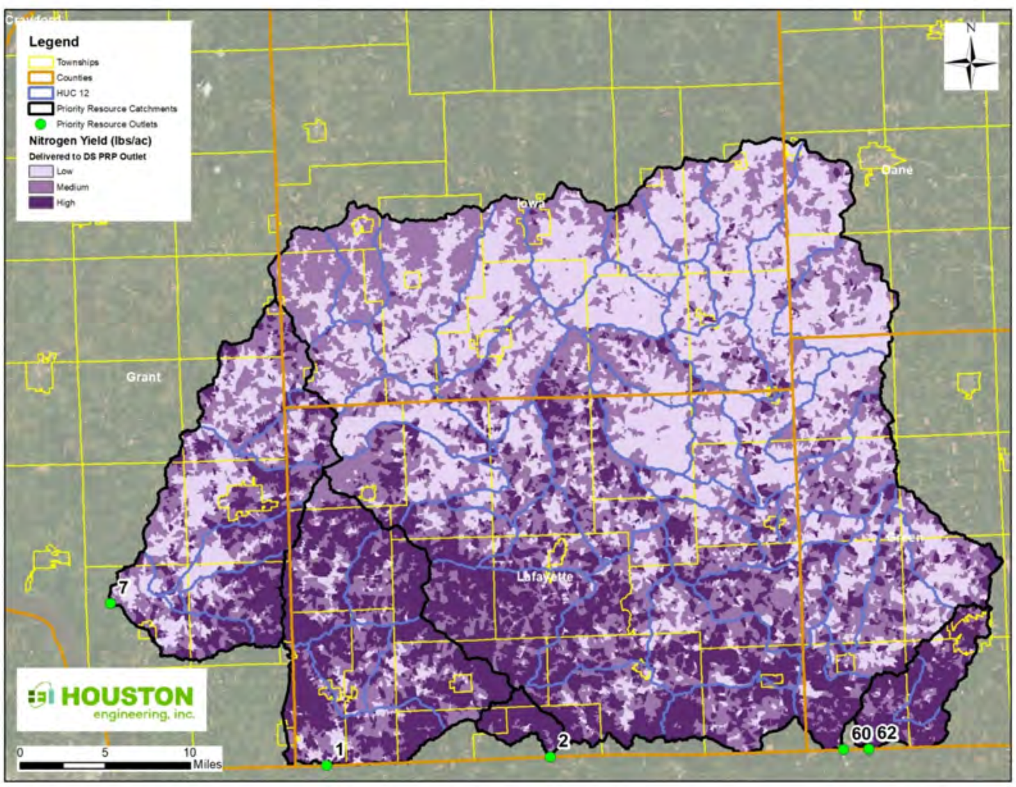


Sediment yield to the downstream priority resource outlet

Figure 13: Sediment source assessment maps showing sediment yield (tons/ac/yr) as the average catchment values delivered to the catchment outlet (top) and to the downstream priority resource outlet (bottom).

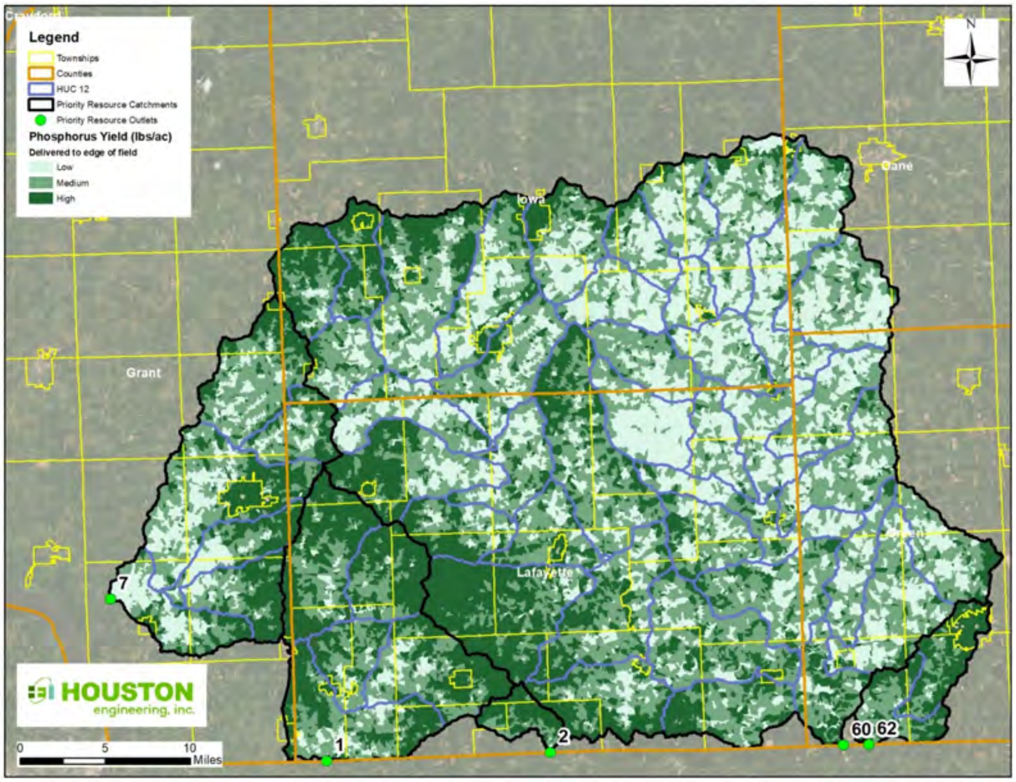


Nitrogen yield to the field edge

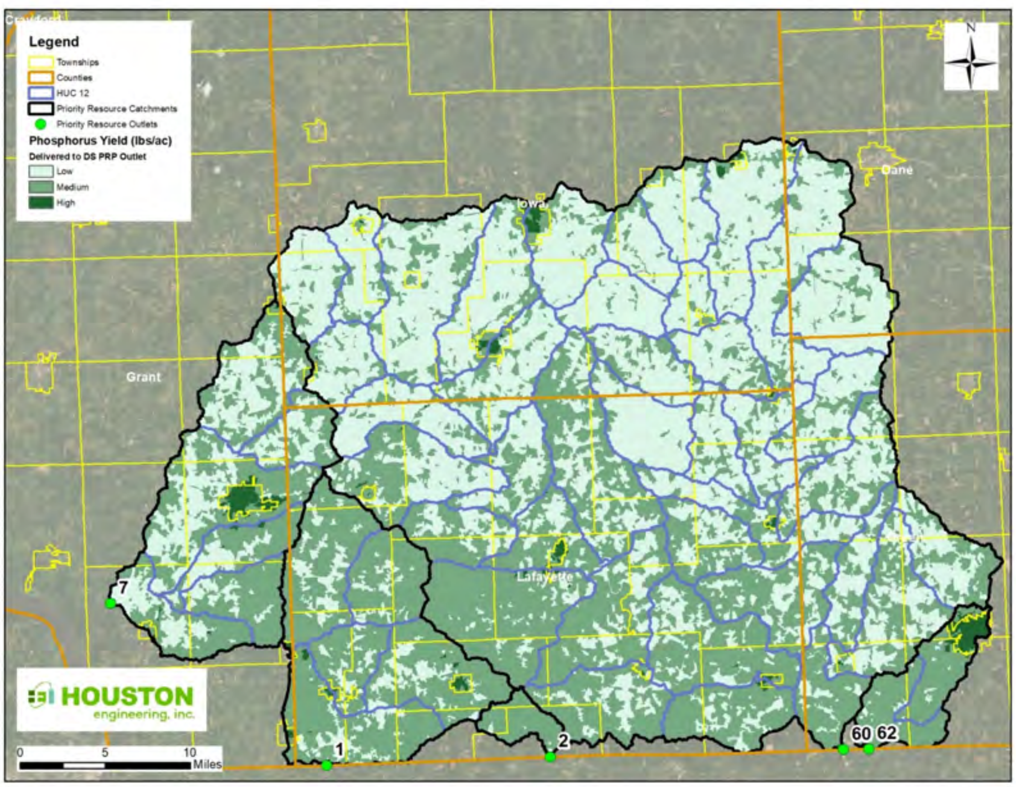


Nitrogen yield to the downstream priority resource outlet

Figure 14: Nitrogen source assessment maps showing nitrogen yield (lbs/ac/yr) as the average catchment values delivered to the catchment outlet (top) and to the downstream priority resource outlet (bottom).



Phosphorus yield to the field edge



Phosphorus yield to the downstream priority resource outlet

Figure 15: Phosphorus source assessment maps showing phosphorus yield (lbs/ac/yr) as the average catchment values delivered to the catchment outlet (top) and to the downstream priority resource outlet (bottom).

5.2.3 EXISTING PRACTICES

The benefits of existing practices, reported by participating project farms in the Fieldprint® Platform, were assessed at a small watershed level (**Figure 16**). At this small watershed scale, benchmark fields were compared against stewardship project fields for the baseline conditions (i.e., no CPs) and existing conditions. Some of the participating project fields shown in **Figure 16** fall outside of the boundaries of the evaluation area watershed. This occurs because PTMApp divides the landscape into catchments based on hydrologic boundaries (i.e., where the water flows), not along ownership boundaries. As a result, some fields may be divided among multiple catchments. Estimated loads and yields for those fields that fall outside of the evaluation area watershed were aggregated and incorporated into the evaluation area analysis to ensure that all estimated reductions of existing practices were accounted for.

The average sediment and nutrient yields were calculated using PTMApp data for the project (stewardship) fields under the baseline and existing conditions and compared against benchmark fields (**Figure 17**). These estimates show the yield and reductions from these fields as measured at the downstream priority resource outlet (project area exit). For example, in the evaluation area the average sediment yield for the project stewardship fields under the baseline condition was 22% less than the benchmark fields, which is likely due to natural landscape and soil factors. More importantly, when compared to the baseline condition of the project stewardship fields, sediment yield from those fields is estimated to have been reduced by 28% due to the implemented CPs (**Figure 17**). The participating project fields within the evaluation watershed are now contributing 0.75 fewer tons/ac/yr of sediment to the watershed outlet due to the current conservation efforts. Nitrogen and phosphorus yields are also presented in **Figure 17**. The effect of conservation efforts from all project fields within the project area was also estimated and is summarized in **Table 5** and will be discussed in greater detail in a later section.

Benchmark	Non-LASA fields where any water quality benefits of implemented CP(s) are not accounted for.
Stewardship baseline	LASA fields where any water quality benefits of implemented CP(s) are not accounted for.
Stewardship existing	LASA fields accounting for the benefit of known CP(s).

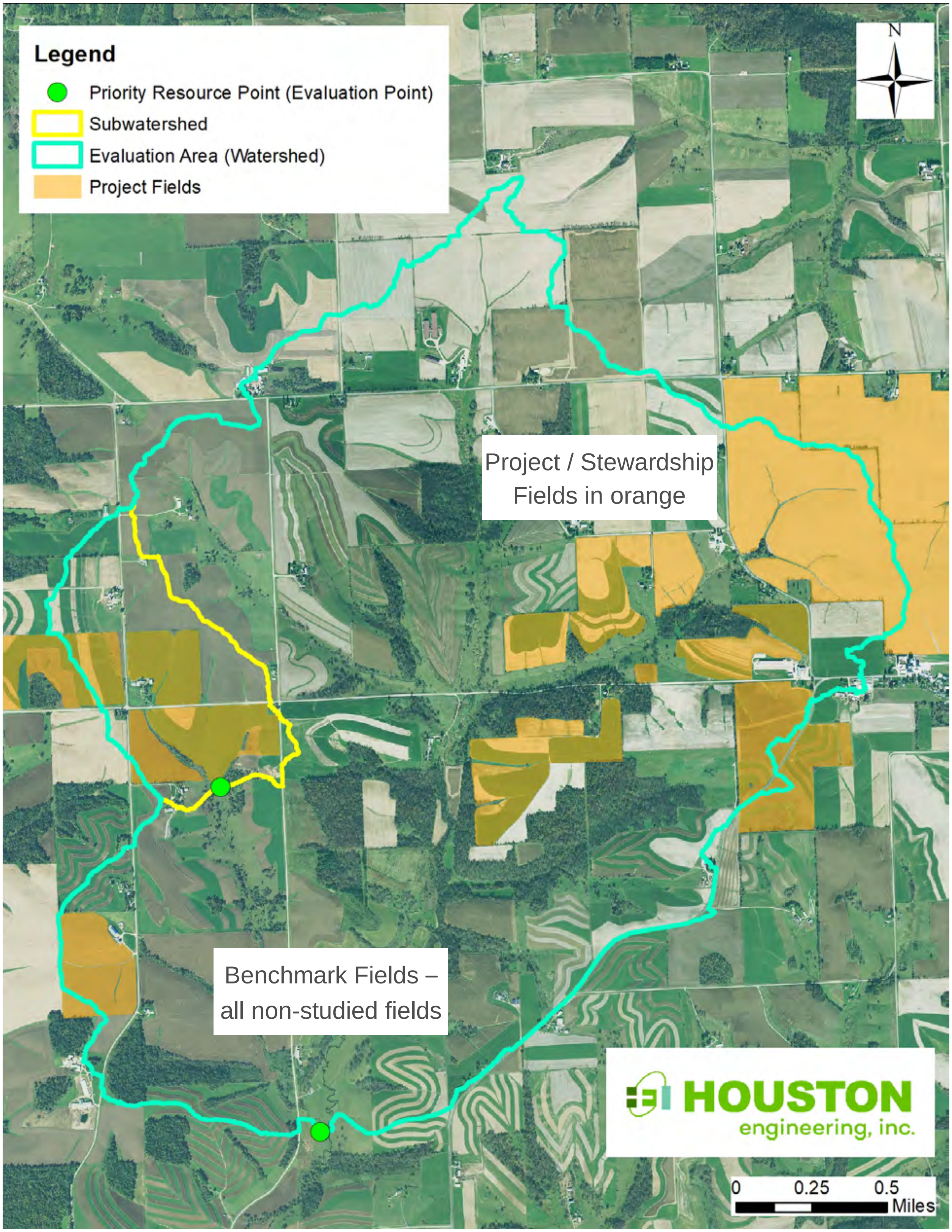


Figure 16: Evaluation area (watershed).

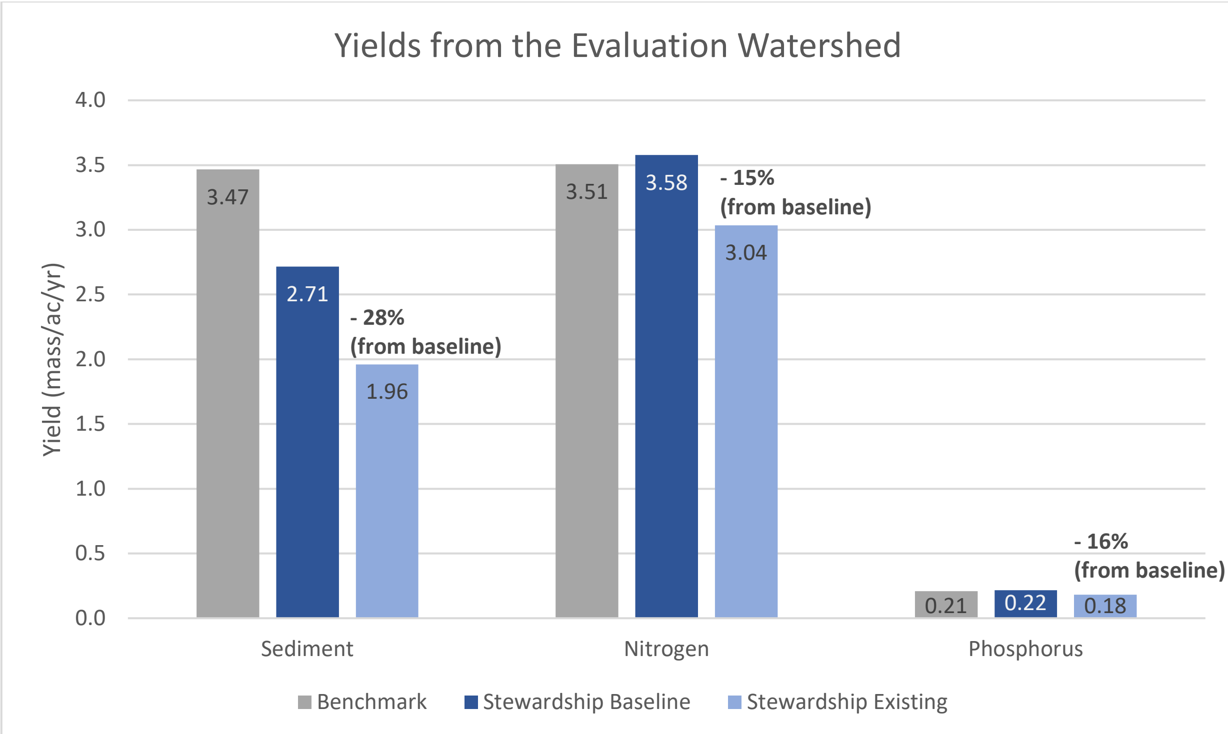


Figure 17: A comparison of the yields between the project stewardship fields and the benchmark fields in the evaluation area watershed.

5.2.4 FUTURE CONDITION

A potential future conservation scenario was explored to estimate the additional sediment and nutrient reductions that could be achieved within the project area through scaling up conservation efforts in non-project fields. For this scenario, the top 50% of feasible cover crop areas with the highest cost-effectiveness (lowest cost per unit of sediment removed) were selected within the evaluation area as an implementation scenario (**Figure 18**). The estimated sediment and nutrient reductions from scaling up the use of cover crops in the evaluation area are shown in **Figure 19**. Implementation of cover crops within the evaluation area could reduce the average sediment yield by 40% compared to baseline conditions.

Two additional scenarios were examined. The second scenario assumes a scaling up of cover crop implementation in catchments near all the LASA project fields throughout the entire project area (shown in **Figure 12**). Finally, the same analysis was performed for all catchments within the entire project area (**Figure 20**). Scaling up conservation to include cover crop implementation on 50% of feasible fields within the entire project area could reduce sediment leaving the entire project area by 35% compared to baseline conditions (**Figure 21**).

It should be noted that PTMApp presents all suitable areas for cover crops. However, **without a complete inventory of existing CPs, PTMApp likely identifies fields where conservation management practices already exist.** Since **Figures 18** and **20** display only 50% of the suitable land for potential future cover crops, many alternate locations exist for cover crop implementation. As mentioned earlier, PTMApp also divides the landscape based on hydrologic boundaries. As a result, a single field may be split between two or more catchments within PTMApp. **Figure 18**, for example, highlights only those portions of fields that are within the evaluation area boundary, even though the field and additional suitable land for potential future cover crop implementation continues beyond that boundary. The potential sediment and nutrient reductions that are associated with the portions of fields that continue beyond the boundary of the evaluation area are included in the implementation scenario that analyzes the entire project area.

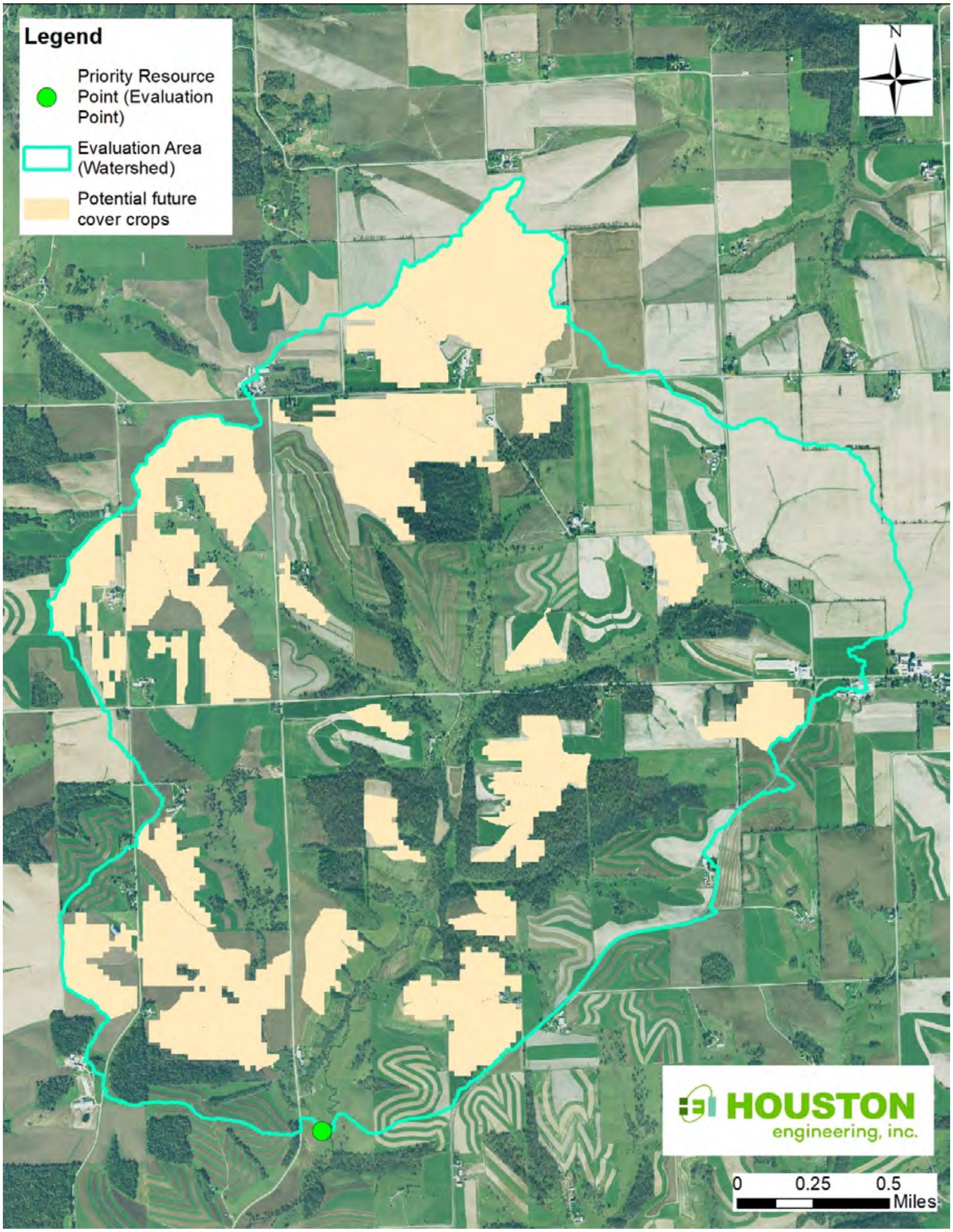


Figure 18: Future potential cover crop locations for the evaluation area watershed.

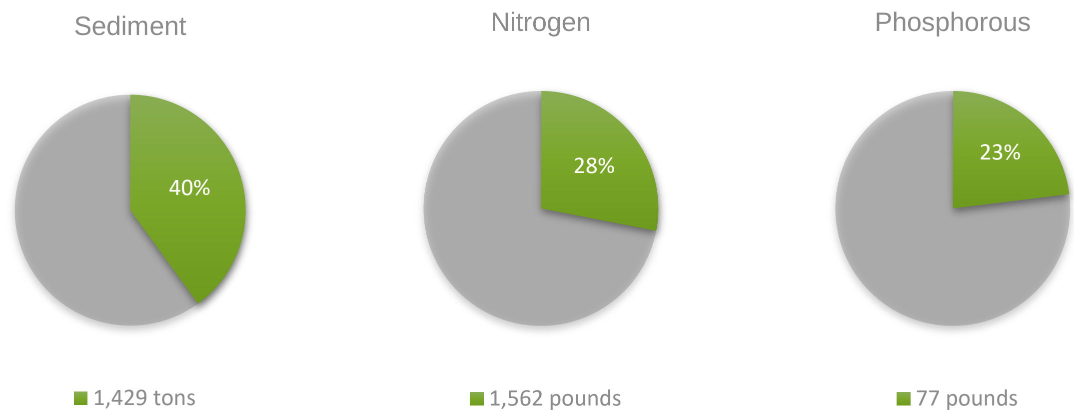


Figure 19: Future potential cover crop sediment and nutrient reductions from the baseline condition for the evaluation area (watershed) draining to the priority resource outlets.

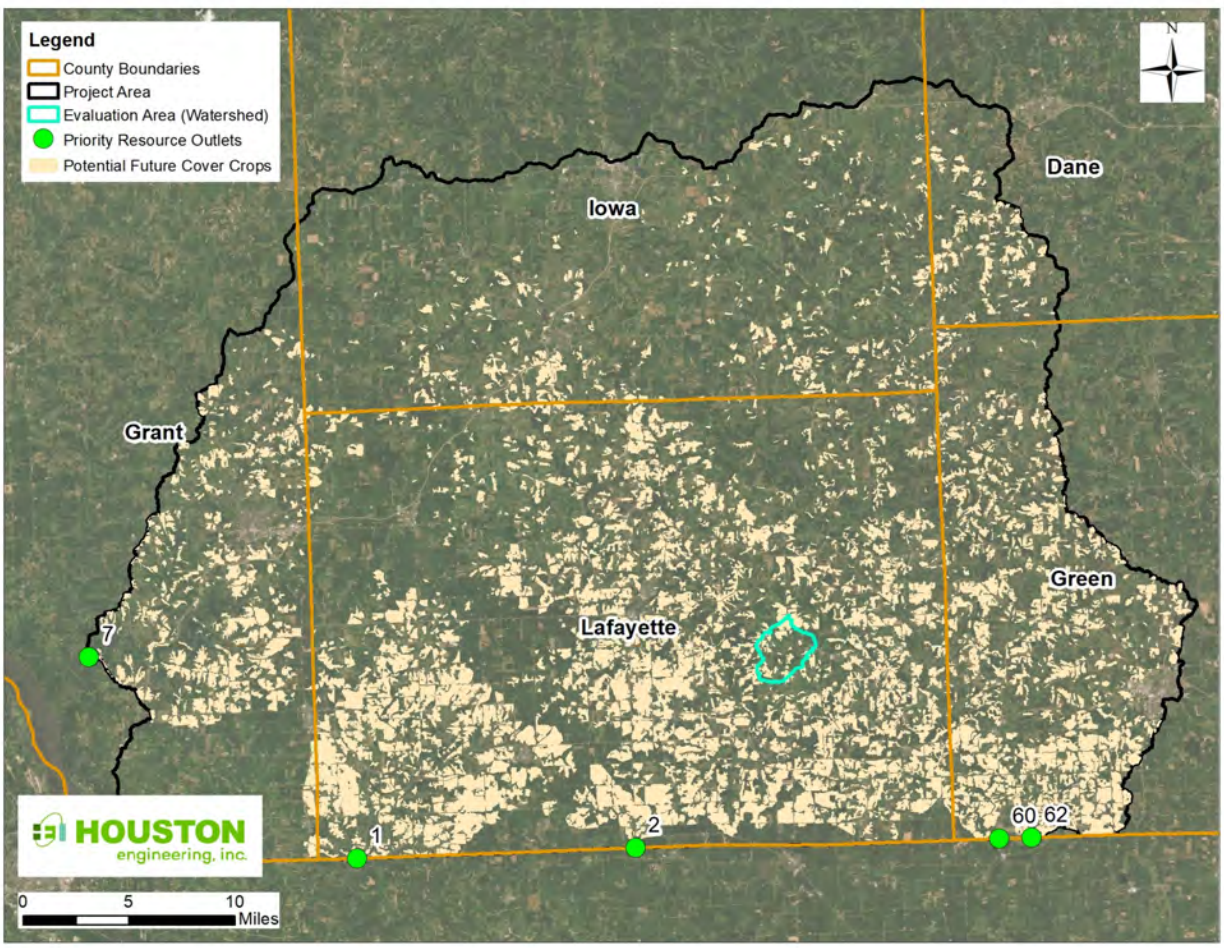


Figure 20: Future potential cover crop locations for the project area draining to the priority resource outlets.

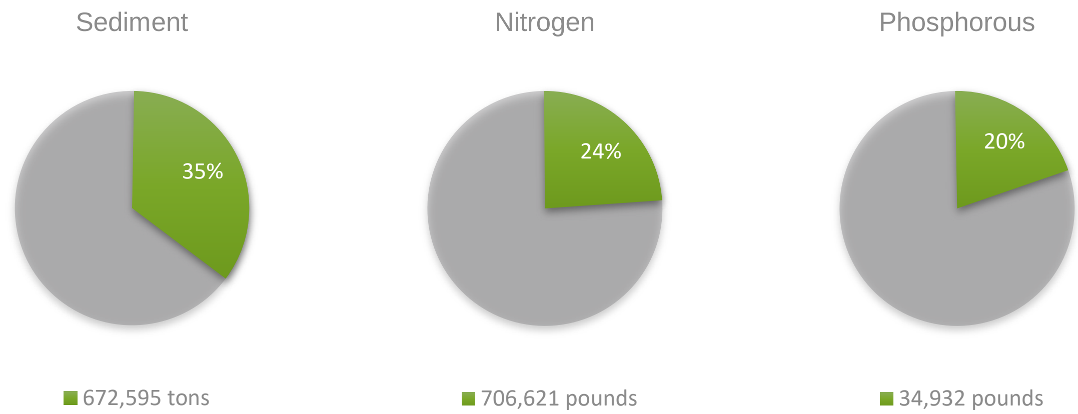


Figure 21: Future potential cover crop sediment and nutrient reductions from the baseline conditions for the project area draining to the priority resource outlets.

Table 5 provides a summary of average sediment and nutrient yields calculated at three spatial scales: catchments containing LASA project farms within the evaluation area (**Figure 18** and **Table 6A**), catchments containing LASA project farms within the entire project area (**Figure 12** and **Table 6B**), and average yields for all catchments within the entire project area (**Figure 20 and Table 6C**). All presented values represent yields from a field or catchment that would be measurable at the edge of the field or small catchment outlet (Field edge) and the estimated yield from a field or catchment that would be measurable at the downstream project area outlet (priority resource outlet). For a given field, measurable sediment and nutrient yields are highest at the field edge and decrease at downstream locations as sediment and nutrients from the field are deposited or reduced in transport.

Yield reductions resulting from existing conservation efforts on project fields are more evident at the small-scale analysis of the evaluation area watershed. For instance, sediment yield reduction from project fields in the evaluation area amounts to 0.75 tons/acre/year from baseline conditions, as measured at the project area outlet (**Table 5A**). This estimate ignores all other sediment contributions from other fields and catchments within the project area. When analyzing all catchments within the entire watershed, the difference between baseline conditions and current conditions appears minimal because so many fields and catchments without any existing conservation management are included in the calculation. Although the conservation efforts of the project fields are making a difference, the measurable effect is often masked at the large scale by the large number of other fields and catchments within the project area.

Table 5. Average sediment and nutrient yields from PTMApp catchments within the evaluation area (A), from all catchments containing LASA project farms (B), and from all catchments within the project area (C). Yield values are presented as measurable at the field edge as well as the downstream priority resource outlet.

A. Evaluation Area

	Field edge			Priority Resource Outlet		
	Sediment (tons/ac/yr)	Nitrogen (lbs/ac/yr)	Phosphorus (lbs/ac/yr)	Sediment (tons/ac/yr)	Nitrogen (lbs/ac/yr)	Phosphorus (lbs/ac/yr)
Baseline	5.31	4.32	0.26	2.71	3.58	0.22
Current Reduction	3.79	3.66	0.22	1.96	3.04	0.18
Future Reduction	2.34	2.65	0.17	1.18	2.19	0.14

B. All LASA Project Farms

	Field edge			Priority Resource Outlet		
	Sediment (tons/ac/yr)	Nitrogen (lbs/ac/yr)	Phosphorus (lbs/ac/yr)	Sediment (tons/ac/yr)	Nitrogen (lbs/ac/yr)	Phosphorus (lbs/ac/yr)
Baseline	5.49	5.10	0.29	2.53	4.06	0.23
Current Reduction	4.74	4.64	0.26	2.19	3.69	0.21
Future Reduction	3.52	3.89	0.22	1.56	3.06	0.18

C. Project area

	Field edge			Priority Resource Outlet		
	Sediment (tons/ac/yr)	Nitrogen (lbs/ac/yr)	Phosphorus (lbs/ac/yr)	Sediment (tons/ac/yr)	Nitrogen (lbs/ac/yr)	Phosphorus (lbs/ac/yr)
Baseline	5.00	4.43	0.26	2.20	3.45	0.21
Current Reduction	4.99	4.43	0.26	2.20	3.45	0.21
Future Reduction	3.49	3.45	0.22	1.42	2.63	0.16

5.2.5 GROUNDWATER NITROGEN RISK

In addition to the PTMApp analysis, a groundwater nitrogen infiltration risk assessment was performed for the entire project area. Infiltration risk is estimated by factoring nitrogen inputs at the soil surface (e.g., fertilizer), soil type, and depth to groundwater. Areas of tight soil (e.g., clay), a deep-water table, and small nitrogen inputs are considered low risk whereas locations with sandy soils, a shallow water table, and high nitrogen inputs are considered high risk.

Areas of highest groundwater nitrogen risk within the project area occur along a diagonal swath from southwestern Green County to southwestern Iowa County. The large majority of south-central and northwestern Lafayette County is of moderate risk as well (**Figure 22**). This type of analysis can help to determine areas where management to reduce nitrogen infiltration could be prioritized in the future.

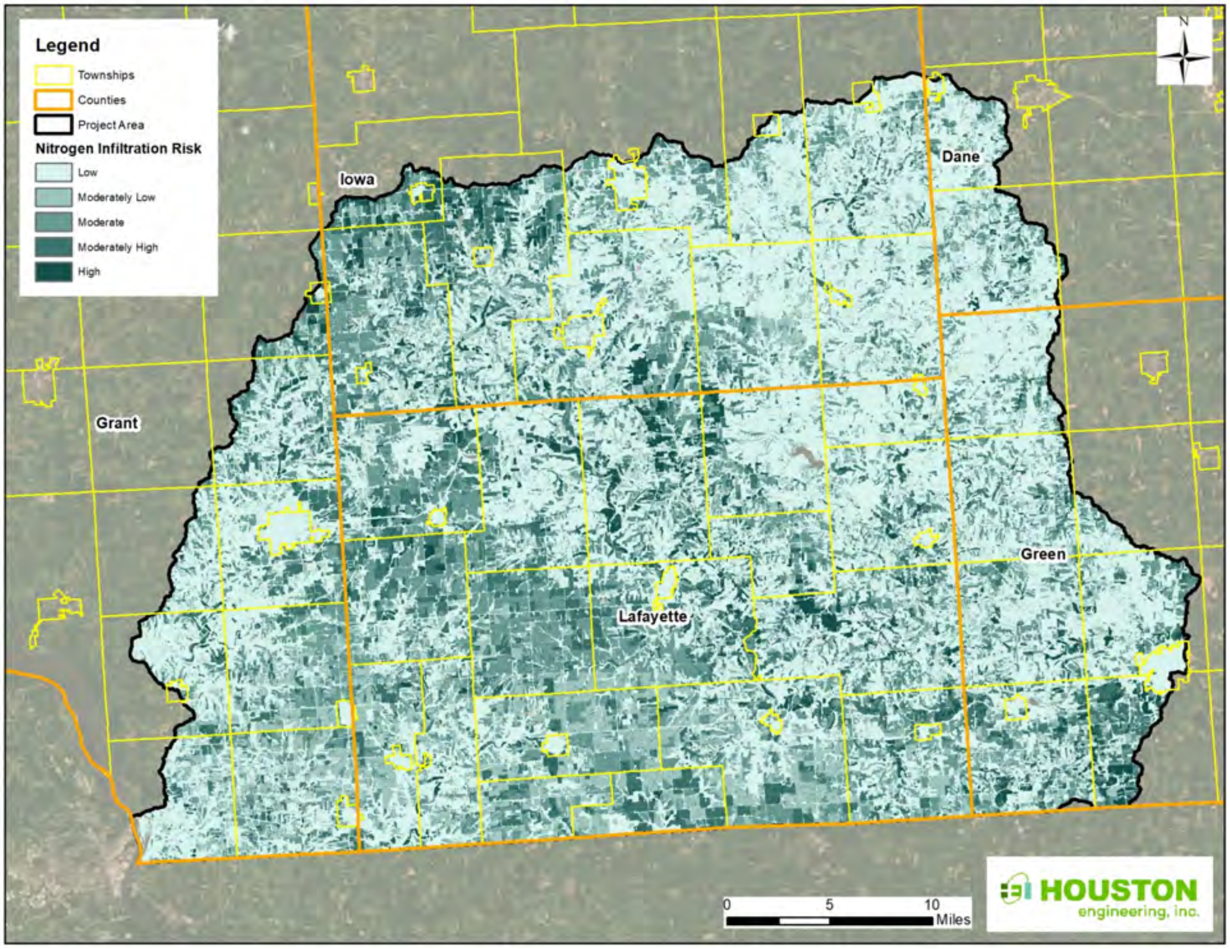


Figure 22: Relative groundwater nitrogen infiltration risk (low to high) across the project area.

6 CONCLUSION

6.1 FIELDPRINT® PLATFORM

On average, farms participating in the pilot project have adopted five conservation practices per field, which Field to Market's Fieldprint Platform recognizes as having a positive impact on sustainability scores. The conservation practices reported included contouring, strip cropping, grassed waterways, field borders, buffer strips, reduced tillage, and nutrient management. For greenhouse gas emission and energy use metric scores, we found that those farms with livestock and that derive most of their crop nutrient needs from manure, on average scored better than the project as a whole.

On average, farms participating in the pilot project have adopted 5 conservation practices per field which Field to Market's Fieldprint Platform recognizes as having a positive impact on sustainability scores.

This is the direct result of using manure for crop nutrient needs. Manure replaces the use of inorganic forms of nitrogen, which have a higher energy (fossil fuel) cost to produce.

In years two and three of the project, we will continue to use state benchmarks for Wisconsin and Illinois for comparative purposes for individual farm field results. Current Field to Market benchmarks are based on historical USDA survey data from 2008-2012. Updated state and national benchmarks will be available in 2022 reflecting data from 2013-2017.For Wisconsin, this resulted in rainfed benchmarks for corn grain based on a fertilizer rate of 90-20-25 N-P-K. When compared to pilot project farms, this was very low and not representative of yield goals and current fertilizer rates following University of Wisconsin guidelines for southwestern Wisconsin. By comparison, the benchmark fertilizer rates for rainfed corn in Illinois is 167-81-90 N-P-K. With the pilot project being adjacent to Illinois, this project used Illinois Field to Market state benchmarks for comparative purposes only by the farmers and individual field results.

Over the next two crop years (2020 and 2021) the project will:

1. collect crop management and operations data for the next crops grown in sequence for each of the 142 enrolled fields,
2. add crops grown for farms that did not report all the crops they currently produce,
3. review opportunities and ways in which scores may be improved, and
4. calculate sustainability metric scores for each new year and compare with the previous year data and metric scores.

6.2 PTMAPP

PTMApp was used to generate a baseline condition for the project area and estimates the potential for loss of sediment, nitrogen, and phosphorus to watershed outlets, lakes, or streams that are of interest to the project (**Figure 23**). The results from this baseline assessment can be used to identify areas where losses are the highest and where to target for conservation implementation. This can be used to show farmers and landowners that if they implement new CPs, they can expect that it will benefit a local water resource and the community at large. It can also target implementation to where practices are expected to provide the largest return on investment and to support completive grant applications.

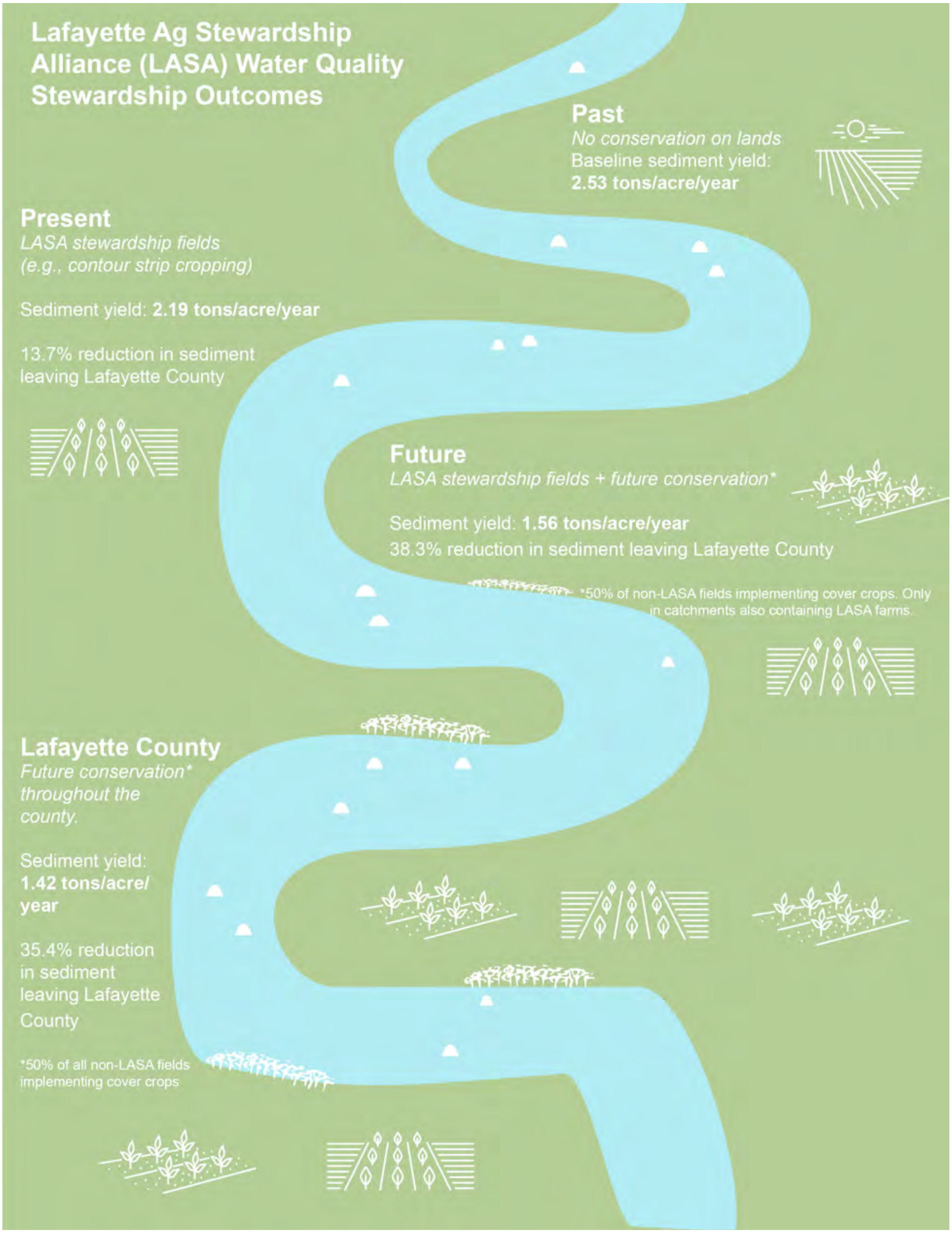


Figure 23: Overall water quality improvement resulting from LASA project fields and estimated future improvement potential from scaling up conservation throughout the watershed.

The assessment showed significant reductions in sediment and nutrients with the existing conservation practices and shows further potential reductions could be achieved with the implementation of additional conservation practices.

By using PTMApp, this project was able to quantify the estimated benefit from both current and planned CPs to local water resources, which could not otherwise be done without the use of sophisticated water quality models. The assessment showed significant reductions in sediment and nutrients with the existing CPs and shows further potential reductions could be achieved with the implementation of additional CPs.

Using PTMApp data in this way can allow water resource and land managers to create conservation implementation scenarios to work toward meeting existing water quality goals. For example, Silver Spring Creek (the evaluation area watershed) is impaired by sediment and has an assigned total maximum daily load (TMDL). The TMDL report for Silver Spring Creek suggests that reducing average sediment yield to 0.9 tons/acre/year for land that drains to the creek would allow Silver Spring Creek to meet the water quality standards for sediment. An implementation scenario could be created to find CPs within the Silver Spring Creek watershed that would reduce sediment transport to the creek and work toward meeting the water quality standard.

The PTMApp data products and desktop toolbar will be made accessible to LASA, the group's advisers, and other natural resource managers as a new tool to target outreach, technical assistance, and financial assistance to those farms and fields where adoption of CPs and land management systems will produce cost-effective land treatment.

7 APPENDICES

Appendix A: “Crop Production Financial Benchmarking” (H:\Maple Grove\JBN\10500\10554\20_10554_0001\Final Deliverables\Appendix_A_SWTC Pilot Milkshed Sustainability Project Final Report 6.3.2021.pdf)

Appendix B: FSF’s “A Framework for Farm-Level Sustainability Projects” ("H:\Maple Grove\JBN\10500\10554\20_10554_0001\Final Deliverables\Appendix_B_DSSA_Framework_9-16-20.pdf")

Appendix C: Field to Market’s “Harnessing Sustainability Insights and Unleashing Opportunity Report” ("H:\Maple Grove\JBN\10500\10554\20_10554_0001\Final Deliverables\Appendix_C_FTM_Harnessing-Sustainability-Insights_WEB.pdf")

Appendix D: Example crop rotation (Excel format) ("H:\Maple Grove\JBN\10500\10554\20_10554_0001\Final Deliverables\Appendix_D_Example crop rotation_LAH_3-3-21.docx")

Appendix E: Example farm FieldPrint Summary Report ("H:\Maple Grove\JBN\10500\10554\20_10554_0001\Final Deliverables\Appendix_E_Example_farmer_report_LAH_2-11-21.docx"

Appendix F: Example farm FieldPrint Analysis Summary Report (“Maple Grove\JBN\10500\10554\20_10554_0001\Final Deliverables\Appendix_F_Example Farm FieldPrint Platform Representative report.docx")

PILOT MILKSHED SUSTAINABILITY PROJECT

CROP PRODUCTION FINANCIAL BENCHMARKING

YEAR ONE REPORT

PREPARED BY SOUTHWEST WISCONSIN TECHNICAL COLLEGE
FARM BUSINESS & PRODUCTION MANAGEMENT PROGRAM

THIS PROJECT WAS FUNDED AND SUPPORTED THROUGH GRANT OPPORTUNITIES PROVIDED BY:

The Nature Conservancy — Protecting nature. Preserving life.

Farmers for Sustainable Food

PROJECT OVERVIEW

Southwest Tech Farm Business and Production Management program has worked in cooperation with the Farmers for Sustainable Food (FSF) and other key stakeholders in the dairy industry to begin assessing a farmer's return on investment when implementing conservation practices on their farms. Financial analyses were completed for 2019 and include a break down by enterprise of corn for grain, corn silage, and alfalfa. This first year of the project was focused on establishing a baseline of data for each participating farm that can be built upon to create trendlines and conclusions of the farm's return on investment with conservation practices implemented.

All three project farms are located in southern Wisconsin, milking nearly 6,000 cows and farming over 9,000 acres combined. Each farm's information is uniquely their own and held in strict confidentiality. Only average financial numbers of the three project farms are used in this report.

Each of the three farms also participated in an assessment of on-farm environmental sustainability utilizing Field to Market's Fieldprint Platform. This identified that all three farms had:

1. comprehensive nutrient management plans and were following university recommended fertilizer rates,
2. use of fall cover crops after corn silage,
3. high crop residue management, and
4. implemented a variety of structural conservation practices, most notably grassed waterways and farming on the contour. These practices resulted in above-average sustainability metric scores when compared to historic state and national averages. Over time, one of the goals of the project is to demonstrate a positive relationship between the achievement of high on-farm environmental sustainability and positive financial performance.

Financial data collected in this report is recorded from the actual financial records kept on each farm. FINPACK software, a product of the Center for Farm Financial Management at the University of Minnesota, is the premier farm financial management program used by educators to help producers better understand and manage their farm finances. FINPACK is not an accounting system, but instead provides tools to evaluate farm records and better understand farm financial position and sustainability.

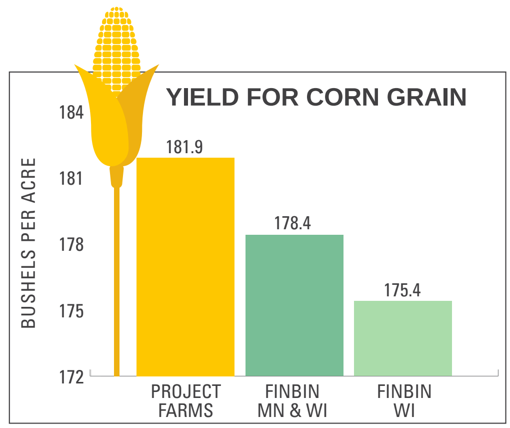
The standardized value used for gross return per acre is determined annually by averaging the commodity value over the previous year as determined by each individual summary group. This value is used for feed inventories on the balance sheet to create consistency. Direct expenses include seed, fertilizer, chemical, crop insurance, custom hire, land rent, fuel and oil, repairs, and operating interest. Manure hauling expense is split 50/50 between livestock custom hire and crop fertilizer expenses. This shared allocation lowers purchased fertilizer costs and shares the manure expense to both enterprises.

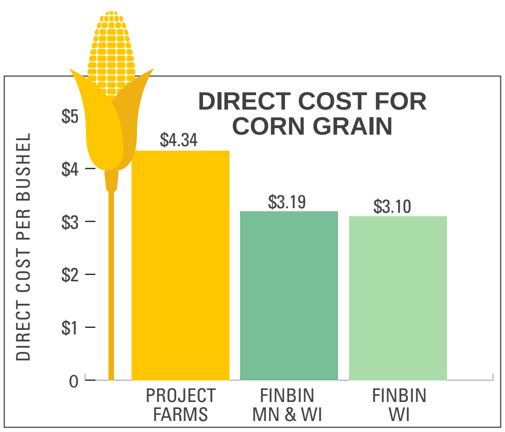
Benchmark numbers used in this report are from the FINBIN database. FINBIN, the FINPACK farm financial database, provides benchmark financial information for farm producers, educators, lenders, and other agricultural professionals. FINBIN reports were pulled for farms comparable in size, scale, and farming practice with our three project farms. Benchmark data includes both income and expense categories for various farm enterprises. This project focused on corn for grain, corn silage, and alfalfa enterprises. Limits to benchmark data exist due to low database farms of special sorts such as: use of cover crops, grown with cover crop, no-till, and non-organic.

CORN GRAIN PRODUCTION ANALYSIS

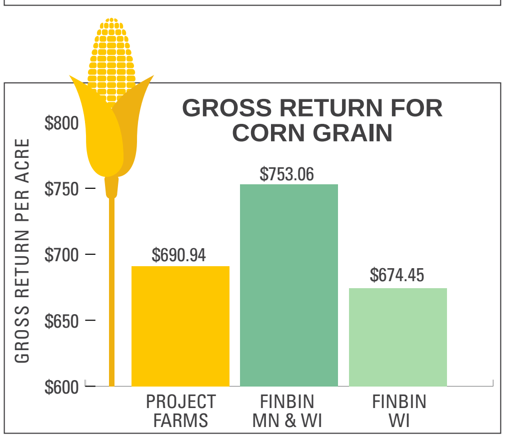
Corn for grain acres for the project farms averaged 700 acres. The Minnesota/Wisconsin combined database averaged 569.6 acres (722 farms) while the average acres for the Wisconsin database was 715.8 acres (8 farms) for corn for grain. The database farms were sorted to include farms that produced 251-1500 acres of corn for grain.

The **average yield** of the three project farms was 181.9 dry bushels of grain per acre. This is 2.3 percent higher, or 3.5 bushels per acre greater, than Minnesota/Wisconsin combined database, and 3.8 percent higher, or 6.5 bushels per acre greater, than Wisconsin farms.





The **direct cost of production** per bushel averaged $4.34 on the three project farms. This is 36.1 percent higher, or $1.15 per bushel higher, than Minnesota/Wisconsin combined farms, and 40 percent, or $1.24 per bushel higher, than Wisconsin farms.

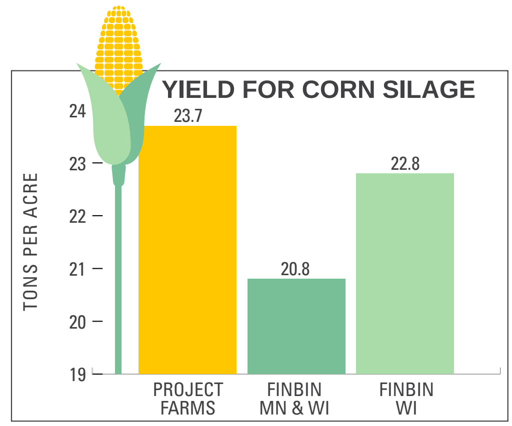


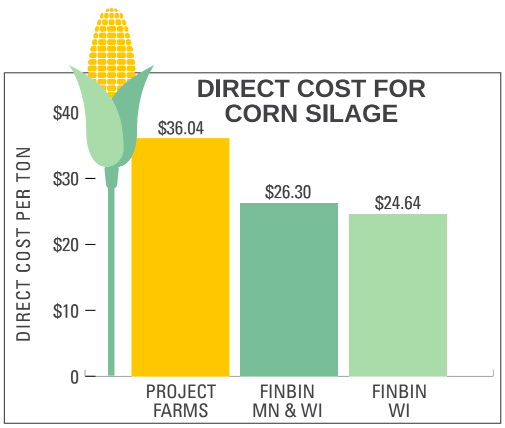
The average **gross return per acre** on the project farms was $690.84. This is 8.3 percent lower than Minnesota/Wisconsin combined, or $62.22 per acre, and 2.4 percent higher, or $16.39 per acre greater return than Wisconsin farms. Gross return per acre is a calculation of bushels per acre times a standard value of $3.50, unless grain is contracted, then the priced value is used. Minnesota/Wisconsin combined standard value is $3.67, indicating more grain was priced. Wisconsin-only grain is $3.54 per bushel, signifying that most are intended for livestock feed. If applicable, the gross return also includes the value of corn fodder, government payments, and crop insurance revenue.

CORN SILAGE PRODUCTION ANALYSIS

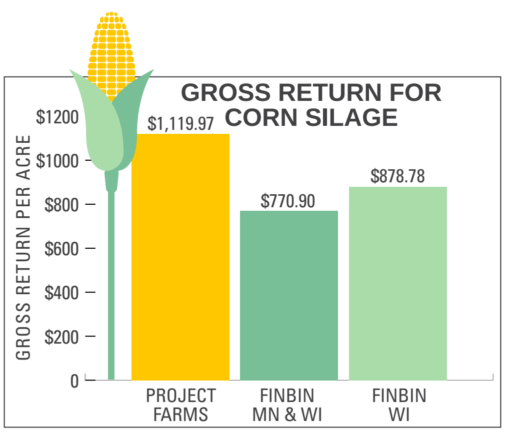
The average corn silage acres for the project farms was 1,002.7 acres. Minnesota/Wisconsin combined database averaged 443.5 acres (41 farms) while the average acres for the Wisconsin database was 142.3 acres (29 farms) for corn silage. The database farms were sorted to include farms that produced 251-1500 acres of corn silage for Minnesota/Wisconsin combined and all farms were included in the Wisconsin data cohort.

The **average yield** of the three project farms was 23.7 tons per acre. This is 13.9 percent higher, or 2.9 tons per acre greater, than Minnesota/Wisconsin combined database, and 3.9 percent higher, or 0.9 tons per acre greater, than Wisconsin farms.





The **direct cost of production** per ton averaged $36.04 on the three project farms. This is 38.5 percent higher, or $10.01 per ton higher, than Minnesota/Wisconsin combined farms, and 46.3 percent, or $11.40 per ton, higher than Wisconsin farms.

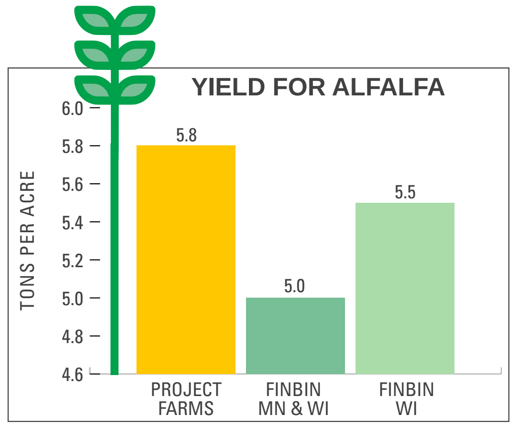


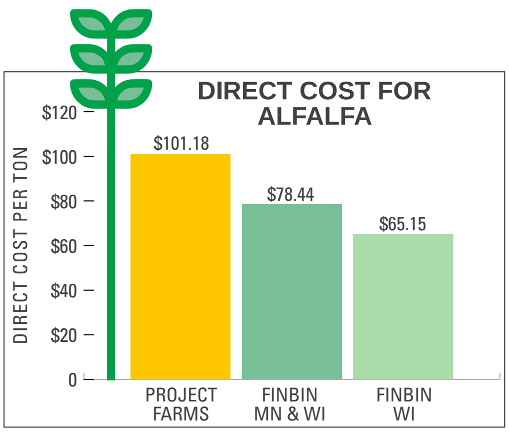
The average **gross return per acre** on the project farms was $1,119.97. This is 45.3 percent higher than Minnesota and Wisconsin, or $349.07 per acre, and 27.5 percent higher, or $241.19 per acre greater, return than Wisconsin farms. Gross return per acre includes tons per acre times a standard value of $45 per ton. Wisconsin and Minnesota were $33.71 and Wisconsin was $37.54 per ton. The value per ton of corn silage on the three project farms is higher due to the farms all harvesting brown midrib corn silage. All three project farms utilize cover crops following corn silage harvest. This cover crop is terminated before planting the following year's crop and the corn silage crop absorbs the cover crop expense.

ALFALFA PRODUCTION ANALYSIS

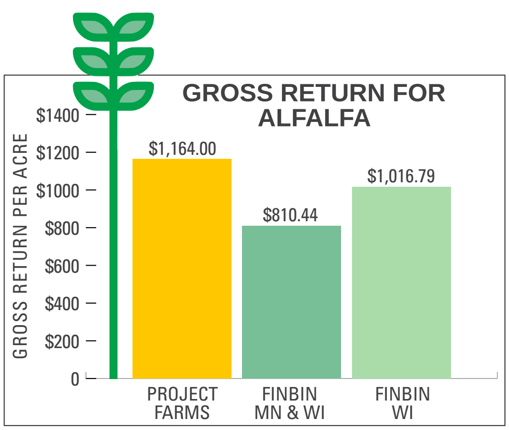
Alfalfa acres for the project farms averaged 548.5 acres. Minnesota/Wisconsin combined database averaged 353.5 acres (27 farms) while the average acres for the Wisconsin database was 216 acres (15 farms) for corn silage. The database farms were sorted to include farms that produced 251-1500 acres of alfalfa for Minnesota/Wisconsin combined, and farms with 100-1500 acres of alfalfa were included in the Wisconsin data cohort.

The **average yield** of the three project farms was 5.8 tons per acre of 85 percent dry matter alfalfa hay. This is 16 percent higher, or 0.8 tons per acre greater, than Minnesota/Wisconsin combined database and 5.5 percent higher, or 0.3 tons per acre greater, than Wisconsin farms. The yield data does not include cost or production data of the seeding year.





The **direct cost of production** per ton averaged $101.18 on the three project farms. This is 29 percent higher, or $22.74 per ton higher, than Minnesota/Wisconsin combined farms and 55.3 percent, or $36.03 per ton higher, than Wisconsin farms.



The average **gross return per acre** on project farms was $1,164.00. This is 43.6 percent higher than Minnesota/Wisconsin combined farms, or $353.56 per acre and 14.5 percent higher, or $147.21 per acre greater, return than Wisconsin farms. Gross return per acre includes tons per acre times a standard value of $200 per ton. Minnesota/Wisconsin combined farms were $153.37, and Wisconsin-only alfalfa hay was $183.45 per ton. The value per ton of alfalfa hay on the three project farms is higher due to all farms harvesting high-quality dairy hay. All three project farms harvested four cuttings of alfalfa with one farm harvesting a fifth cutting on a majority of acres. All project farms apply manure after the third year of production.

■ CONCLUSION & SUMMARY

Year one data of corn grain, corn silage, and alfalfa enterprises showed the highest yield compared to the benchmarks. Corn grain, corn silage, and alfalfa direct cost of production were the highest for project farms compared to the benchmarks. Using the standardized value per unit of each commodity, corn silage and alfalfa show a positive return over direct expenses, whereas, corn grain does not. Higher direct costs can be attributed to custom hire of manure hauling and harvesting, along with land rent.

The three project dairy farms grow their crops to feed their livestock. Knowing corn grain cost of production is higher than the standardized value may allow the project farms to make management decisions of producing corn grain or purchasing it from another source.

For these farms, it is important to remember that profit margins are established collectively with individual crop enterprises and milk sales from livestock. This diversification of enterprises on-farm can provide a financial balance when one enterprise endures a higher cost of production versus another in a given year. An individual farm needs to assess its level of financial risk annually to determine the best management practices to incorporate.

Challenges were faced in finding FINBIN benchmark reports that compared similar farms in acres size or similarly sized farms in acres and special conservation sorts. The database also does not have the ability to sort farms that own all, or the majority of, their equipment versus hiring custom operators, which impacted the cost of production. More years of data are needed to track specific management practices, develop trend lines, and create conclusions of how these practices relate to environmental stewardship and economic benefit, but year one results are trending in a positive direction. These three farms are utilizing many environmentally conscious practices, including farming on the contour and seeding grass waterways, as their solid sustainability metrics scores show in the Field to Market platform. Looking forward to the future years of financial analyses on these farms, more work will be done to show the financial value of cover crops and reduced tillage practices that in turn build soil health, while reducing fertilizer and chemical use.

Southwest Wisconsin TECHNICAL COLLEGE

Southwest Wisconsin Technical College is one of 16 institutions that comprise the Wisconsin Technical College System. Southwest Tech offers more than 60 programs in a wide variety of disciplines. The Farm Business & Production Management Program helps farm families reach their goals! This program gives current farm owners/operators opportunities to develop and fine tune their skills with production agriculture. Knowledge presented and skills demonstrated are provided through classroom settings and individual on-farm instruction. Individual instruction includes, but is not limited to: farm financial analysis, cash flows, recordkeeping, nutrient management planning and farm succession. To learn more, visit **www.swtc.edu/fbpm**.

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DAIRY STRONG

SUSTAINABILITY ALLIANCE

A Framework for Farm-Level Sustainability Projects

September 2020

Acknowledgements

Lead Authors

This report was authored by representatives from the Dairy Strong Sustainability Alliance, The Wisconsin Chapter of The Nature Conservancy and Houston Engineering, Inc.

Partners

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- GPS Dairy Consulting LLC
- Lafayette County Land Conservation Department
- Lafayette Ag Stewardship Alliance
- University of Wisconsin - SnapPlus
- Wisconsin Department of Agriculture, Trade and Consumer Protection
- Southwest Wisconsin Technical College
- Dairy Farmers of Wisconsin

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Terminology

1. **Metrics:** categorical indicators used to rate an entity, system or process in relation to others of similar character
2. **Precision agricultural decision support system:** technological systems used to assist users in making well-informed decisions regarding agricultural activities that are complex and nuanced and change over time and space
3. **Proof-of-concept:** pilot project for the employment of a framework as a means for testing workability and determining future revision
4. **Soil health:** the condition of the soil associated with the ability to support high levels of biological activity and withstand extreme meteorological events
5. **Sustainability (sustainable agriculture):** Field to Market: The Alliance for Sustainable Agriculture defines sustainable agriculture as meeting the needs of the present while improving the ability of future generations to meet their own needs by:
    - Increasing productivity to meet future food, feed, fiber and fuel demands
    - Improving the environment
    - Improving human health
    - Improving the social and economic well-being of agricultural communities

Framework Purpose

Farmers face mounting challenges to:

1. Operate in challenging financial and economic conditions
2. Satisfy the on-farm sustainability demands of consumers
3. Meet local environmental regulations

This framework outlines a project-based approach for farmers, other businesses as well as conservation professionals and organizations within a region to collectively address these challenges. The approach combines financial and environmental factors to tackle these challenges. This framework is for use by various groups throughout the Upper Midwest and beyond. It is intended to serve as a durable approach to establishing agricultural sustainability projects. Projects implemented through this framework will communicate the sustainability of farming practices to consumers, the agricultural supply chain and regulatory agencies. This vision will be accomplished by documenting the continued progress made by farmers using sustainability metrics, financial indices and environmental assessment tools to estimate benefits of conservation practices to local water and land resources.

Viable conservation practices contribute to sustainable farming and to the overall success of a farming enterprise. On-farm conservation practices have the potential to not only produce a financial and economic benefit, but an environmental improvement as well. This framework is intended to utilize new and existing technology for assessing the sustainability of on-farm practices. The goal is to provide a summary of the benefits of current conservation practices, as well as to create opportunities for further farm-specific conservation discussions.

This framework utilizes expertise from a range of public and private partners. This partnership consists of farmers, entities from local government, private industry and academia. This framework can be used to establish agricultural sustainability projects that are consistent with existing sustainability programs and local regulatory guidance. This framework is being tested under a pilot project with the Dairy Strong Sustainability Alliance and a group of conservation-minded dairy, hog, beef and crop farmers in southwestern Wisconsin.

Introduction

The Dairy Strong Sustainability Alliance (DSSA) is a collaborative, industry-supported organization that promotes and supports farmer-led solutions to today's environmental challenges, considering business viability and community engagement. The DSSA connects farmers, processors and brands to resources that will help them advance sustainability efforts.

The DSSA vision is one where farmers, their communities and the environment thrive. The organization's mission is to empower farmers to develop and implement practical, innovative solutions collaboratively for environmental, economic and social outcomes.

The DSSA was established in 2016 and supports farmer-led watershed conservation initiatives around Wisconsin, with potential for growth in other states. These non-profit organizations work to foster innovation and shared learning among members to bring about continuous measurable improvements in areas such as water quality, soil health, and groundwater by exploring on-farm conservation strategies.

The farmer-led groups focus on ways to prevent and reduce runoff from farm fields and farmsteads, helping to both retain soil in the field where it belongs and ensure cleaner lakes, streams and groundwater. Some of the methods farmers use include planting cover crops, conservation tillage and no-till planting, soil testing, low-disturbance manure application and nutrient management planning. Many participate in on-farm research as well as emphasize community outreach and education through field days and workshops.

The DSSA is driven primarily by the Dairy Business Association, Edge Dairy Farmer Cooperative and The Nature Conservancy.

Projects pursued through this framework should strive to add value to the farmer and the agricultural supply chain overall, while seeking improved environmental outcomes.

Water quality, consumer demand for sustainably sourced products and government regulations are important issues within the agricultural industry. In response to these issues, farmers and partners are striving toward continuous improvements through the use of on-farm conservation assessment tools. Some of these tools are proprietary while others are freely accessible to the public. Most tools require input of on-farm data, which can be done through an online application or software program. These tools are designed to serve as a means of communication up the agricultural supply chain.

DSSA is conducting a proof-of-concept (POC) project in southwestern Wisconsin to pilot the use of this framework. This POC project will be conducted in collaboration with the Lafayette Ag Stewardship Alliance (LASA), a famer-led watershed conservation group formed in 2017 to identify and promote conservation practices in southwestern Wisconsin. In addition, this POC project will be used to inform future enhancements to this framework.

Focus Areas

Finance and Economics

The agricultural industry often faces challenging financial and economic conditions. Amid these challenges, there are ongoing pressures to produce improved environmental outcomes. Research indicates conservation practices that can lead to improved environmental outcomes may also have positive or neutral effects on farm finances and economics. However, there is a lack of data to demonstrate on-farm feasibility.

We refer to economic issues as those associated with farm profitability in relation to the adoption of conservation practices along with the risks associated with these changes. We use the economic condition to describe the effects of conservation on market conditions within a region (e.g. whether there is a financial incentive for an agricultural product produced with better environmental outcomes). In general, economic conditions can be more challenging to assess with on-farm data alone. Projects using this framework may explore economic issues but will focus primarily on financial conditions.

Conversely, we refer to financial issues as those that affect on-farm profitability, such as factors that impact income, expenses, worth and profit. A farm budget analysis can help farmers better understand their financial performance relative to the costs and benefits of conservation practices. It is important to evaluate financials across practices and over time to understand and realize the long-term benefits of conservation. Conservation has the potential to increase farm profits through reduced inputs, reduced labor, improved farm resiliency, increased yields and improved soil health. A comprehensive analysis can be used to assess the value of conservation. The information obtained from the analysis can then help farmers determine which types of practices give the largest return on their investments.

Several partners would be well suited to work with when creating a full farm financial analysis. This may include members of agricultural financial institutions, university extension systems or farm business advisers. Members of these entities often utilize software programs for efficiently collecting, calculating and assessing the necessary budget information.

Environmental

This framework is separated into two environmental analysis categories:

1. **On-Farm Sustainability –** on-farm metrics that relate to current and future environmental outcomes (e.g. greenhouse gas emissions or soil erosion)
2. **Local Resources –** the condition of local environmental resources that may be tied to government and non-governmental programs that look at surface water, groundwater and fish and wildlife habitat.

These categories are described in more detail below.

Sustainability

In general, sustainability programs seek to maintain or increase farm productivity while continuously improving environmental outcomes. There are many ongoing efforts to develop definitions for and programs to manage agricultural sustainability. This framework references existing sustainability efforts where partners have developed on-farm metrics for quantifying the relationship between farm management and environmental outcomes.

Projects implemented through this framework will utilize existing sustainability programs that fit the goals and objectives of the partners involved in the project.

Various data management and assessment programs are available to assist farmers in evaluating their farm sustainability. Depending on project partners, there are numerous farmland management programs supported by private industry, non-profits and public institutions that can collect and analyze on-farm data against various sustainability metrics, such as energy use, water quality and greenhouse gas emissions.

Local Resources

Farming communities have local resource issues, such as drinking water supplies, recreational lakes, adequate drainage or permit requirements for farms, that are not typically addressed by sustainability programs. Projects conducted through this framework may also address issues such as these in addition to on-farm sustainability issues. In general, actions taken to improve sustainability outcomes can also assist with local resource issues and vice versa. However, the tools needed to address local resource issues will likely differ from the tools and software used to understand on-farm sustainability metrics.

There is a need to connect on-farm practices to local water resource conditions. Numerous entities are keenly interested in how land-use decisions have affected water resources and how conservation practices can play a role in a mitigation of these effects. It is important to demonstrate improvements to these entities and government agencies and to be able to answer the question, "Are water resources being improved?"

As an optional add-on for sustainability projects, there are tools that can assess the impact of conservation practices on the local environment and be paired with other sustainability outcomes. These tools can evaluate the condition of nearby waterways, biological health and/or fish and wildlife habitat. Similar to assessing on-farm sustainability metrics, numerous public, non-profit and private tools that can assess land use and land management decisions and predict their impact on water and land-related resources at both watershed and field scales.

Establishing Projects

This section describes the steps needed to establish an agricultural sustainability project in other locations. These steps are repeatable and generally universal, minus small changes depending on the focus area, issues and groups. A more detailed list of project sub-steps with an associated purpose and outcome is provided in **Appendix A.**

1. Engagement

- Gather key project partners
- Develop a project idea
- Identify existing complementary programs and projects
- Gauge local interest

2. Formation

- Obtain funding
- Establish local leadership and advisory teams
- Refine project goals and purpose
- Recruit farmer participants

3. Operation

- Hold meetings
- Collect data for economic, sustainability and local resource assessments
- Analyze data and develop conclusions
- Hold local farmer workshop

4. Conclusion

- Report results to stakeholders and broader audiences
- Continue project for additional years

Continuation of Projects

This framework document describes the steps and activities that would typically occur during the planning, initiation and one-year implementation and reporting. It is widely recognized that to show improvement in all of the sustainability metrics and outcomes over time, a project should strive to be implemented for three to five years. A project implemented over a longer period of time will be better positioned to show that improvement in sustainability metrics, farm financials and local resources are indeed happening.

A longer project period provides added benefits:

- Increasing dialogue and information sharing between farmers in project area Iincreasing time for farmers to interact with local resource professionals to assist with planning and implementation of new conservation practices
- Improving the on-farm financials of conservation systems
- Substantiating sustainability claims with sufficient data
- Communicating the sustainability of farming practices to consumers, the agricultural supply chain and regulatory agencies

Operating Projects

This section describes the steps that could be taken to provide information on how on-farm decisions impact farm financials, sustainability and the local environment. It describes tools that could be used as part of each analysis.

Financial Analysis

The financial analysis for the projects implemented through this framework will be based on a farm budget assessment or farm enterprise analysis. Farm budget categories that may be evaluated include revenue, internal feed cost, internal feed value, external feed costs, crop yield, commodity price, variable costs and fixed costs. Important outputs will include a display of categories where current practices are cutting into or, conversely, boosting revenue and/or overall profit.

The purpose of the financial analysis is to develop sufficient information to compare farm management decisions to impacts on on-farm profits and environmental outcomes. This may be done at the level of the individual farmer but also, possibly, based on the set of aggregated data. It may also be used to identify areas of potential future profitability increases.

There are several software programs available to create a farm or enterprise budget analysis. One public option in the Upper Midwest is FINPACK. Developed by the University of Minnesota, FINPACK is considered the premier farm financial management program and is used to help farmers better understand and manage their farm finances. Access it at https://finpack.umn.edu/.

Environmental Analysis

Farm-Level

The sustainability analysis for projects should consider using a tool or technology from an existing sustainability program. The tool or technology selected for a project conducted under this framework should address the environmental goals and objectives of the project partnership using established methods. It should have the capacity to estimate sustainability for several on-farm metrics, such as soil condition and land use. Ideally, it would have built-in capacity to compare the individuals results to that of some population benchmark. Examples of established on-farm sustainability tools:

- Fieldprint® Platform (https://fieldtomarket.org/our-programs/leading-with-science/fieldprint-platform/)
- 4Rs program (https://nutrientstewardship.org/4rs/)
- Minnesota Agricultural Water Quality Certification Program (https://www.mda.state.mn.us/environment-sustainability/minnesota-agricultural-water-quality-certification-program)

A list of other sustainability tools can be found in the Trust in Food 2020 Report "Farmers Perspectives on Data" (**Appendix B**).

Local Environment

The local environmental analysis for a sustainability project should focus on assessing local or watershed resource concerns, such as surface water quality, groundwater quality/quantity or fish and wildlife habitat. Projects should utilize tools capable of documenting the relationship between upstream conservation and downstream resources. An example would be estimating the reduction of sediment delivered to a local recreational lake resulting from on-farm conservation practices. The selected tool or method must be capable of estimating the sediment and nutrient removal benefits of conservation practices that are, or could be, placed on the landscape. Ideally, the tool should also be able to inform participants on opportunities for future conservation efforts. Examples of local environmental analysis tools:

- BasinScout Platform: https://basinscout.org/
- Prioritize Target and Measure Application (PTMApp): https://ptmapp.bwsr.state.mn.us/
- FARM Environmental Stewardship: https://nationaldairyfarm.com/dairy-farm-standards/environmental-stewardship/

ASSESSMENT COMBINATIONS

Projects conducted under this framework will address at least one aspect of financial character and at least one component of environmental issues. Partners may choose to address only sustainability issues or local resource issues. They may also address sustainability and local resource issues in tandem following the framework. A combined assessment can be used to measure where the project area is on the sustainability curve in comparison to other areas.

Outcomes

Desired outcomes for a project implemented through this framework should be developed as part of the project initiation process. Listed here are several financial, economic and environmental outcomes that can be included in a project:

- Show that current conservation efforts are having a positive impact on on-farm sustainability metrics and water quality
- Demonstrate the financial benefits of conservation work done on the farm
- Provide support to farmers pursuing conservation on their land
- Demonstrate to farmers and others that improvements in the environment can result from farm management decisions, such as using soil health practices (cover crops, reduced tillage, diverse crop rotations) and improvements in fertilizer/manure management
- Engage more people in conservation, including non-operator landowners so they understand farm conservation practices
- Increase engagement and landowner involvement in conservation groups and studies
- Create a positive and meaningful experience for farmers with regards to engaging public and private entities in conservation

Appendix A

Detailed Guidance for Establishing Projects

1. Engagement

Gather Key Project Partners:

- A small group of farmers, agricultural industry representatives, non-profit conservation organizations that have a sustainability focus, and local conservation professionals (conservation district, crop advisers, university extension)
- Establish an area of interest for developing a sustainability project where there is also a desire to scale up adoption of conservation practices
  - ✓ Generally, an area with conservation-minded landowners
  - ✓ A group of fewer than 50 landowners preferred for management ease
  - ✓ An area with a farmer-led conservation group in place, a small drainage area with a significant resource issue or concern or a group of farms supplying an agricultural processor
- Determine if there is technical and leadership capacity within the project area to successfully lead and carry out the project
  - ✓ Need someone connected to the area and the people willing to do boots-on-the-ground work in the form of individual farmer meetings. This could be staff from a conservation district, non-profit conservation organization, crop consultants, retired farmer, etc.
- **Purpose:** Build adequate capacity to support project implementation
- **Outcome:** Local ownership, leadership and implementation

Develop Project Idea

- Outline the purpose, issues and goals
- Identify the natural resource concerns
- Select assessment tools

(continued)

- **Purpose:** Create a clear understanding and unanimous support for direction
- **Outcome:** Agreed upon scope and outline

Identify Complementary Projects/Programs

- Investigate/research what has been or is currently being done in the area of interest or, more broadly, the state or region to capitalize on existing efforts and programs while avoiding duplication of efforts
- Determine what laws and/or rules that are currently in effect that impact how agricultural practices are conducted in your area of interest
- Contact leads from complimentary programs/projects to discuss collaboration
- Engage related public and private groups for further involvement/ support
- **Purpose:** Gain additional support and broaden understanding in the community of goals/purpose
- **Outcome:** Fully formed professional team that leverages other efforts to maximize participation, technical and financial resources, and impact of project

Gauge Local Interest

- Contact individual farmers/landowners within the area of interest to introduce the idea and determine interest
    - ✓ This should likely be done through the local government unit (LGU) or private partners who have direct contact and trust with the landowners in the area
- If less than 50 percent of landowners in the area or members of the farmer-led group are interested and willing to participate in the project, consider investigating another area of interest
- **Purpose:** Assure that this is a good area for a project
- **Outcome:** Establish a targeted area where success is likely

2. Formation

Obtain Funding

- Determine key funding sources
  - ✓ Explore both traditional and less-conventional sources of funding (Public sources may include local, state and federal grants.)
  - ✓ Explore whether local and state agencies can contribute in-kind support for the project areas such as data collection and data entry for assessment
  - ✓ Pursue funding from private sources like ag businesses foundations or small grant programs. Some businesses may also have local staff that might contribute in-kind support
  - ✓ Private non-profit organizations can be a source of both cash and in-kind staff time
- Apply for funding
  - ✓ Work with project partners to develop the application materials or letters of request
- **Purpose:** Obtain financial support for at least two-thirds of project tasks
- **Outcome:** At least one year of project funding

Establish Local Team

- Develop local stakeholder list
  - ✓ This list is likely best developed by the project leader along with any project partners
  - ✓ Include farmers, landowners, conservation professionals and other local groups with a vested interest in project
  - ✓ Collect names, phone numbers, mailing addresses, email addresses
- Establish key stakeholder group
  - ✓ Refine list to those who want to be involved on an ongoing basis to be the trusted advisers and champions

(continued)

- ✓ If known, note the level of involvement each person is willing to commit
- **Purpose:** Gain local support
- **Outcome:** Fully formed local team

Refine Project

- Refine the project to get buy-in from all parties
- Define tasks, actions and responsible parties
- Determine which tools/methods will be used in the assessment
- Establish desired outcomes
- Determine if use of consultants is necessary
- **Purpose:** Come to a consensus on direction and mode of execution
- **Outcome:** Fully formed project concept

3. Operation

Meetings

- Initial meeting with project partners
  - ✓ Build familiarity with project scope, deliverables and assessments/tools/models
- Individual farmer meetings
  - ✓ Collect and enter farmer financial and land management data
    1. Use pre-meeting survey to understand and engage farmers to get information on their perspectives about conservation
    2. Use worksheets to collect farm data that will be required for selected financial and/or environmental tools
    3. Evaluate what farm management programs, precision farming tools or other certification tools might already be in use and determine ability to transfer required data to the assessment tools

(continued)

- ✓ Meet with farmers in person to review worksheets and enter data into assessment tools
- ✓ Provide a project contract to each farmer which assures that data and individual farm assessments/analyses will be kept confidential and only aggregated data will be made available unless the farmer agrees to release information
- ✓ Provide documentation of assessment/analysis to the farmer either at the meeting or shortly after. Ideally, this should include discussion on how changes in management or adoption of conservation practices influence the assessment scores either positively or negatively.
- ✓ Conduct follow-up meetings to discuss interest or opportunity to work with the farmer to plan and implement new conservation practices

- **Purpose:** Execute the financial and sustainability portions
- **Outcome:** Aggregated financial and sustainability results

Additional Data Collection (Local Environment)

- If the project incorporates a local environmental analysis, collect any other necessary data
- Consider the use of third-party contractor or local GIS expert. They will be needed because local environmental analyses are likely to utilize physical-based, GIS software programs or tools capable of analyzing landscape variables to quantify processes that impact water quality.
- **Purpose:** Execute the local environmental analysis
- **Outcome:** Local environmental results

Analyses

- Once data is collected and assessment tools have been run for participating farms, the project will move into the phase of analyzing the information and summarizing it in relation to project outcomes in summary form. Individual assessments:
  - ✓ Financial

(continued)

- ✓ Farm-Level sustainability
- ✓ Local environmental

- Complete overarching assessment that ties individual assessments together showing where participating farms and the project are at collectively in demonstrating sustainability.
- Consider comparing farmer results to conventional farms in a similar area. Several of the tools that can be used to develop project-specific analyses are also able to compare those results with state, regional, or national data.
- **Purpose:** Interpret results
- **Outcome:** Important findings regarding impacts of conservation practices, including trends and correlations

Host Workshop for Farmers and Key Partners

- Review results from analyses
- Discuss implications
- Provide suggestions for future direction
- Answer questions from farmers
- Connect farmers to more resources
- **Purpose:** Share findings with farmers and key partners
- **Outcome:** Understanding of the analyses

4. Conclusion (Year 1)

Reporting

- Create and distribute project report with aggregate information:
  - ✓ Introduction and background
  - ✓ Describe methods
  - ✓ Document results and findings
- **Purpose:** Share findings with broader public
- **Outcome:** Project area condition report

4. Conclusion (Years 2-5)

- **Purpose:** It is widely recognized that to show improvement in all of the sustainability metrics and outcomes over time, a project should take place for three to five years. A project implemented over a longer period of time will be better positioned to show that improvement in sustainability metrics, farm financials and local resources is indeed being achieved.
- **Outcome:** Projects conducted over multiple years provide the added benefit of:
  - ✓ Increase dialogue and information sharing between farmers in project area
  - ✓ Increase time for farmers to interact with local resource professionals to assist with planning and implementation of new conservation practices
  - ✓ Improve the exploration of on-farm economics of conservation systems
  - ✓ Substantiate on-farm sustainability claims through data
  - ✓ Communicate the sustainability of farming practices to consumers, the agricultural supply chain and regulatory agencies

Appendix B

Useful Sustainability Resources

- Environmental Defense Fund (EDF). 2019. How conservation makes dairy farms more resilient, especially in a lean agricultural economy. https://www.edf.org/sites/default/files/content/how-conservation-makes-dairy-farms-more-resilient.pdf
- Purdue University. 2016. Social Science Evaluation Report, Fieldprint Calculator Project: Big Pine Creek Watershed, Benton County, IN and Indian Creek watershed, Livingston County IL. https://www.purdue.edu/fnr/prokopy/wp-content/uploads/2014/06/Fieldprint_Final_Report_20170321.pdf
- Trust in Food (Farm Journal). 2020. Farmer Perspectives on Data. https://www.trustinfood.com/wp-content/uploads/2020/05/Farmer-Data-Perspectives-Research_final.pdf

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Farmers for Sustainable Food™

A Framework
for Farm-Level Sustainability Projects

March 2021

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Acknowledgements

Lead Authors

This report was authored by representatives from Farmers for Sustainable Food, The Wisconsin Chapter of The Nature Conservancy and Houston Engineering, Inc.

Partners

A diverse group of public and private partners supported the development of this framework and a pilot project. The partners, in addition to those listed under "Lead Authors" and "Funding Support," included representatives from:

- Lafayette Ag Stewardship Alliance
- University of Wisconsin – Madison Division of Extension
- Wisconsin Department of Agriculture, Trade and Consumer Protection
- Southwest Wisconsin Technical College

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Initial funding for this framework and the associated pilot project was provided by Compeer Financial Fund for Rural America, Dairy Farmers of Wisconsin, Grande Cheese Company, the Innovation Center for U.S. Dairy, Nestlé, Professional Dairy Producers Foundation, the Sally Mead Hands Foundation, and the Wisconsin Corn Growers Association.

Terminology

1. **Metrics:** categorical indicators used to rate an entity, system or process in relation to others of similar character
2. **Precision agricultural decision support system:** technological systems used to assist users in making well-informed decisions regarding agricultural activities that are complex and nuanced and change over time and space
3. **Proof-of-concept:** pilot project for the employment of a framework as a means for testing workability and determining future revision
4. **Soil health:** the condition of the soil associated with the ability to support high levels of biological activity and withstand extreme meteorological events
5. **Sustainability (sustainable agriculture):** Field to Market: The Alliance for Sustainable Agriculture defines sustainable agriculture as meeting the needs of the present while improving the ability of future generations to meet their own needs by:
    - Increasing productivity to meet future food, feed, fiber and fuel demands
    - Improving the environment
    - Improving human health
    - Improving the social and economic well-being of agricultural communities

Framework Purpose

Farmers face mounting challenges to:

1. Operate in challenging financial and economic conditions
2. Satisfy the on-farm sustainability demands of consumers
3. Meet local environmental regulations

This framework outlines a project-based approach for farmers, other businesses as well as conservation professionals and organizations within a region to collectively address these challenges. The approach combines financial and environmental factors to tackle these challenges. This framework is for use by various groups throughout the Upper Midwest and beyond. It is intended to serve as a durable approach to establishing agricultural sustainability projects. Projects implemented through this framework will communicate the sustainability of farming practices to consumers, the agricultural supply chain and regulatory agencies. This vision will be accomplished by documenting the continued progress made by farmers using sustainability metrics, financial indices and environmental assessment tools to estimate benefits of conservation practices to local water and land resources.

Viable conservation practices contribute to sustainable farming and to the overall success of a farming enterprise. On-farm conservation practices have the potential to not only produce a financial and economic benefit, but an environmental improvement as well. This framework is intended to utilize new and existing technology for assessing the sustainability of on-farm practices. The goal is to provide a summary of the benefits of current conservation practices, as well as to create opportunities for further farm-specific conservation discussions.

This framework utilizes expertise from a range of public and private partners. This partnership consists of farmers, entities from local government, private industry and academia. This framework can be used to establish agricultural sustainability projects that are consistent with existing sustainability programs and local regulatory guidance.

This framework is being tested under a pilot project with Farmers for Sustainable Food and a group of conservation-minded dairy, hog, beef and crop farmers in southwestern Wisconsin.

Introduction

Farmers for Sustainable Food is a collaborative, non-profit organization that provides resources, advocacy, support and empowerment for farmers who are innovating and demonstrating sustainable farming practices. FSF connects farmers, processors, environmental groups, scientists, food companies, community leaders and ag businesses to share ideas and collaborate on projects.

FSF was established in 2016 and supports farmer-led watershed conservation initiatives throughout Wisconsin, with potential for growth in other states. These non-profit organizations foster innovation and shared learning among members to bring about continuous measurable improvements in areas such as water quality, soil health and groundwater.

The farmer-led groups focus on ways to prevent and reduce runoff from farm fields and farmsteads, helping to both retain soil in the field where it belongs and ensure cleaner lakes, streams and groundwater. Some of the methods farmers use include planting cover crops, conservation tillage and no-till planting, soil testing, low-disturbance manure application and nutrient management planning. Many participate in on-farm research as well as emphasize community outreach and education through field days and workshops.

Farmers for Sustainable Food is driven primarily by the Dairy Business Association, Edge Dairy Farmer Cooperative and The Nature Conservancy.

Projects pursued through this framework should strive to add value to the farmer and the agricultural supply chain overall, while seeking improved environmental outcomes.

Water quality, consumer demand for sustainably sourced products, and government regulations are important issues within the agricultural industry. In response to these issues, farmers and partners are striving toward continuous improvements through the use of

on-farm conservation assessment tools. Some of these tools are proprietary while others are freely accessible to the public. Most tools require input of on-farm data, which can be done through an online application or software program. These tools are designed to serve as a means of communication up the agricultural supply chain.

FSF is conducting a proof-of-concept (POC) project in southwestern Wisconsin to pilot the use of this framework. This POC project will be conducted in collaboration with the Lafayette Ag Stewardship Alliance (LASA), a famer-led watershed conservation group formed in 2017 to identify and promote conservation practices in southwestern Wisconsin. In addition, this POC project will be used to inform future enhancements to this framework.

Focus Areas

Finance and Economics

The agricultural industry often faces challenging financial and economic conditions. Amid these challenges, there are ongoing pressures to produce improved environmental outcomes. Research indicates conservation practices that can lead to improved environmental outcomes may also have positive or neutral effects on farm finances and economics. However, there is a lack of data to demonstrate on-farm feasibility.

We refer to economic issues as those associated with farm profitability in relation to the adoption of conservation practices along with the risks associated with these changes. We use the economic condition to describe the effects of conservation on market conditions within a region (e.g. whether there is a financial incentive for an agricultural product produced with better environmental outcomes). In general, economic conditions can be more challenging to assess with on-farm data alone. Projects using this framework may explore economic issues but will focus primarily on financial conditions.

Conversely, we refer to financial issues as those that affect on-farm profitability, such as factors that impact income, expenses, worth and profit. A farm budget analysis can help farmers better understand their financial performance relative to the costs and benefits of conservation practices. It is important to evaluate financials across practices and over time

to understand and realize the long-term benefits of conservation. Conservation has the potential to increase farm profits through reduced inputs, reduced labor, improved farm resiliency, increased yields and improved soil health. A comprehensive analysis can be used to assess the value of conservation. The information obtained from the analysis can then help farmers determine which types of practices give the largest return on their investments.

Several partners would be well suited to work with when creating a full farm financial analysis. This may include members of agricultural financial institutions, university extension systems or farm business advisers. Members of these entities often utilize software programs for efficiently collecting, calculating and assessing the necessary budget information.

Environmental

This framework is separated into two environmental analysis categories:

On-Farm Sustainability – on-farm metrics that relate to current and future environmental outcomes (e.g. greenhouse gas emissions or soil erosion)
Local Resources – the condition of local environmental resources that may be tied to government and non-governmental programs that look at surface water, groundwater and fish and wildlife habitat.

These categories are described in more detail below.

Sustainability

In general, sustainability programs seek to maintain or increase farm productivity while continuously improving environmental outcomes. There are many ongoing efforts to develop definitions for and programs to manage agricultural sustainability. This framework references existing sustainability efforts where partners have developed on-farm metrics for quantifying the relationship between farm management and environmental outcomes. Projects implemented through this framework will utilize existing sustainability programs that fit the goals and objectives of the partners involved in the project.

Various data management and assessment programs are available to assist farmers in evaluating their farm sustainability. Depending on project partners, there are numerous farmland management programs supported by private industry, non-profits and public institutions that can collect and analyze on-farm data against various sustainability metrics, such as energy use, water quality and greenhouse gas emissions.

Local Resources

Farming communities have local resource issues, such as drinking water supplies, recreational lakes, adequate drainage or permit requirements for farms, that are not typically addressed by sustainability programs. Projects conducted through this framework may also address issues such as these in addition to on-farm sustainability issues. In general, actions taken to improve sustainability outcomes can also assist with local resource issues and vice versa. However, the tools needed to address local resource issues will likely differ from the tools and software used to understand on-farm sustainability metrics.

There is a need to connect on-farm practices to local water resource conditions. Numerous entities are keenly interested in how land-use decisions have affected water resources and how conservation practices can play a role in a mitigation of these effects. It is important to demonstrate improvements to these entities and government agencies and to be able to answer the question, “Are water resources being improved?”

As an optional add-on for sustainability projects, there are tools that can assess the impact of conservation practices on the local environment and be paired with other sustainability outcomes. These tools can evaluate the condition of nearby waterways, biological health and/or fish and wildlife habitat. Similar to assessing on-farm sustainability metrics, numerous public, non-profit and private tools can assess land use and land management decisions and predict their impact on water and land-related resources at both watershed and field scales.

Establishing Projects

This section describes the steps needed to establish an agricultural sustainability project in other locations. These steps are repeatable and generally universal, minus small changes depending on the focus area, issues and groups. A more detailed list of project sub-steps with an associated purpose and outcome is provided in **Appendix A.**

1. Engagement

- Gather key project partners
- Develop a project idea
- Identify existing complementary programs and projects
- Gauge local interest

2. Formation

- Obtain funding
- Establish local leadership and advisory teams
- Refine project goals and purpose
- Recruit farmer participants

3. Operation

- Hold meetings
- Collect data for economic, sustainability and local resource assessments
- Analyze data and develop conclusions
- Hold local farmer workshop

4. Conclusion

- Report results to stakeholders and broader audiences
- Continue project for additional years

Continuation of Projects

This framework document describes the steps and activities that would typically occur during the planning, initiation and one-year implementation and reporting. It is widely recognized that to show improvement in all of the sustainability metrics and outcomes over time, a project should strive to be implemented for three to five years. A project implemented over a longer period of time will be better positioned to show that improvement in sustainability metrics, farm financials and local resources are indeed happening.

A longer project period provides added benefits:

- Increasing dialogue and information sharing between farmers in project area
- Increasing time for farmers to interact with local resource professionals to assist with planning and implementation of new conservation practices
- Improving the on-farm financials of conservation systems
- Substantiating sustainability claims with sufficient data
- Communicating the sustainability of farming practices to consumers, the agricultural supply chain and regulatory agencies

Operating Projects

This section describes the steps that could be taken to provide information on how on-farm decisions impact farm financials, sustainability and the local environment. It describes tools that could be used as part of each analysis.

Financial Analysis

The financial analysis for the projects implemented through this framework will be based on a farm budget assessment or farm enterprise analysis. Farm budget categories that may be evaluated include revenue, internal feed cost, internal feed value, external feed costs, crop yield, commodity price, variable costs and fixed costs. Important outputs will include a display of categories where current practices are cutting into or, conversely, boosting revenue and/or overall profit.

The purpose of the financial analysis is to develop sufficient information to compare farm management decisions to impacts on on-farm profits and environmental outcomes. This may be done at the level of the individual farmer but also, possibly, based on the set of aggregated data. It may also be used to identify areas of potential future profitability increases.

There are several software programs available to create a farm or enterprise budget analysis. One public option in the Upper Midwest is FINPACK. Developed by the University of Minnesota, FINPACK is considered the premier farm financial management program and is used to help farmers better understand and manage their farm finances. Access it at https://finpack.umn.edu/.

Environmental Analysis

Farm-Level

The sustainability analysis for projects should consider using a tool or technology from an existing sustainability program. The tool or technology selected for a project conducted under this framework should address the environmental goals and objectives of the project partnership using established methods. It should have the capacity to estimate sustainability for several on-farm metrics, such as soil condition and land use. Ideally, it would have built-in capacity to compare the individual results to that of some population benchmark. Examples of established on-farm sustainability tools:

- Fieldprint® Platform (https://fieldtomarket.org/our-programs/leading-with-science/fieldprint-platform/)
- 4Rs program (https://nutrientstewardship.org/4rs/)
- Minnesota Agricultural Water Quality Certification Program (https://www.mda.state.mn.us/environment-sustainability/minnesota-agricultural-water-quality-certification-program)
- FARM Environmental Stewardship: https://nationaldairyfarm.com/dairy-farm-standards/environmental-stewardship/

A list of other sustainability tools can be found in the Trust in Food 2020 Report "Farmers Perspectives on Data" (**Appendix B**).

Local Environment

The local environmental analysis for a sustainability project should focus on assessing local or watershed resource concerns, such as surface water quality, groundwater quality/quantity or fish and wildlife habitat. Projects should utilize tools capable of documenting the relationship between upstream conservation and downstream resources. An example would be estimating the reduction of sediment delivered to a local recreational lake resulting from on-farm conservation practices. The selected tool or method must be capable of estimating the sediment and nutrient removal benefits of conservation practices that are, or could be, placed on the landscape. Ideally, the tool should also be able to inform participants on opportunities for future conservation efforts. Examples of local environmental analysis tools:

- BasinScout Platform: https://basinscout.org/
- Prioritize Target and Measure Application (PTMApp): https://ptmapp.bwsr.state.mn.us/

Assessment Combinations

Projects conducted under this framework will address at least one aspect of financial character and at least one component of environmental issues. Partners may choose to address only sustainability issues or local resource issues. They may also address sustainability and local resource issues in tandem following the framework.

A combined assessment can be used to measure where the project area is on the sustainability curve in comparison to other areas.

Outcomes

Desired outcomes for a project implemented through this framework should be developed as part of the project initiation process. Listed here are several financial, economic and environmental outcomes that can be included in a project:

- Show that current conservation efforts are having a positive impact on on-farm sustainability metrics and water quality
- Demonstrate the financial benefits of conservation work done on the farm
- Provide support to farmers pursuing conservation on their land
- Demonstrate to farmers and others that improvements in the environment can result from farm management decisions, such as using soil health practices (cover crops, reduced tillage, diverse crop rotations) and improvements in fertilizer/manure management
- Engage more people in conservation, including non-operator landowners so they understand farm conservation practices
- Increase engagement and landowner involvement in conservation groups and studies
- Create a positive and meaningful experience for farmers with regard to engaging public and private entities in conservation

Appendix A

Detailed Guidance for Establishing Projects

1. Engagement

Gather Key Project Partners:

- A small group of farmers, agricultural industry representatives, non-profit conservation organizations that have a sustainability focus, and local conservation professionals (conservation district, crop advisers, university extension)
- Establish an area of interest for developing a sustainability project where there is also a desire to scale up adoption of conservation practices
  - ✓ Generally, an area with conservation-minded landowners
  - ✓ A group of fewer than 50 landowners preferred for management ease
  - ✓ An area with a farmer-led conservation group in place, a small drainage area with a significant resource issue or concern or a group of farms supplying an agricultural processor
- Determine if there is technical and leadership capacity within the project area to successfully lead and carry out the project
  - ✓ Need someone connected to the area and the people willing to do boots-on-the-ground work in the form of individual farmer meetings. This could be staff from a conservation district, non-profit conservation organization, crop consultants, retired farmer, etc.
- **Purpose:** Build adequate capacity to support project implementation
- **Outcome:** Local ownership, leadership and implementation

Develop Project Idea

- Outline the purpose, issues and goals
- Identify the natural resource concerns
- Select assessment tools

- **Purpose:** Create a clear understanding and unanimous support for direction
- **Outcome:** Agreed upon scope and outline

Identify Complementary Projects/Programs

- Investigate/research what has been or is currently being done in the area of interest or, more broadly, the state or region to capitalize on existing efforts and programs while avoiding duplication of efforts
- Determine what laws and/or rules that are currently in effect that impact how agricultural practices are conducted in your area of interest
- Contact leads from complimentary programs/projects to discuss collaboration
- Engage related public and private groups for further involvement/support
- **Purpose:** Gain additional support and broaden understanding in the community of goals/purpose
- **Outcome:** Fully formed professional team that leverages other efforts to maximize participation, technical and financial resources, and impact of project

Gauge Local Interest

- Contact individual farmers/landowners within the area of interest to introduce the idea and determine interest
  - ✓ This should likely be done through the local government unit (LGU) or private partners who have direct contact and trust with the landowners in the area
- If less than 50 percent of landowners in the area or members of the farmer-led group are interested and willing to participate in the project, consider investigating another area of interest
- **Purpose:** Assure that this is a good area for a project
- **Outcome:** Establish a targeted area where success is likely

2. Formation

Obtain Funding

- Determine key funding sources
  - ✓ Explore both traditional and less-conventional sources of funding (Public sources may include local, state and federal grants.)
  - ✓ Explore whether local and state agencies can contribute in-kind support for the project areas such as data collection and data entry for assessment
  - ✓ Pursue funding from private sources like ag businesses foundations or small grant programs. Some businesses may also have local staff that might contribute in-kind support
  - ✓ Private non-profit organizations can be a source of both cash and in-kind staff time
- Apply for funding
  - ✓ Work with project partners to develop the application materials or letters of request
- **Purpose:** Obtain financial support for at least two-thirds of project tasks
- **Outcome:** At least one year of project funding

Establish Local Team

- Develop local stakeholder list
  - ✓ This list is likely best developed by the project leader along with any project partners
  - ✓ Include farmers, landowners, conservation professionals and other local groups with a vested interest in project
  - ✓ Collect names, phone numbers, mailing addresses, email addresses
- Establish key stakeholder group
  - ✓ Refine list to those who want to be involved on an ongoing basis to be the trusted advisers and champions

- ✓ If known, note the level of involvement each person is willing to commit

- **Purpose:** Gain local support
- **Outcome:** Fully formed local team

Refine Project

- Refine the project to get buy-in from all parties
- Define tasks, actions and responsible parties
- Determine which tools/methods will be used in the assessment
- Establish desired outcomes
- Determine if use of consultants is necessary
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  - ✓ Provide documentation of assessment/analysis to the farmer either at the meeting or shortly after. Ideally, this should include discussion on how changes in management or adoption of conservation practices influence the assessment scores either positively or negatively.
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- **Purpose:** Execute the local environmental analysis
- **Outcome:** Local environmental results

Analyses

- Once data is collected and assessment tools have been run for participating farms, the project will move into the phase of analyzing the information and summarizing it in relation to project outcomes in summary form. Individual assessments:
    - ✓ Financial
    - ✓ Farm-Level Sustainability
    - ✓ Local environmental
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- Consider comparing farmer results to conventional farms in a similar area. Several of the tools that can be used to develop project-specific analyses are also able to compare those results with state, regional, or national data.
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- **Outcome:** Important findings regarding impacts of conservation practices, including trends and correlations

Host Workshop for Farmers and Key Partners

- Review results from analyses
- Discuss implications
- Provide suggestions for future direction
- Answer questions from farmers
- Connect farmers to more resources
- **Purpose:** Share findings with farmers and key partners
- **Outcome:** Understanding of the analyses

4. Conclusion (Year 1)

Reporting

- Create and distribute project report with aggregate information:
  - ✓ Introduction and background
  - ✓ Describe methods
  - ✓ Document results and findings
- **Purpose:** Share findings with broader public
- **Outcome:** Project area condition report

4. Conclusion (Years 2-5)

- **Purpose:** It is widely recognized that to show improvement in all of the sustainability metrics and outcomes over time, a project should take place for three to five years. A project implemented over a longer period of time will be better positioned to show that improvement in sustainability metrics, farm financials and local resources is indeed being achieved.
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- Purdue University. 2016. Social Science Evaluation Report, Fieldprint Calculator Project: Big Pine Creek Watershed, Benton County, IN and Indian Creek watershed, Livingston County IL. https://www.purdue.edu/fnr/prokopy/wp-content/uploads/2014/06/Fieldprint_Final_Report_20170321.pdf
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Field to Market®

Harnessing Sustainability Insights & Unleashing Opportunity

Leveraging Data to Deliver Operational Efficiencies & Build Consumer Trust

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Introduction

Just as science and technology have unlocked agronomic insights, they can also unleash opportunities for sustainability improvements that deliver operational efficiencies, demonstrate continuous improvement to the supply chain, and build consumer trust in food and agriculture. That's exactly what the eight sustainability metrics of Field to Market's Fieldprint Platform—developed through the Alliance's multi-stakeholder and consensus-driven process—offer commodity crop farmers.

To help you harness sustainability insights and unleash opportunities for your farm, we have developed this guide to better understand how your management practices intersect with sustainability metrics and potential factors that can influence improved outcomes in the areas of:

- **Biodiversity**
- **Energy Use Efficiency**
- **Greenhouse Gas Emissions**
- **Irrigation Water Use Efficiency**
- **Land Use Efficiency**
- **Soil Carbon**
- **Soil Conservation**
- **Water Quality**

Each guide explains the environmental, economic and community-level importance of the sustainability indicator; how it is measured by the Fieldprint Platform; the field characteristics and management practices used to calculate sustainability outcomes encapsulated in a Fieldprint Analysis; and the top ways to improve your results. Included at the end of each guide are a set of practical questions to explore with your trusted adviser about potential opportunities to improve your operation and utilize resources available through conservation programs.

This guidance is not intended to be prescriptive. We acknowledge that farm management decisions are crop-dependent and strongly influenced by local factors such as climate, soil and topography as well as financial constraints imposed by input and land costs. We hope that by giving you a better understanding of how your management practices relate to sustainability outcomes, you will be able to find opportunities to fine tune your operations and continuously improve the resource efficiency, profitability and environmental outcomes of your farm.

Interpreting The Metric

Biodiversity

Why It Matters

MMost farms are in rural landscapes and tend to be near natural forests, prairies, wetlands or deserts that give wildlife a place to forage for food, breed and nest. Few sustainability issues are as visible and understandable by consumers than the preservation of wildlife habitat. In addition, outdoor enthusiasts value these areas for hunting, fishing and enjoying nature with their families. As farmers and landowners work to build and maintain trust in agricultural production, it’s important to take steps to conserve healthy ecosystems.

Of course, most producers already understand that productive farming systems depend on biodiversity. For example, native pollinators provide the majority of crop pollination and support resilience where domesticated honeybees struggle. Integrated pest management relies on ecosystems that support sufficient populations of natural pest predators. Both cultivated and non-cultivated areas on the farm can be managed in ways that support biodiversity.

How It Is Measured In The Fieldprint® Platform

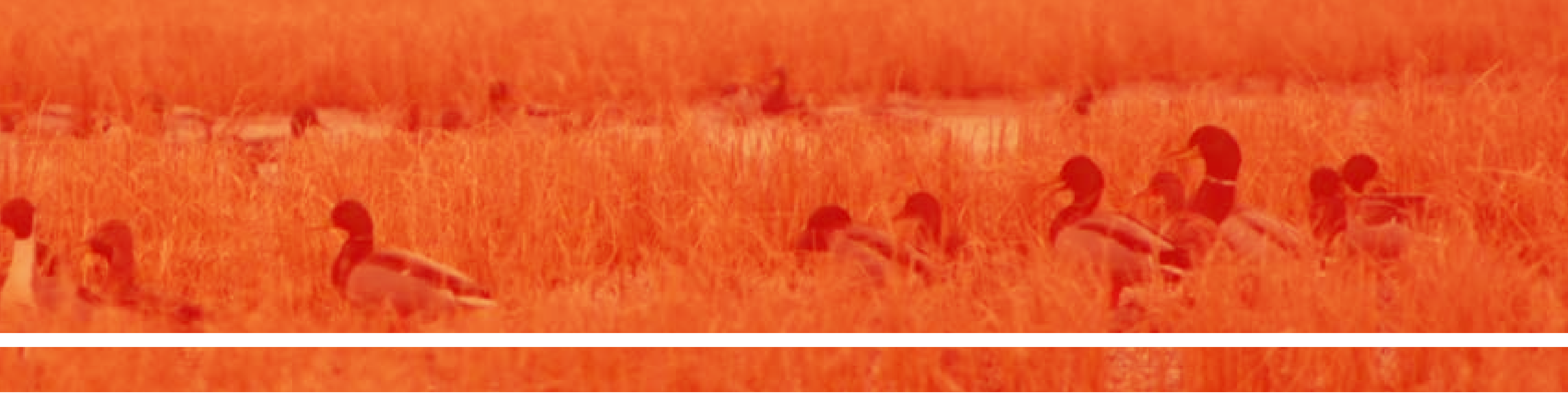
The Fieldprint Platform assesses biodiversity using the Habitat Potential Index (HPI). HPI scores the *potential* for a given farm to provide wildlife habitat on land or in the water. HPI scores range from 0-100 and measure the level of opportunity to improve or maximize habitat potential.

Higher scores are desirable and indicate a greater potential to support wildlife habitat. Separate scores for cultivated cropland and non-cultivated lands, e.g. pasture, forestland and water as applicable, plus an aggregated score for the whole farm are calculated. Scores less than 50% represent significant opportunities for improving habitat potential, whereas values of 50-80% indicate moderate realized potential and scores greater than 80% demonstrate farms that have maximized opportunities for biodiversity to flourish. Note that for 2018, only scores for the cultivated field entered will have an HPI score; the non-cultivated lands and full-farm biodiversity scores will be included in 2019.

Factors That Affect The Fieldprint Score

HPI is a complex measurement that factors in several variables:

- Attributes of the farm, including the acreage of both cultivated and non-cultivated land, the land cover type and ecoregion where the farm is located. Some combinations of land cover and ecoregions, such as natural wetlands, inherently have greater potential to support biodiversity than others, such as non-native grasslands.
- Changes in land use. For instance, putting previously uncultivated land, particularly native landscapes, into production significantly lowers scores. Conversely, converting field edges into vegetated buffer strips managed for biodiversity will improve scores.
- Land management practices, such as field borders, that provide forage and cover for breeding and nesting wildlife.
- Crop production practices including water, nutrient and pest management that conserve and protect water quality.



How To Improve Your Score

Provide **forage and nesting habitat** for wildlife. Maintain vegetative cover on cultivated areas with cover crops and retain crop residues on fields. In uncultivated areas, encourage native plants.

Implement **integrated pest management**, which discourages the development of pest populations while ensuring the least possible disruption to agroecosystems.

Develop and follow a **nutrient management plan** that implements 4Rs of nutrient stewardship to optimize fertilizer utilization by crops.

Other factors to consider:

Irrigation water source and water use efficiency
Irrigation water drawn from surface sources may deplete wetlands and other aquatic ecosystems that support diverse populations of organisms.

Tile drainage and drainage water management
Drainage water may contain excess nutrients and crop protectants. Drainage water management plans and systems improve HPI scores when tile drainage is used.

Opportunities To Explore With Your Trusted Adviser

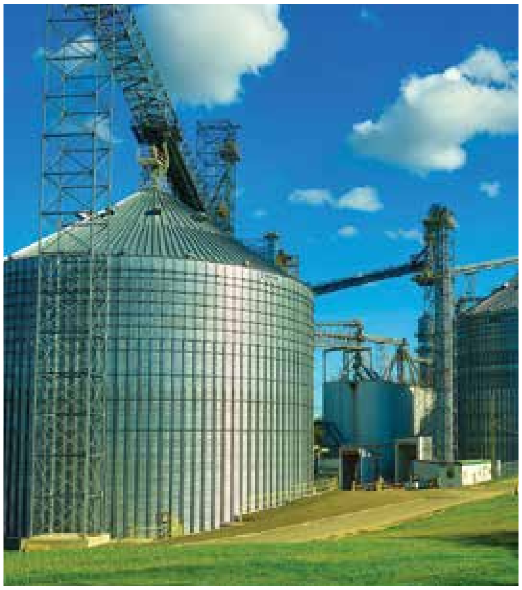
- How can the non-cultivated areas on the farm be managed to provide nesting habitat and forage for wildlife?
- Does my farm qualify for federal, local, or state conservation programs?
- How could I reduce or eliminate tillage to increase the amount of crop residue on the soil?
- Does my IPM plan include regular scouting and early interventions to optimize utilization of chemical interventions?
- How can cover crops, particularly leguminous types, be included in my crop rotation?
- What changes would you suggest to how I am managing nutrients to maximize habitat potential?
- Are there invasive species present?

Interpreting The Metric

Energy Use

Why It Matters

Energy use is a variable cost of farming and is strongly affected by diesel and electricity prices. Reducing energy use can lead to significant cost savings for your operation. In a price-constrained market, farms that utilize their energy efficiently have a better prospect of remaining competitive in challenging economic times.



Energy use efficiency is one of the fastest and easiest ways to improve your profitability, while also producing environmental benefits by reducing greenhouse gas emissions. Combustion of diesel releases the potent greenhouse gas carbon dioxide which is a primary contributor to climate change[1] (discussed in *Interpreting the Metric: Greenhouse Gases*). In addition to forcing climate change, fossil fuels must be mined or drilled, often in sensitive wildlife habitats.

How It Is Measured In The Fieldprint® Platform

The Fieldprint Platform measures all the energy required to produce a crop, from pre-plant to first point of sale or delivery at the processing facility. This includes **direct energy** used for operating equipment, pumping irrigation water, grain drying and transport as well as **embedded energy**, which is required to produce crop inputs like seeds, fertilizers and crop protectants.

Energy use is expressed as British thermal units (BTU) per unit of crop production *(i.e., bushel, pound or hundred weight)*. It takes one BTU to raise the temperature of one pound of water by 1° F. One gallon of diesel produces 137,452 BTU.

Lower numbers are desirable and indicate less energy used to produce a unit of crop.

Factors That Affect The Fieldprint Score

Energy Use Efficiency in your Fieldprint Score is affected by both direct and embedded energy use.

- **Direct:**
  - Irrigation pumping – the amount of water pumped has the greatest impact, but pumping depth and pump energy source are also factors.
  - Grain drying – the number of points of moisture removed by mechanical drying is the primary factor, drying system and energy source have lesser impacts.
  - Equipment operation – fertilizer application and aerial sprays, soil fumigation, land prep and tillage.
  - Hauling – haul weight and distance traveled to first point of sale or processing.

- **Embedded:** The energy embedded in seed production, fertilizers and crop protectant products will depend on the crop grown and the products used. Field to Market uses a combination of USDA data on crop protection products used, literature data on energy required to produce products, and literature and research on energy required for fertilizer production.

How To Improve Your Score

Follow the **principles of 4R nutrient stewardship** to ensure optimal uptake of fertilizers and reduce embedded energy use.

For irrigated crops, use **irrigation scheduling technology** to improve irrigation efficiency and reduce the amount of water that must be pumped.

Ensure grain is **dried to the optimum moisture and temperature** for storage and delivery.

Opportunities To Explore With Your Trusted Adviser

- Am I optimizing the rate, source, timing and placement of applied nutrients for maximum uptake by my crops?
- Can I use solar or another renewable energy source to pump water for irrigation?
- What irrigation scheduling technology will increase application efficiency?
- What is the optimal amount of moisture to remove from my grain to balance long-term storage with energy use efficiency?
- Is it possible to reduce the moisture in my grain before mechanical drying?
- Can I consolidate equipment passes on my fields?
- Am I using the most appropriate herbicide formulations to manage weeds, terminate cover crops and aid harvest?
- How can I improve germination and stand establishment through variety selection and planter settings?

[1] *Global Climate Change: Vital Signs of the Planet.* https://climate.nasa.gov/causes/.

Interpreting The Metric

Greenhouse Gas Emissions

Why It Matters

Like a greenhouse trapping heat inside enclosed glass, greenhouse gases hold heat inside the Earth's atmosphere, causing the atmosphere to warm and weather patterns to become more volatile. Warmer temperatures extend insect, weed and disease pressure, increase plant heat stress and crop irrigation requirements. Extreme weather events like prolonged drought and severe flooding can cause catastrophic crop losses. And in coastal areas, farmland may be impacted by salt water intrusion in future years, or lost entirely, due to rising sea levels.

Agricultural activities are known to produce three types of greenhouse gases: carbon dioxide, nitrous oxide, and methane.

- Carbon Dioxide (CO_2) is released to the atmosphere by burning fossil fuels and when soil organic matter is oxidized by aerobic respiration. The concentration of CO_2 in Earth's atmosphere has increased 42% in the last 60 years[1].
- Nitrous Oxide (N_2O) is released from nitrate in fertilizer, manure, or other organic matter by bacteria. Up to 20% of applied nitrogen is lost as N_2O. One molecule of N_2O is 298 times as potent as one molecule of CO_2 when released to the atmosphere, and for most farmers, it is the largest contributor to their greenhouse gas emissions.
- Methane (CH_4) is produced by bacteria in anaerobic conditions such as in the guts of livestock or water-saturated rice fields. One molecule of methane is 25 times as potent as one molecule of CO_2.

How It Is Measured In The Fieldprint® Platform

Greenhouse gas emissions are reported in the Fieldprint® Platform as pounds of carbon dioxide equivalent (CO_2e) per crop unit produced (e.g. bushels or pounds). "CO_2e" simply means all other emission sources are converted to the equivalent amount of CO_2. This conversion provides a common unit for all emissions in one measure, which is comparable over time and influenced by all the actions a farmer takes.

To calculate CO_2 emissions, the Fieldprint® Platform uses standard U.S. government assumptions regarding fuel use, such as the 22.3 pounds of CO_2 that are emitted per gallon of diesel combusted. CO_2 emissions also result from electricity and fuel usage as well as from burning crop residues.

The Fieldprint Platform uses data on crop type, region of the country and soil texture to determine the "emissions factor", which means how much N_2O results from additions of nitrogen (N). This factor is used to convert N from fertilizer and manure additions into N_2O, based on a look-up table from detailed crop modeling performed for the annual U.S. government inventory of emissions. Corn, soybean and wheat producers can utilize this default emissions factor or complete an optional module on advanced nutrient management practices scientifically shown to reduce N_2O emissions. By demonstrating advanced nutrient management, the N_2O emissions factor can be reduced between 7%-14%. As the science advances, we hope to make this approach available for other crops.

Methane is only calculated for rice, and emissions are based on region of the country. To calculate CH_4 emissions, the Fieldprint Platform evaluates a farmer's responses to questions about water management, organic and fertilizer amendments and other management practices.

Low scores are desirable and indicate less greenhouse gas emitted per unit of crop produced.

Factors That Affect The Fieldprint Score

- Greenhouse gas emissions are directly related to energy use. Energy-intensive practices that produce CO_2 as a by-product are:
  - Manufacturing crop seed, protectants and fertilizers
  - Grain drying
  - Irrigation pumping
  - Transportation to first point of sale
- Burning crop residues to prepare a field
- Nutrient management practices and the amount of applied nitrogen in fertilizer or manure
- Management of water, amendments and other management for rice fields

How To Improve Your Score

Reduce on-farm and embedded energy use. See *Interpreting the Metric: Energy Use.*

Follow the **4Rs of nutrient stewardship** to ensure optimal uptake of fertilizers and reduce nutrient loss.

Plan crop rotations and consider use of cover crops to **fix nitrogen biologically**.

Other factors to consider:

Carbon sequestration

While the Greenhouse Gas Emissions Metric does not currently factor the amount of CO_2 stored in soil in its calculations, it is well recognized that certain farming practices can remove CO_2 from the atmosphere and sequester it in soil. See *Interpreting the Metric: Soil Carbon* to learn more.

Opportunities To Explore With Your Trusted Adviser

- Where can I reduce energy consumption in my operation?
- Which 4R nutrient stewardship practices can I adopt to more efficiently use the nitrogen I apply?
- How can I update my rotation to incorporate a nitrogen-fixing crop?
- Am I optimizing fertilizer and/or manure applications?
- How can I build and preserve organic matter in the soil?
- Since burning crop residues impacts GHG emissions, what alternatives do you recommend?
- Can I adopt alternate wetting and drying approaches for flooding of my rice fields?

[1] *IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. R.K. Pachauri and L.A. Meyer (eds.) IPCC, Geneva, Switzerland, 151 pp. Available at http://www.ipcc.ch/report/ar5/syr/.*

Interpreting The Metric

Irrigation Water Use

Why It Matters

Applied water can significantly improve yields, and in arid locations production is impossible without supplemental irrigation. Irrigation can be expensive; there are costs associated with the purchase of water, irrigation equipment and the energy needed to pump it into fields.

There is a finite supply of fresh water; expanding urbanization puts ever-increasing demands on this limited resource and water availability is restricted for agricultural use in parts of North America. In some water-scarce areas, extensive groundwater pumping has caused sinkholes to form, leading to destruction of property and loss of human life. Diverting water for agricultural use impacts natural environments and wildlife habitats.

Worldwide, the availability of clean water to support the world's growing human population is a cause for concern. In the United States, agriculture accounts for 80% of fresh water consumed[1]. The people in our communities rely us to make the best use of the water resources all life depends upon.

How It Is Measured In The Fieldprint® Platform

Irrigation Water Use (IWU) is expressed in the Fieldprint Platform as the amount of water, measured in acre-inches (ac-in) required to produce a unit of crop (pound, bushel, etc.). IWU is calculated using the difference irrigation contributes to yield improvement. In places where production is impossible without irrigation, the non-irrigated yield is zero.

IWU = ac-in water applied / (irrigated yield – non-irrigated yield)

Lower numbers are desirable, indicating less water required to produce a unit of crop.

Factors That Affect The Fieldprint Score

The amount of water required by a crop is determined by

- The crop species, variety and stage of crop development
- Evapotranspiration – the combined losses of water through direct soil evaporation and transpiration through leaves. Warm temperature, high windspeed, low relative humidity and high light intensity increase evapotranspiration and crop irrigation requirements.
- Physical and chemical characteristics of the soil, including soil texture, structure and salinity.

The amount of water applied to bring a crop to harvest is determined by factors within and outside the direct control of the farmer. For example, although a grower cannot feasibly change the texture of the soil, the impacts of soil texture can be mitigated using management practices that improve water holding capacity and infiltration.

How To Improve Your Score

Use soil moisture meters and irrigation scheduling programs to **precisely apply water when and where it is needed**. Laser level fields and regularly maintain irrigation equipment.

Select crop varieties adapted to local soil and **climate conditions** and **able to manage pest/ disease pressure**. Healthy plants use applied irrigation water more efficiently than stressed plants.

Improve soil water holding capacity and infiltration by **increasing organic matter content to reduce run-off, evaporation** and **leaching**. (See *Interpreting the Metric: Soil Carbon* for more information).

Other factors to consider:

Soil salinity

Applied water becomes less available to crops as soil salinity increases. Manage soil salinity with infrequent, deep irrigations rather than frequent, shallow applications of water. Reduce water evaporation from soils by reducing or eliminating tillage and other activities that disturb the soil.

Opportunities To Explore With Your Trusted Adviser

- Is irrigation being applied according to actual crop requirements, or by the calendar?
- Am I using the best seed varieties for my local conditions?
- What irrigation scheduling technology is available?
- Should I convert to drip irrigation?
- Can pest pressure be further reduced using integrated pest management?
- How can I reduce or eliminate tillage in my operation?
- How can cover crops and residue management improve the water holding capacity and infiltration in my field?

[1] *United States Department of Agriculture Environmental Research Service. 2017. Irrigation & Water Use. Available at* https://www.ers.usda.gov/topics/farm-practices-management/irrigation-water-use/.

Interpreting The Metric

Land Use

Why It Matters

High quality farmland is one of the most valuable resources in the world; protecting that land is at the heart of sustainable agriculture. Efficient use of agricultural land is necessary for the financial stability of any farming business. Since 2000, the average value of an acre of U.S. farmland has nearly tripled, leading to rising land rental costs[1]. As the global population continues to grow and become more affluent, the demand for meat and dairy is rising. Farmers are challenged with growing more food, fiber and fuel on less land with minimal environmental impact.

The best land for agricultural use is already under cultivation in the U.S. Expanding production into marginal lands is less sustainable because it requires more inputs to produce acceptable yields, thereby increasing production costs and cutting into profits. Increased inputs may not be optimally utilized by crops and are prone to loss by volatilization, run-off and leaching. In addition, when new land is brought into cultivation, natural areas and the habitats they provide to wildlife are lost.

How It Is Measured In The Fieldprint® Platform

Land use efficiency is a measure of the amount of land (acres) used to produce a unit of crop (bushels, pounds, etc.) Examples: In corn, land use is measured in acres/bushel; in cotton as acres/pound of lint. This is an inverse of yield measures, which are expressed as bushels per acre or pounds of lint per acre.

Lower scores are desirable and indicate greater land use efficiency.

Factors That Affect The Fieldprint Score

Balancing yield with input optimization is the single factor that affects Land Use Efficiency in your Fieldprint Score. Although yields are heavily influenced by yearly fluctuations in temperature, rainfall and other weather events outside the control of the farmer, management decisions within your control such as variety selection, planting and harvest dates, irrigation, pest and nutrient management and crop rotation can have positive impacts on productivity. Increase yields in existing fields to improve your land use efficiency.

How To Improve Your Score

Select **crop varieties** and **plan rotations best suited to your location** to optimize yields and return on investment.

Work closely with your trusted adviser to evaluate your operation and **identify opportunities for improvement**.

Monitor yields in every field to determine return on seed and input investment and **remove consistently unprofitable fields from production**.

Opportunities To Explore With Your Trusted Adviser

- Am I using the seed varieties best suited for my field conditions?
- Does my integrated pest management plan need modification to reduce pest pressure?
- How can I optimize irrigation to drive greater yields?
- How can I improve my soil health?
- Am I applying fertilizer from the right source, in the right place at the right time and rate?
- Is my crop rotation the most efficient it can be?
- Are any of my fields not providing a reasonable yield return on input investment?
- Within my fields, are there trouble spots that should be managed differently or removed from production?
- What practices are eligible for cost-sharing through NRCS or other sources that can improve my productivity and profitability?[2]

[1] *USDA National Agricultural Statistics Service website: https://www.nass.usda.gov/quickstats*

[2] *USDA-Natural Resource Conservation Service Financial Assistance website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/*

Interpreting The Metric

Soil Carbon

Why It Matters

Carbon is a primary component found in organic matter, which is an important indicator of soil health. Organic matter is beneficial in soils because it:[1]

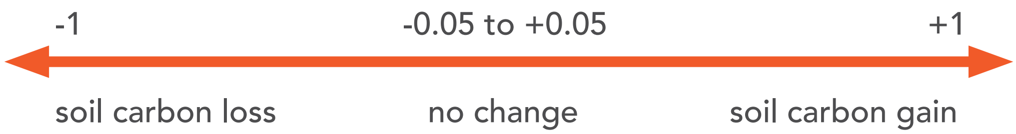
- Serves as a reservoir for plant nutrients that become gradually available over time, decreasing the amount of applied fertilizer needed to meet crop requirements;
- Stores water that is available to plant roots, reducing irrigation water requirements and improving resilience to drought; and
- Causes aggregates to form, thereby improving soil structure and water infiltration.

The importance of soil health cannot be emphasized enough. Investing in increasing soil carbon is a long-term investment in the productivity, and ultimately, the profitability of your land.

Carbon dioxide, a greenhouse gas, is removed from the atmosphere by photosynthesis and is tied up in living organisms. Because the soil stores carbon long term, enhancing soil carbon removes carbon dioxide from the atmosphere. By adding more carbon to the soil than is removed, farmers play a crucial role in reducing greenhouse gases and the impacts of climate change.

How It Is Measured In The Fieldprint® Platform

The Soil Carbon Metric in the Fieldprint® Platform is measured using the USDA Natural Resources Conservation Service's Soil Conditioning Index. Scores ranges from +1 to -1 and are unitless, relative, and crop-specific.

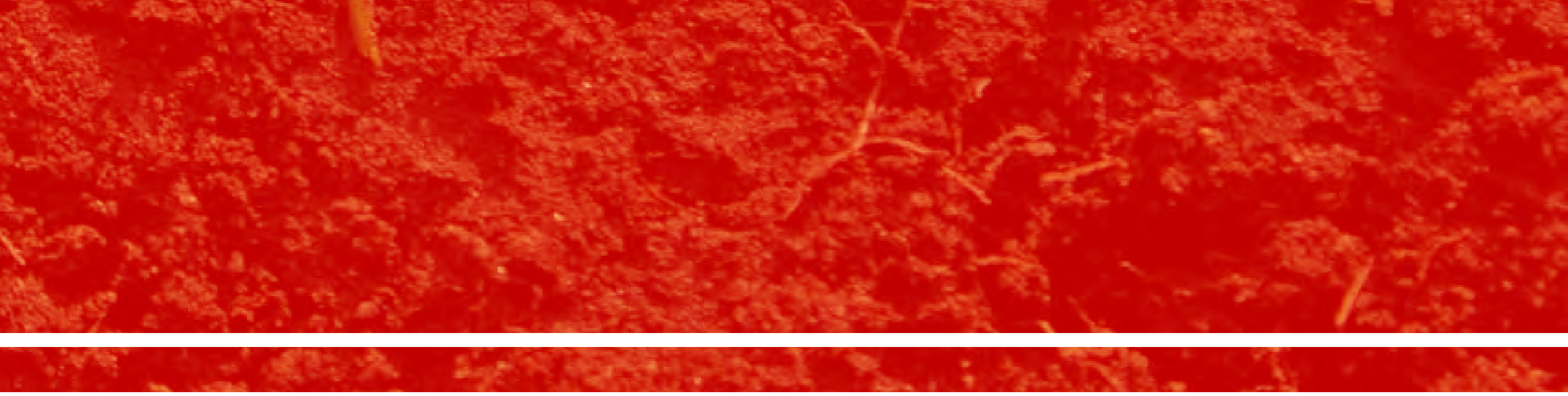


Positive values (>0.05) indicate that soil carbon is increasing. As the value approaches +1, the confidence that there is a gain in soil carbon increases. Inversely, as the value (<-0.05) approaches -1, the confidence increases that you are losing soil carbon. As a result, **positive numbers are desirable**.

Factors That Affect The Fieldprint Score

The Soil Carbon Fieldprint Score is calculated using three factors:

- Organic matter – residues from cash and cover crops left on the soil, animal manure and other organic material added to the soil.
- Field operations – practices that accelerate decomposition of organic matter and resulting carbon loss as carbon dioxide into the atmosphere. Tillage and other practices that disturb soil stimulate decomposition and change the location of organic matter in the soil profile.
- Erosion – the loss of soil carried by water or wind.



How To Improve Your Score

Minimize soil disturbance and consider strip- or no-till to conserve soil carbon and **prevent release of CO_2** from organic matter decomposition.

Keep soil covered to **prevent erosion** and manage tillage, planting date, harvest timing, row spacing, crop residues and cover crops to **maintain constant coverage**.

Increase organic matter by adding residues from both cash and cover crops while minimizing soil disturbance to **increase soil carbon**.

Other factors to consider:
Some factors that affect soil carbon are easily within the power of the farmer to manage, others are not. For example, a farmer can reduce soil disturbance, plant cover crops and improve crop residue retention to increase soil carbon. Field characteristics such as slope and soil texture affect soil erosion, and therefore soil carbon, but cannot realistically be modified. Other factors that affect the Fieldprint score include:

Wind barriers
Usually trees or shrubs planted to provide a break from prevailing winds, barriers reduce wind erosion and conserve soil and the carbon stored within.

Crop type and variety
Some produce more carbon-rich residues than others.

Field characteristics
Slope, slope length and surface soil texture are estimated from USDA soil surveys and are therefore not easily modified.

Opportunities To Explore With Your Trusted Adviser

- Can I adopt a no-till or strip-till system?
- Are there cultivation tools that will cause less soil disturbance when planting or managing pests?
- How can I incorporate cover crops into my rotation?
- Should I be managing crop residues differently?
- How can I rotate in higher residue crops?
- Can I reduce soil losses by installing a wind barrier?

[1] *Funderburg, E. 2001. What Does Organic Matter Do In Soil? Available from* www.noble.org/news/publications/.

Interpreting The Metric

Soil Conservation

Why It Matters

Soil is one your farm's most valuable assets. Ensuring that soil remains on your fields rather than being washed or blown away is essential. When soil leaves the farm due to wind or water erosion, it takes valuable inputs with it, including nutrients, crop protectants, irrigation water and the associated investment of financial and energy resources.

Soil loss is not only expensive, but it also directly and negatively impacts farm productivity and yields[1]. Plants are only as healthy as their root system and well-developed crop roots depend on deep, healthy soil.

When soil washes into waterways, there are broader impacts on your local economy and surrounding community. When rivers, gulfs and ports fill up with sediment, they must be dredged to maintain water levels high enough to accommodate the barges and ships that are relied upon to move commodity crops through inland waterways. This is costly and can reduce transportation efficiencies.

Sedimentation of drinking water lakes also costs municipalities and water suppliers millions of dollars every year in dredging costs. Water induced erosion can cause crop nutrients and protectants to wash into rivers, lakes and streams, negatively impacting water quality (See *Interpreting the Metric: Water Quality*).

In arid regions or during a drought, unprotected soil can be picked up and carried away by strong winds. This wind erosion can lead to severe dust storms, which dangerously limit visibility for drivers and have been implicated in deadly traffic accidents. Also, inhaling soil particles is associated with respiratory problems, particularly among children and the elderly.

How It Is Measured In The Fieldprint® Platform

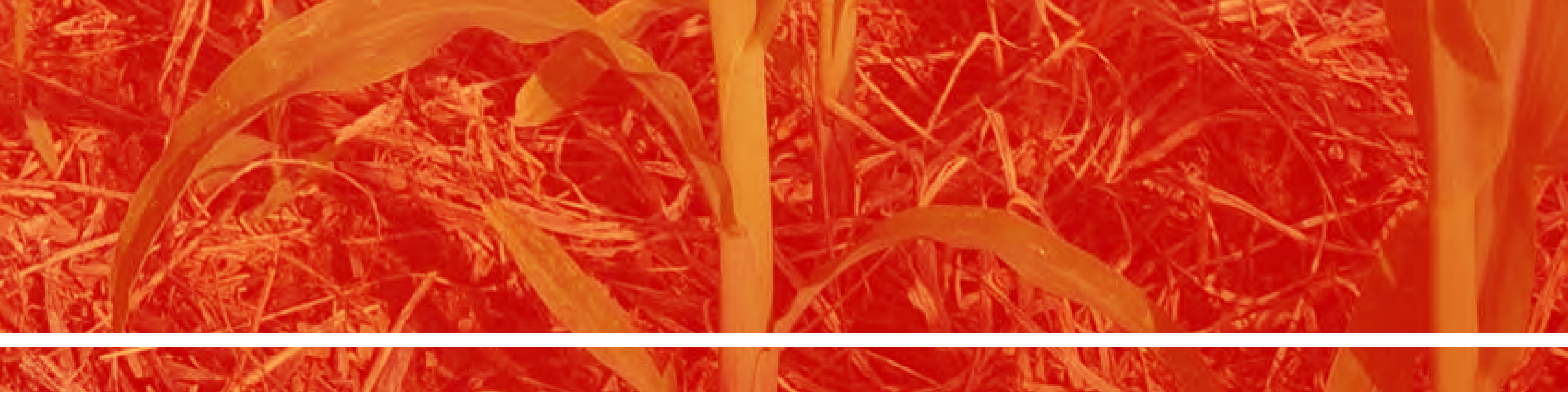
The Soil Conservation metric is expressed as soil erosion and is measured as tons of soil lost (T) per unit of land area (acre) per year for all crops.

Lower numbers are desirable and indicate less soil lost from erosion per acre. A Soil Erosion Fieldprint Score of 0 would indicate that no soil was lost in that year.

Factors That Affect The Fieldprint Score

The Soil Conservation Fieldprint Score is most affected by:

- Field characteristics including slope, soil texture and wind barriers. The greater the slope (%) and longer the slope length, the more potential for soil to be washed away by water. In the Fieldprint Platform, the value for slope is automatically entered, based on soil survey data. Users can adjust this estimate if they have measured the field's slope or have determined a more accurate measurement. Fine soils, high in clay and silt are more prone to erosion than sandy soils.
- Soil disturbance. Soil that has been tilled, plowed, amended or otherwise disturbed is easily picked up by wind and water and carried offsite.
- Coverage by living plants and residues. Soils covered by cash crops, cover crops, weeds and crop residues are less likely to be lost to erosion than bare soil. Plant roots hold soil in place, reducing erosion potential.



How To Improve Your Score

Minimize soil disturbance and consider strip- or no-till to conserve soil carbon and **prevent release of CO_2** from decomposing organic matter.

Keep soil covered to **prevent erosion** by managing tillage, planting and harvest timing, row spacing, crop residues and cover crops

Install wind barriers like hedgerows of appropriate trees and shrubs upwind from fields to **reduce soil loss** due to wind erosion.

Other factors to consider:

Mitigate slope

Consider laser-leveling or terracing fields in areas where water erosion is a problem.

Opportunities To Explore With Your Trusted Adviser

- Can I combine reduced tillage with cover crops to conserve soil on my farm?
- How do yields in fields with the greatest slope compare to flatter fields?
- Should I laser level my fields or install terraces?
- What species of trees and shrubs work well in my area as a wind barrier?
- Should my rotation be adjusted to include higher residue crops?
- Can I leave coarser crop residues without interfering with planting?
- Is it feasible to narrow my row spacing?
- Are there crop varieties that perform well in my conditions that close canopy sooner?

[1] *Pimentel, D., C. Harvey, P. Resosudarmo, et. al. 1995. Environmental and Economic Costs of Soil Erosion and Conservation Benefits. Science 267(5201): 1117-1123.*

Interpreting The Metric

Water Quality

Why It Matters

When water leaves the farm field it takes the soil and residual crop inputs with it resulting in lost investments, reduced yields and negative impacts on water quality. Protecting water quality is beneficial for the economic health of the farm and the health of the local and downstream communities and industries that rely on clean water.

Crop protectants and nutrients can runoff directly into surface waters; leach through the soil profile and enter either tile lines that discharge to surface water; or leach into groundwater. Groundwater supplies approximately 95% of people living in agricultural communities with drinking water[1]. Agricultural chemicals can give drinking water a foul odor and flavor. More importantly, there are known negative health effects of nitrates in drinking water, particularly for infants and children[2].

Excess nutrients from fertilizer and manure that run off of fields into surface water are also known to stimulate rapid expansion of algae populations. The massive algal "blooms" cause hypoxic, or oxygen-scarce, zones in ecologically and economically important bodies of water. Wildlife and fishing industries have been negatively impacted by hypoxia.

To reduce the amount of crop nutrients in watersheds, some states have created laws regulating nutrient application and manure management. These states may require nutrient management plans to be filed by growers with their state department of agriculture.

How It Is Measured In The Fieldprint® Platform

The Fieldprint Platform uses the Water Quality Index for Agricultural Runoff (WQIag) to indirectly measure the quality of water leaving a farm field.

WQIag is unitless and ranges from zero to ten. **High scores are desirable** and reflect better water quality.

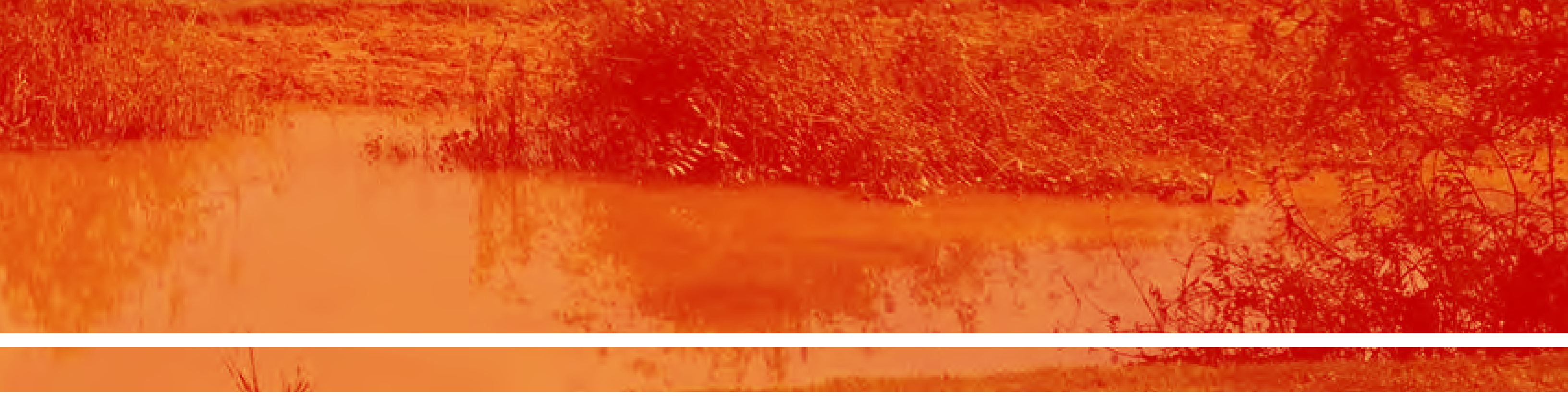
0 (poor) ⟷ 10 (good)

Factors That Affect The Fieldprint Score

WQI is a complex index with several components. First, a WQI sub-factor is calculated by averaging the values of four sub-indices:

- **Field Physical Sensitivity** measures the potential of water to be retained in the field, rather than running off, and factors in soil type, slope, organic matter, precipitation, vegetative cover, presence of drainage tile and hydrological soil group.
- **Nutrient Management** assesses opportunity for applied nutrients to be taken up by plants or retained in the soil and factors rate of N+P application, soil condition at time of application, application method and tile drainage system.
- **Tillage system** indexes soil disturbance and the likelihood soil will move off the field in runoff.
- **Pest management** scores the reliance on chemical interventions in proportion to other strategies in an integrated pest management system.

Adjustments for irrigation and NRCS conservation practices are made to the WQI sub-factor to calculate the final WQIag score. Irrigation generally lowers the score, unless accompanied by a water management system. Implementing NRCS conservation practices (up to three) to address the water quality resource concerns can increase your score several points.



How To Improve Your Score

Consider structural and edge of field practices to create a last line of defense, **trapping and treating water before it leaves the field**.

Precisely apply crop nutrient, protectant and irrigation inputs to **maximize uptake** by plants and **keep inputs on the field**.

Minimize soil disturbance and consider strip- or no-till to conserve soil carbon and **prevent release of CO_2** from decomposing organic matter.

Other factors to consider:

Drainage water management
If tile drainage is used, implement in-field drainage water management or end of pipe treatment practices.

Maintain soil coverage
Keep soil covered to prevent erosion by managing tillage, planting and harvest timing, row spacing, crop residues and cover crops.

Opportunities To Explore With Your Trusted Adviser

- What financial incentives are available to install a riparian or forest buffer, filter strip or other NRCS conservation practices?
- How can I reduce or eliminate tillage?
- Should I convert to a drip irrigation system?
- Would polyacrylamide reduce irrigation runoff from my fields?
- Can my rotation be adjusted to increase the amount of vegetative cover on the fields each month?
- What are the best cover crops to include in my rotation?
- Is my nutrient management plan up-to-date?
- How can we incorporate more pest scouting or use cultural and biological controls to get more targeted integrated pest management?

[1] *Pesticides in Groundwater, https://water.usgs.gov/edu/pesticidesgw.html*
[2] *Nitrates in Drinking Water, https://extension.psu.edu/nitrates-in-drinking-water*

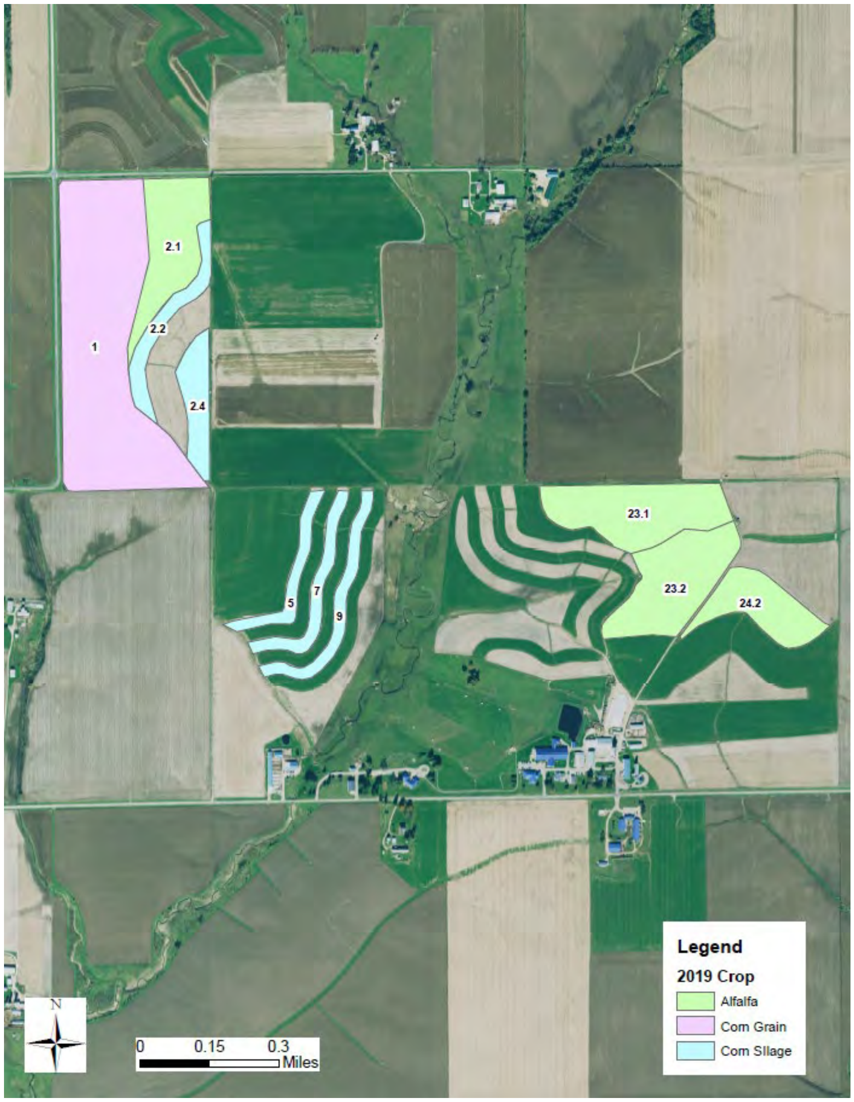
Field to Market: The Alliance for Sustainable Agriculture is a diverse collaboration working to create opportunities across the agricultural supply chain for continuous improvements in productivity, environmental quality, and human well-being. Our work is grounded in science-based tools and resources, unparalleled, system-wide collaboration and increased supply-chain transparency.

We bring together a diverse group of grower organizations; agribusinesses; food, beverage, apparel, restaurant and retail companies; conservation groups; universities; and public sector partners to define, measure and advance the sustainability of food, fiber and fuel production in the United States.

777 N. Capitol Street NE, Suite 803 | Washington, DC 20002 | www.fieldtomarket.org

Operation Name	Year	Day	Crop	Residue	Residue Amount
Manure spreader, liquid	Year 1	5-Apr		manure, liquid	0
Planter, double disk opnr with starter fertilizer	Year 1	20-Apr	Corn, silage		
Sprayer, pre-emergence	Year 1	25-Apr		weed residue; 0-3 mo	250
Sprayer, post emergence	Year 1	15-May		weed residue; 0-3 mo	250
Fert applic. surface broadcast	Year 1	15-Jun			
Harvest, silage	Year 1	1-Sep			
Drill or air seeder, combo single disk-hoe openers, 10 in spac	Year 1	15-Sep	Rye, cereal, winter, grain		
Manure spreader, liquid	Year 2	10-Apr		manure, liquid	0
Planter, double disk opnr	Year 2	20-Apr	Corn, silage		
Sprayer, pre-emergence	Year 2	25-Apr		weed residue; 0-3 mo	250
Sprayer, post emergence	Year 2	15-May		weed residue; 0-3 mo	250
Fert applic. surface broadcast	Year 2	15-Jun			
Harvest, silage	Year 2	1-Sep			
Drill or air seeder, single disk openers 7-10 in spac.	Year 2	15-Sep	Rye, cereal, winter, grain		
Manure spreader, liquid	Year 3	10-Apr		manure, liquid	0
Planter, double disk opnr	Year 3	20-Apr	Corn, silage		
Sprayer, pre-emergence	Year 3	25-Apr		weed residue; 0-3 mo	250
Sprayer, post emergence	Year 3	15-May		weed residue; 0-3 mo	250
Fert applic. surface broadcast	Year 3	15-Jun			
Harvest, silage	Year 3	1-Sep			
Manure spreader, slurry	Year 3	10-Sep		manure, liquid	0
Drill or air seeder, single disk openers 7-10 in spac.	Year 3	15-Sep	Small grain, winter, forage		

Example Farm – 2019 Fieldprint Report



2-11-21

Unique Identifier: 5827

Data entry performed by:

Joshua Kamps, Agricultural Educator, University of Wisconsin Extension
608-776-4820, joshua.kamps@wisc.edu

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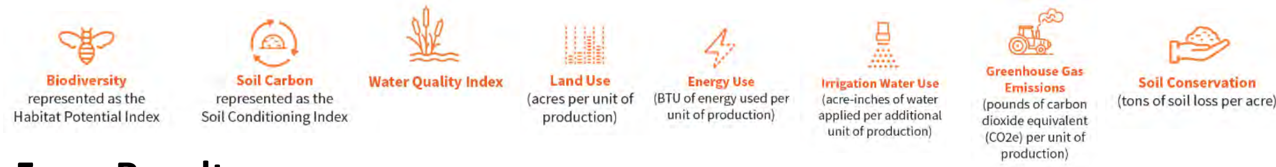
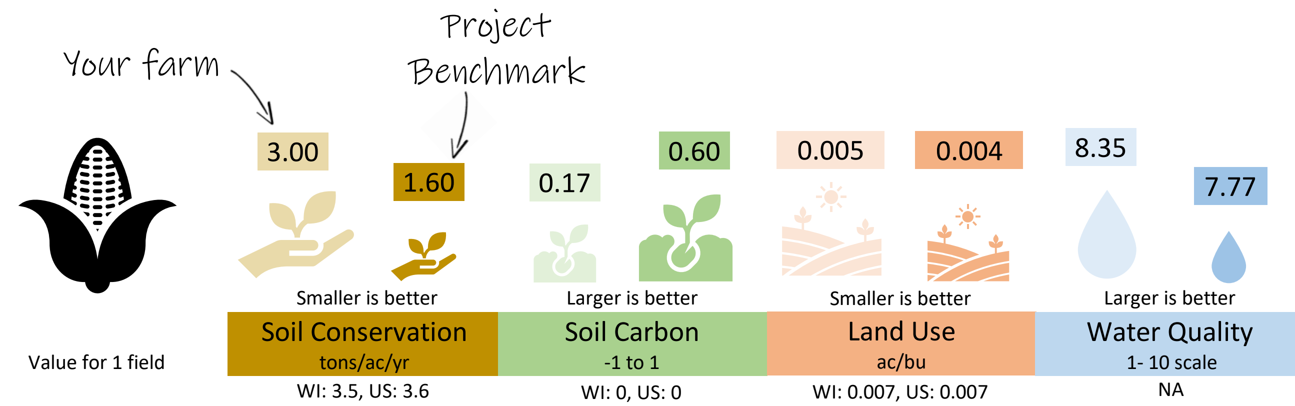
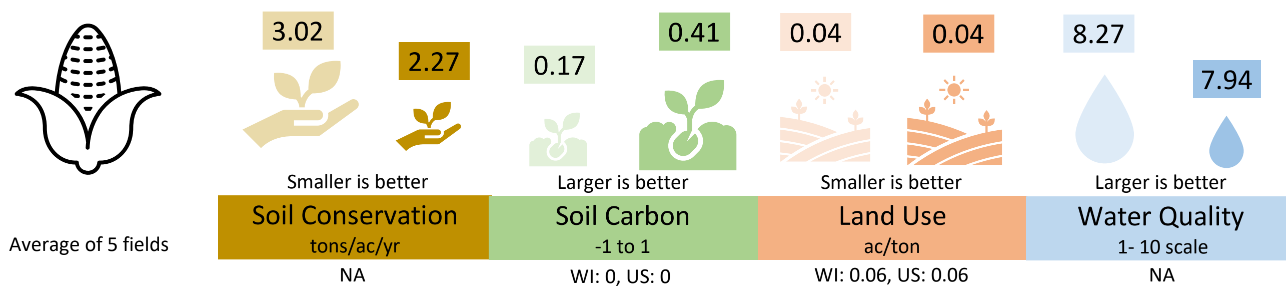


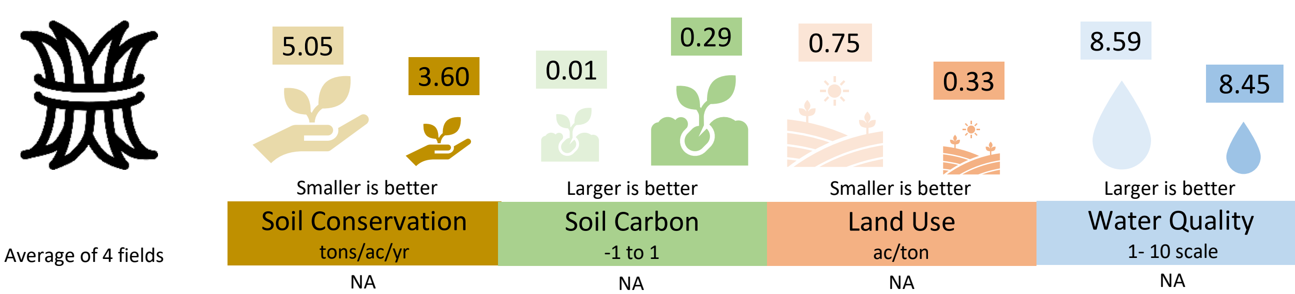
Farm Results

Field to Market uses 8 sustainability metrics (above). For this report we have used 4 metrics that have been identified as important for the LASA pilot project. Scores represent the average of all fields entered into the platform for the 3 crops shown that were grown in 2019. In the case that there is only 1 field for a crop, the value for that field is presented in lieu of an average. For scores on additional metrics, refer to the Fieldprint Platform reports.

In broad terms across crop types, the ***Example Farm scored better (higher) than the project benchmark for 1 metric where a larger score is desirable (water quality).***







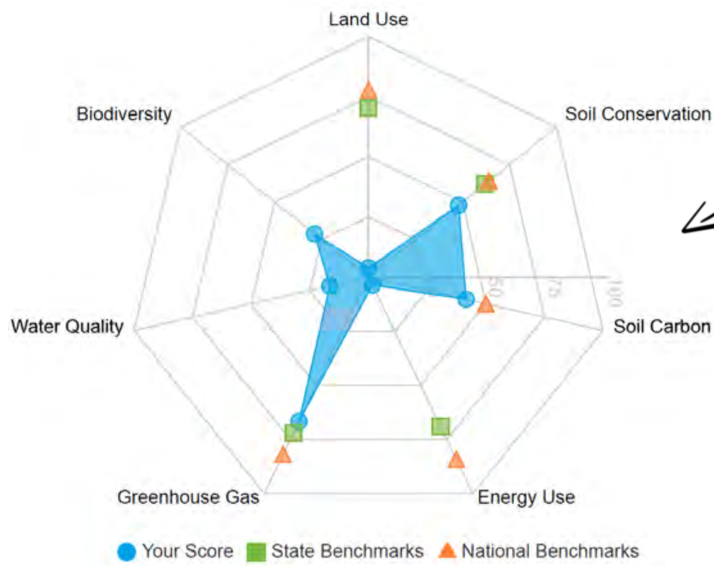
Key: Corn Grain Corn Silage Alfalfa **State and national benchmarks listed below each metric**

Individual Field Results

The spidergram (below) is the graphic used by Field to Market's Fieldprint Platform™ to visually display your sustainability metric scores on a scale from 0 – 100 relative to state and national benchmarks, where applicable. From this graphic, you will be able to see quickly if your field scores are relatively lower or higher than the state and national benchmarks.

Example: 2019 Corn Grain

You can think of the spidergram as your sustainability footprint. A smaller footprint is desirable.



There are no state or national benchmarks for biodiversity and water quality and no state benchmark for soil carbon because they are site specific or dependent on soil and/or climate, which is highly variable across the state and nation.

In the Fieldprint Analysis Summary report, you can view the specific metric values for each field that has been entered into the platform, the example below is for one of your corn grain fields in 2019.

Metric	Your Result	State Benchmark	National Benchmark
Land Use (acre / bushel)	0.0045	0.0069	0.0074
Soil Conservation (ton / acre / year)	3.0	3.5	3.6
Soil Carbon	0.17	N/A	0.00
Energy Use (btu / bushel)	9303	25291	35312
Greenhouse Gas (lbs_co2e / bushel)	8.8	9.3	11.4
Water Quality	8.35	N/A	N/A
Biodiversity	71%	N/A	N/A

To access more detailed information, you can login to the Fielprint Platform™ at https://calculator.fieldtomarket.org/#/. Your login username is your email address, and the password is lasa2019.

Understanding Your Scores

Soil Conservation

How It Is Measured In The Fieldprint® Platform

The Soil Conservation metric is expressed as soil erosion and is measured as tons of soil lost (T) per unit of land area (acre) per year for all crops. Lower numbers are desirable and indicate less soil lost from erosion per acre. **A score of 0 would indicate that no soil was lost in that year.**

Factors That Affect The Fieldprint Score

The Soil Conservation Fieldprint Score is most affected by:

- Field characteristics including slope, soil texture and wind barriers. The greater the slope (%) and longer the slope length, the more potential for soil to be washed away by water.
- Soil disturbance. Soil that has been tilled, plowed, amended, or otherwise disturbed is easily picked up by wind and water and carried offsite.
- Coverage by living plants and residues. Soils covered by cash crops, cover crops, weeds, and crop. Residues are less likely to be lost to erosion than bare soil. Plant roots hold soil in place, reducing erosion potential.

Opportunities To Explore With Your Trusted Adviser to Improve Score

- Review crop rotation to make sure tillage type and operations accurately reflect what you are doing.
- Can I combine reduced tillage with cover crops to conserve soil on my farm?
- Can my rotation be adjusted to include higher residue crops?
- Can I leave coarser crop residues without interfering with planting?
- Look at practices to reduce slope length, such as contour filters strips.

Land Use

How It Is Measured In The Fieldprint® Platform

Land use efficiency is a measure of the amount of land (acres) used to produce a unit of crop (bushels, tons, pounds, etc. **Lower scores are desirable and indicate greater land use efficiency.**

Factors That Affect the Fieldprint Score

Balancing yield with input optimization is the single factor that affects Land Use Efficiency in your Fieldprint Score. Although yields are heavily influenced by yearly fluctuations in temperature, rainfall, and other weather events outside the control of the farmer, management decisions within your control such as variety selection, planting and harvest dates, irrigation, pest and nutrient management and crop rotation can have positive impacts on productivity. Increase yields in existing fields to improve your land use efficiency.

Opportunities To Explore With Your Trusted Adviser to Improve Score

- Review accuracy of Fieldprint crop rotation
- Where can I reduce energy consumption in my operation?
- Which 4R nutrient stewardship practices can I adopt to more efficiently use the nitrogen I apply?
- How can I update my rotation to incorporate a nitrogen-fixing crop?
- Am I optimizing fertilizer and/or manure applications?
- How can I build and preserve organic matter in the soil?

Water Quality

How It Is Measured In The Fieldprint® Platform

The Fieldprint Platform uses the Water Quality Index for Agricultural Runoff (WQIag) to indirectly measure the quality of water leaving a farm field. **High scores are desirable and reflect better water quality.**

Factors That Affect The Fieldprint Score

- Potential of water to be retained in the field, rather than running off, and factors in soil type, slope, organic matter, precipitation, vegetative cover, presence of drainage tile and hydrological soil group.
- Nutrient Management assesses opportunity for applied nutrients to be taken up by plants or retained in the soil and factors rate of N+P application, soil condition at time of application, application method and tile drainage system.
- Tillage system indexes soil disturbance and the likelihood soil will move off the field in runoff.
- Pest management scores the reliance on chemical interventions in proportion to other strategies in an integrated pest management system.

Opportunities To Explore With Your Trusted Adviser to Improve Score

- Review accuracy of Fieldprint crop rotation.
- What financial incentives are available to install a riparian or forest buffer, filter strip or other NRCS conservation practices?
- How can I reduce or eliminate tillage?
- Can my rotation be adjusted to increase the amount of vegetative cover on the fields each month?
- What are the best cover crops to include in my rotation?
- Is my nutrient management plan up to date?
- How can we incorporate more pest scouting or use cultural and biological controls to get more targeted integrated pest management?

Soil Carbon

How It Is Measured In The Fieldprint® Platform

The Soil Carbon Metric in the Fieldprint® Platform is measured using the USDA Natural Resources Conservation Service's Soil Conditioning Index. **Scores closer to +1 indicate a gain in soil carbon.**

Factors That Affect the Fieldprint Score

- Organic matter – residues from cash and cover crops left on the soil, animal manure and other organic material added to the soil.
- Field operations – practices that accelerate decomposition of organic matter and resulting carbon loss as carbon dioxide into the atmosphere. Tillage and other practices that disturb soil stimulate decomposition and change the location of organic matter in the soil profile.
- Erosion – the loss of soil carried by water or wind.

Opportunities To Explore With Your Trusted Adviser to Improve Score

- Review accuracy of Fieldprint crop rotation.
- Can I adopt a no-till or strip-till system?
- How can I incorporate cover crops into my rotation?
- Should I be managing crop residues differently?
- How can I rotate in higher residue crops?
- Can I reduce soil losses by installing practices to reduce slope length such as contour filter strips?

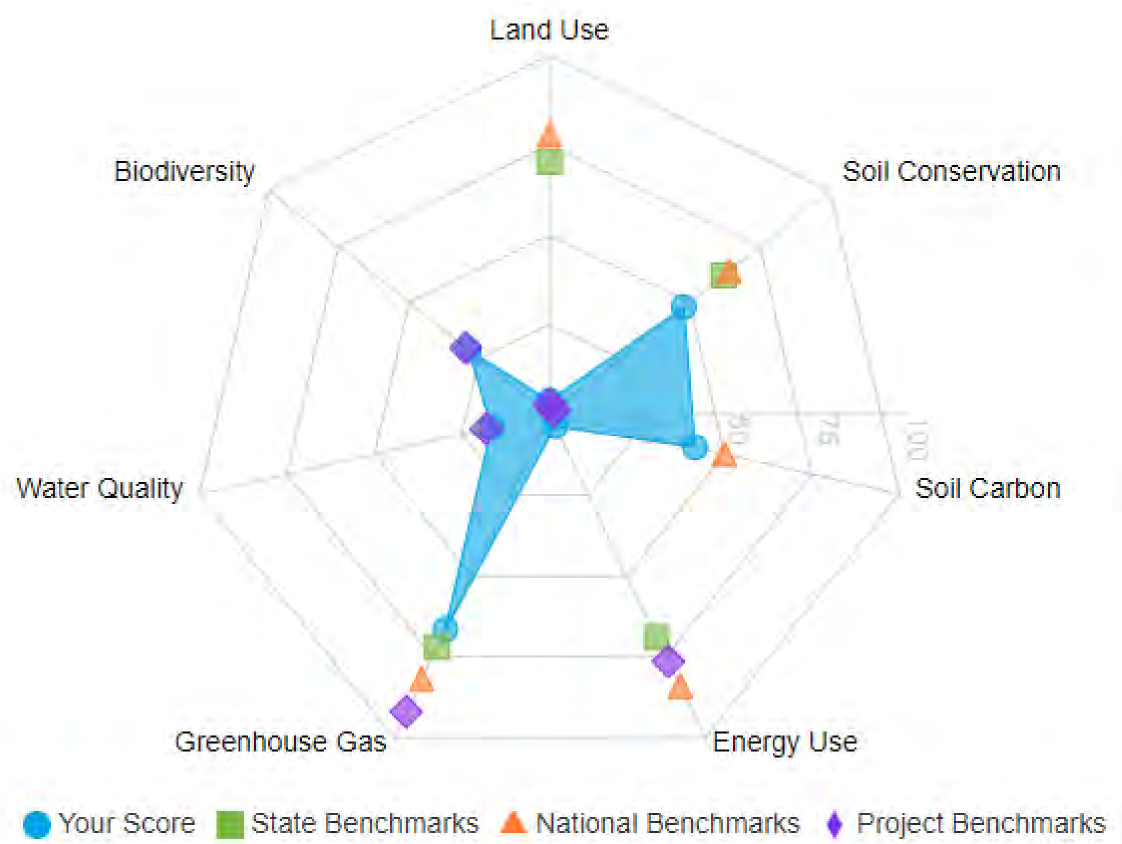
Fieldprint Analysis Summary

Grower/Account Name: dthomas@houstoneng.com	Year: 2019
Farm: Example	Crop: Corn (grain)
Location: Lafayette County, WI	Plantable Acres: 44.39 acre
Report Generated: 03/03/2021 06:39 PM	Irrigated: No

Fieldprint Result

Fieldprint results are shown on the spidergram as relative indices on a scale of 1-100 that represent your metric scores. The indices are calculated so that smaller values indicate less resource use or environmental impact from your field.

This illustration can be used to identify where the greatest opportunities for improvement are for your field, and over time can be used to evaluate progress and trade-offs between different sustainability metrics for your field.



Benchmark Comparison Summary

Benchmarks represent an average based on USDA statistical data for the period 2008-2012 and provide context for how your scores relate to this known point. Benchmarks should not be interpreted as a specific level of sustainability, or a performance target. State and National benchmarks that are not shown in the table or on the spidergram are not available for the applicable metric. Project benchmarks represent the average performance across fields enrolled in the Lafayette Ag Stewardship Alliance Project.

Metric	Your Result	Project Benchmark	State Benchmark	National Benchmark
Land Use (acre / bushel)	0.0045	0.0041	0.0069	0.0074
Soil Conservation (ton / acre / year)	3.0	1.0	3.5	3.6
Soil Carbon	0.17	N/A	N/A	0.00
Energy Use (btu / bushel)	9303	28857	25291	35312
Greenhouse Gas (lbs_co2e / bushel)	8.8	15.0	9.3	11.4
Water Quality	8.35	8.20	N/A	N/A
Biodiversity	71%	70%	N/A	N/A

Land Use

The Land Use metric is an efficiency metric that uses a simple equation to account for the planted area used to produce a crop. Land Use is calculated as the simple inverse of user-supplied crop yield. Outcomes are in units of planted land area per unit of production. A lower number indicates greater efficiency.

Your Score

Land use efficiency is a measure of the amount of land (acres) used to produce a unit of crop (bushels, pounds, etc.) Examples: In corn, land use is measured in acres/bushel; in cotton as acres/pound of lint. This is an inverse of yield measures, which are expressed as bushels per acre or pounds of lint per acre. Lower scores are desirable and indicate greater land use efficiency.

Land Use

2019 Corn (grain)

0.0045

acre / bushel

Comparison to Benchmarks

Land Use score in comparison to available benchmarks. Benchmarks are an average of USDA statistical data for the period 2008-2012, to provide context for your scores. Benchmarks should not be interpreted as a specific level of sustainability, or a performance target. State and National benchmarks that are not shown in the table or on the spidergram are not available for the applicable metric.

Score	Result
Your Score	0.0045 acre / bushel
Project Benchmarks	0.0041 acre / bushel
State Benchmarks	0.0069 acre / bushel
National Benchmarks	0.0074 acre / bushel

Soil Conservation

The Soil Conservation metric is a measure of soil lost to erosion from water and wind, and is calculated using USDA NRCS models and reported to the user as tons of soil lost per acre. It is an efficiency metric that uses a complex biophysical model to simulate crop growth, water flow across the field, and sediment runoff.

Your Score

The Soil Conservation metric is expressed as soil erosion and is measured as tons of soil lost (T) per unit of land area (acre) per year. Lower numbers are desirable and indicate less soil lost from erosion per acre. A Soil Erosion Fieldprint Score of 0 would indicate that no soil was lost in that year.

Soil Conservation

2019 Corn (grain)

3

ton / acre / year

Comparison to Benchmarks

Soil Conservation score in comparison to available benchmarks. Benchmarks are an average of USDA statistical data for the period 2008-2012, to provide context for your scores. Benchmarks should not be interpreted as a specific level of sustainability, or a performance target. State and National benchmarks that are not shown in the table or on the spidergram are not available for the applicable metric.

Score	Result
Your Score	3.0 ton / acre / year
Project Benchmarks	1.0 ton / acre / year
State Benchmarks	3.5 ton / acre / year
National Benchmarks	3.6 ton / acre / year

Soil Carbon

Soil carbon is important in supporting water infiltration, water and nutrient holding, crop productivity and carbon storage. The Fieldprint Platform utilizes the Soil Conditioning Index (SCI) a qualitative, directional measure of how soil carbon is impacted by the organic matter and crop residue on your field, the soil lost to wind and water erosion, and soil impacting characteristics of your field operations.

Your Score

The Soil Carbon metric in the Fieldprint Platform® is measured using the NRCS Soil Conditioning Index. The SCI returns a value between -1 and 1 for each field. A positive value indicates increasing soil carbon, a neutral value (between -0.05 and 0.05) indicates maintaining soil carbon, and a negative value indicates depletion of soil carbon. The magnitude of the index reflects confidence in the directionality and does not indicate a higher or lower quantity of carbon in the soil. Scores ranges from +1 to -1 and are unitless, relative, and crop-specific.

Soil Carbon

2019 Corn (grain)

0.17

SCI

Soil Carbon Score Description

The SCI returns a value between -1 and 1 for each field. A positive value indicates increasing soil carbon, a neutral value (between -0.05 and 0.05) indicates maintaining soil carbon, and a negative value indicates losses of soil carbon. The magnitude of the index reflects confidence in the directionality and does not indicate a higher or lower quantity of carbon in the soil.

SCI — 2019 Corn (grain)

-1
-0.5
0
0.51
DepletingMaintainingIncreasing

Energy Use

The Energy Use Metric calculates all energy used in the production of the crop in one year from pre-planting activities through to the first point of sale. It is an efficiency metric, calculated using a series of algorithms and designed to provide feedback on the energy used per unit of crop production.

Your Score

The Energy Use metric includes direct energy used for operating equipment, pumping irrigation water, grain drying and transport as well as embedded energy, which is required to produce crop inputs like seeds, fertilizers and crop protectants.

Energy use is expressed as British thermal units (BTU) per unit of crop production (i.e., bushel, pound or hundred weight). It takes one BTU to raise the temperature of one pound of water by 1°F. One gallon of diesel produces 137,452 BTU.

Lower numbers are desirable and indicate less energy used to produce a unit of crop.

Energy Use

2019 Corn (grain)

9303

btu / bushel

Comparison to Benchmarks

Energy Use score in comparison to available benchmarks. Benchmarks are an average of USDA statistical data for the period 2008-2012, to provide context for your scores. Benchmarks should not be interpreted as a specific level of sustainability, or a performance target. State and National benchmarks that are not shown in the table or on the spidergram are not available for the applicable metric.

Score	Result
Your Score	9303 btu / bushel
Project Benchmarks	28857 btu / bushel
State Benchmarks	25291 btu / bushel
National Benchmarks	35312 btu / bushel

Breakdown of Energy Use Score Components

Table showing values for each individual component of your Energy Use score, in both BTU / acre and BTU / bushel.

Component	Energy (btu / acre)	Energy (btu / bushel)
Management Energy	724,303	3,263
Application Energy	299,478	1,349
Manure Loading Energy	1,010,565	4,552
Seed Energy	21,154	95
Irrigation Energy	0	0
Post-Harvest Energy	0	0
Transportation Energy	9,682	44
Total Energy	2,065,182	9,303

Greenhouse Gas

The Greenhouse Gas (GHG) Emissions metric calculates the total emissions from four main sources – energy use, nitrous oxide emissions from soils, methane emissions (rice only) and emissions from residue burning. It is an efficiency metric calculated using a series of complex algorithms to determine the total GHG emissions per unit of crop production.

Your Score

Greenhouse gas emissions are reported in the Fieldprint® Platform as pounds of carbon dioxide equivalent (CO_2e) per crop unit produced (e.g. bushels or pounds). “CO_2e” simply means the N_2O and CH_4 emissions are converted to the equivalent amount of CO_2, to provide a common unit of all emissions in one measure, which is comparable over time and influenced by all the actions a farmer takes.

The Fieldprint® Platform uses standard U.S. government assumptions regarding fuel use, such as the 22.3 pounds of CO_2e that are emitted per gallon of diesel combusted. Emissions also result from electricity and fuel usage as well as from burning crop residues.

Low scores are desirable and indicate less greenhouse gas emitted per unit of crop produced.

Greenhouse Gas

2019 Corn (grain)

8.8

lbs_co2e / bushel

Comparison to Benchmarks

Greenhouse Gas score in comparison to available benchmarks. Benchmarks are an average of USDA statistical data for the period 2008-2012, to provide context for your scores. Benchmarks should not be interpreted as a specific level of sustainability, or a performance target. State and National benchmarks that are not shown in the table or on the spidergram are not available for the applicable metric.

Score	Result
Your Score	8.8 lbs_co2e / bushel
Project Benchmarks	15.0 lbs_co2e / bushel
State Benchmarks	9.3 lbs_co2e / bushel
National Benchmarks	11.4 lbs_co2e / bushel

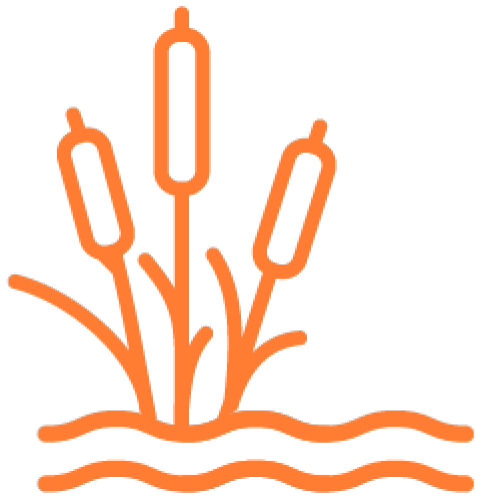
Breakdown of Greenhouse Gas Score Components

Breakdown of Greenhouse Gas Emission components. Values are shown on both a per acre and per bushel basis.

Nitrous oxide emissions from a field are taken from results of a detailed crop model based on crop type, region of the country and soil texture to determine how much N_2O results from additions of nitrogen (N) from fertilizer and manure.

Component	GHG Emissions (lbs_co2e / acre)	GHG Emissions (lbs_co2e / bushel)
Emissions associated with energy used on the Farm		

Component	GHG Emissions (lbs_co2e / acre)	GHG Emissions (lbs_co2e / bushel)
Management Energy Emissions	118.7	0.5
Application Energy Emissions	51.7	0.2
Manure Loading Energy Emissions	165.6	0.7
Seed Energy Emissions	6.3	0
Irrigation Energy Emissions	0	0
Post-Harvest Energy Emissions	0	0
Transportation Energy Emissions	1.6	0
Subtotal Energy Emissions	343.9	1.4
Soil N2O emissions	1,608.8	7.2
Methane emissions (rice only)	0	0
Residue burning emissions	0	0
Total GHG Emissions	1,952.7	8.8



Water Quality

The Water Quality metric is a qualitative measure of the risk of loss of nitrogen, phosphorous, sediment, and chemicals from water runoff across a field. It is an index-based metric calculated in the Fieldprint Platform by the “WQIag” model. WQIag is tool developed by USDA NRCS to provide a qualitative index measure that describes the quality of surface water that leaves a field.

Your Score

WQIag is unitless and ranges from zero to ten. High scores are desirable and reflect better water quality.

Water Quality
2019 Corn (grain)
8.35
WQI

Comparison to Benchmarks

Water Quality score in comparison to available benchmarks. Benchmarks should not be interpreted as a specific level of sustainability, or a performance target. State and National benchmarks that are not shown in the table or on the spidergram are not available for the applicable metric.

Score	Result
Your Score	8.35
Project Benchmarks	8.20

Breakdown of Water Quality Score Components

Breakdown of Water Quality subfactors including weighting and score.

Factor	Weighting	Score (1-10 scale, poor to good)
Field Characteristics and Soil Physical / Erosion Factors	25%	6.48
Nutrient Management	25%	4.50
Tillage Management	25%	10.00
Pest Management	25%	5.00
Sub-Factor Score	100%	6.49
Adjustment for Tile Drain Management	0%	6.49
Adjustment for Irrigation Management	0%	6.49
Adjustment forGrass waterway	+35%	7.72
Adjustment forContour strip cropping	+27.5%	8.35
Final Water Quality Index Score		8.35

Biodiversity

The Biodiversity metric is a measure of the potential capacity of the field to support diverse ecosystems. It is an index metric calculated based on both inherent land properties and land management.

Your Score

Biodiversity is assessed using the Habitat Potential Index (HPI). HPI scores the potential for a given farm to provide wildlife habitat on land or in the water. HPI scores range from 0-100 and measure the level of opportunity to improve or maximize habitat potential. Higher scores are desirable and indicate a greater potential to support wildlife habitat.

Scores less than 50% represent significant opportunities for improving habitat potential, whereas values of 50-80% indicate moderate realized potential and scores greater than 80% demonstrate farms that have maximized opportunities for biodiversity to flourish.

Your HPI score is **Moderate (50-80%)**; you have opportunities to improve the habitat support on this field.

For all scores, consult the Fact Sheet and consult with your advisor about specific opportunities to improve your score on this field.

Biodiversity
2019 Corn (grain)
Your Total % Realized HPI for your Cultivated Land
71%
Total HPI Score
444

Comparison to Benchmarks

Biodiversity score in comparison to available benchmarks. Benchmarks should not be interpreted as a specific level of sustainability, or a performance target. State and National benchmarks that are not shown in the table or on the spidergram are not available for the applicable metric.

Score	Result
Your Score	71%
Project Benchmarks	70%

User Input

Soils Information

Slope

4.0 %

Slope Length

180 feet

Surface Soil Texture Class

Silt loam

Organic Matter Content

3.5 %

Rotational and Residue Practices

Was the previous crop residue burned?

No

What is the predominant crop rotation practice used?

Conventional rotation

Do you use a cover crop?

Yes

What is the predominant tillage practice used?

15-30% residue (Reduced tillage)

Crop Rotation System (dthomas@houstoneng.com)

UW Plateville - (Al_Sg-Al(3)-Cs_Cc(2)-Cg)

Management Practices

Does the field have a wind barrier based on NRCS standards?

No

Tile Drainage System Type

No tile drainage system

Are you implementing an approved Nutrient Management Plan?

Yes

Do you apply nutrients according to the 4 R's of nutrient stewardship?

Right Source, Right Rate, Right Time, Right Place

Nutrient Application Rate (N+P) as a percentage of the University or Extension recommendation

University/extension recommendation

Soil conditions at the time of primary nitrogen application

Dry/Well Drained

Dominant Application Method

Injected

Did you apply lime for this crop?

No

Integrated Pest Management

Pests managed primarily using chemical control and additional site-specific techniques to reduce environmental risks of the pesticides

Was any part of this field converted from anything other than cropland in the past 5 years.

No

Do you practice any seasonal enhancements for wildlife habitat?

No

Conservation Practices

Grass waterway, Contour strip cropping

Operations

Planting

Seeding Rate

32000 - 33999 seeds / acre

Are Seed Treatments Used?

Yes

Harvesting

Yield

222.0 bushel / acre

Did you abandon or not harvest any acres you planted for this year?

No

Distance from field to point of sale

1.0 mile

Did you haul back a load?

No

Drying System

No Drying System Used

Points of Moisture Removed from Drying

Commercial Fertilizer and Protectant Trips

Trip 1

Protectants

Herbicides

1

Insecticides

0

Fungicides

0

Growth Regulators

0

Fumigants

0

Trip 2

Protectants

Herbicides

1

Insecticides

0

Fungicides

1

Growth Regulators

0

Fumigants

0

Manure Fertilizer Trips

Trip 1

Type

Liquid

Amount

14,000 - 16,000 gal / acre

N Amount

200.0 lb / acre