TRIANGLE SYSTEMS MAP PROJECT

INCENTIVIZING SUSTAINABLE AGRICULTURE THROUGH CAPITAL MARKETS

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EXECUTIVE SUMMARY

PROJECT SCOPE

Triangle Systems (TS) has successfully developed AssetOS, a big data platform that integrates climate and infrastructure assets with real-time usage data and generates Digital IDs. The Digital IDs allow financial stakeholders to achieve Task Force on Climate-related Financial Disclosures (TCFD) Climate Compliance, Sustainability-linked Underwriting, and Carbon Minting. To extend the use of this technology, TS is exploring the opportunity to expand into the agricultural market, in collaboration with the University of Michigan's Center for Digital Asset Finance (CDAF) and the School for Environment and Sustainability (SEAS).

To this end, TS invited our team from the University of Michigan's Stephen M. Ross School of Business to help assess and develop a define the needs and opportunities of the agricultural market and offer recommendations for TS's implementation and penetration into this market.

Over seven weeks, the MAP project team collaborated with TS, University of Michigan faculty, and agriculture, industry, and financial partners to uncover motivating factors and key performance metrics in the path to link sustainability with infrastructure assets in alignment with TCFD rules and compliance.

The MAP team conducted an analysis of the overall agricultural loan market and defined key agricultural technologies and assets of integration capabilities with AssetOS. TS also invited the MAP team to a one-week trip to Bermuda to participate in the International Tech Summit, where the team investigated applications of blockchain and other technology innovations into climate compliance needs for a variety of industries, with an aim to incorporate relevant learnings into the analysis of the agricultural market.

Given the diverse agricultural issues and topics within the U.S. and Canada, the analysis of specific farms and markets focused on the Great Lakes Region. However, our recommendations and research incorporated learnings and findings from the broader United States and global markets to provide a comprehensive viewpoint of opportunities and risks for TS.

METHODOLOGY

RESEARCH PROCESS

The MAP team's engagement with TS fell into three phases of engagement with unique methodologies:

In **Phase 1 Outline and Scope**, the team spent a focused week engaging with the sponsor team, including both TS and University of Michigan faculty, to identify the project scope and deliverables through a formal Letter of Engagement (LOE).

During **Phase 2 Research and Analysis**, the MAP team conducted both primary and secondary research to dive deep into areas of focus as identified in the LOE. The team conducted 8 informational interviews with identified core stakeholder groups:

- **Investors**: First Interstate Bank, AllianceBernstein, and StateStreet
- **Environmental**: The Nature Conservancy, The Michigan Department of Agriculture, and Michigan State University Institute of Water Research
- **Data and Technology**: Perennial
- **Policy**: Grove Climate Group

Finally, during **Phase 3 Report and Presentation**, the MAP team synthesized key findings and recommendations into the working models and deliverables presented in this report.

RESEARCH SOURCES

The MAP team also identified existing research and data available for use in model and messaging recommendations. Pertinent data are cited throughout this report, with several key data sources that served as important context for our findings (Figure 1):

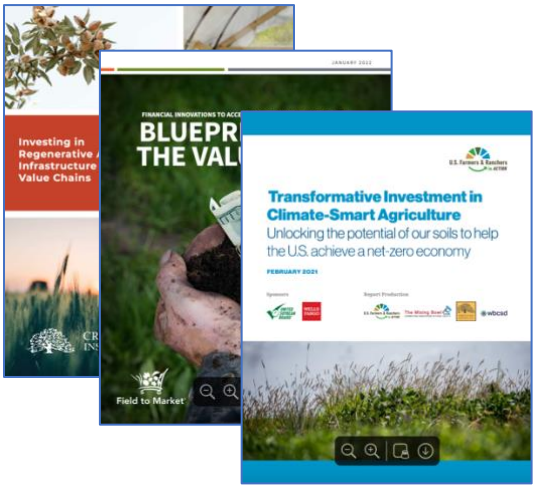


Figure 1 Existing Resources on Sustainable-Linked Agricultural Financing

- **Sustainability-Linked Agricultural Finance Research**
  - Investing in Regenerative Agriculture Infrastructure Across Value Chains (Croatan Institute)
  - Financial Innovations to Accelerate Sustainable Agriculture (Field to Market)
  - Transformative Investment in Climate-Smart Agriculture (U.S. Farmers and Ranchers in Action)
- **Farmer Survey Data:**
  - Banking on Soil Health: Farmer Interest in Transition Loan Products (Environmental Defense Fund)

    - State of Sustainable Ag 2022 and 2020 (Farm Journal, Field to Market)
    - Farmer Perspectives on Data 2021 (Farm Journal's Trust in Food)
- **Agricultural Data:**
    - USDA NASS 2017 Census Data
- **Financial Data:**
    - Bloomberg – Holders of farm credit, sustainability-linked bonds (HDS Screen)
    - Farm Credit Administration 2021 Annual Report and Farm Credit System 2021 Annual Report (Farm Credit)

KEY RECOMMENDATIONS FROM OUR FINDINGS

Through seven weeks of research and analysis, the MAP team developed key recommendations in two principle areas: 1) Design of financial products which can incentivize farmers to uptake sustainability practices that will positively impact natural resource concerns within the Great Lakes region, and 2) Recommendations for implementation by TS in order to drive partnerships which will develop the identified financial products.

DESIGN OF FINANCIAL PRODUCT

1. **Target large farms** with sustainability-linked loan products
2. **Leverage government subsidies** and **carbon markets** to optimize basis points discounts, with a primary focus on **incentivizing cover cropping and reduced tillage**
3. **Pilot innovative financing models** such as flexible and group financing and subscription models to **meet the needs of small and diverse farmers**

IMPLEMENTATION BY TRIANGLE SYSTEMS

1. **Partner with public and private sustainability leaders** in order to reduce burdens of farmer recruitment, data collection, and environmental modeling
2. **Leverage diverse monitoring technologies** and **connect to existing third-party data sources** to streamline data collection

PROJECT BACKGROUND

Triangle Systems (TS) and the University of Michigan, among other grant partners, have been funded by the Great Lakes Protection Fund (GLPF) and the Foundation for Food and Agriculture Research (FFAR) to investigate how sustainability-linked agriculture finance can be mobilized to incentivize more sustainable on-farm practices. As part of this grant, TS engaged a team from the University of Michigan's Stephen M. Ross School of Business to help assess and develop a define the needs and opportunities of the agricultural market and offer recommendations for TS's implementation and penetration into this market.

As the Task Force on Climate-Related Disclosures (TCFD) is increasingly adopted by governments and corporations on the global stage, there is increasing attention being paid to how capital markets can influence sustainability practices across many industries. Driven by both regulatory pressure and voluntary sustainability targets, stakeholders across financial markets as well as physical supply chains are seeking measurement and verification technology solutions to monitor and report on TCFD-compliant reporting data.

The MAP team has investigated opportunities to bridge emerging market structures as well as new technology innovations within the context of U.S. agriculture. As an industry, agriculture is both uniquely at risk from a changing climate, while contributing substantially to poor environmental outcomes including GHG emissions as well as water quality degradation through farm nitrogen runoff.

Due to the regional focus of the University and relevant funding partners, the MAP team's research and the contents of this report focus primarily on row crop commodity agriculture within the Great Lakes region. The MAP team has explored existing environmental issues within the Great Lakes that are attributable to local agriculture as well as opportunities for conservation practices to mitigate these harms. The team has also investigated the existing agricultural finance market and opportunities to develop sustainability-linked financing products. Finally, the team has considered demands from both physical and financial supply chains for on-farm TCFD-compliant climate disclosure data, and how this can be captured accurately through Triangle System's AssetOS to underwrite emerging sustainability-linked products.

Put simply, the MAP team's objective was to explore how farmers, banks, and the supply chain can speak the same language and drive a more sustainable agriculture system.

AGRICULTURE AND ITS IMPACT ON THE GREAT LAKES

AGRICULTURE'S ECONOMIC FOOTPRINT

American agriculture is highly influential to our broader national economy and produces key inputs that drive many related industries—from the food we eat to the clothes we wear.

Field-level agriculture production ("farming") contributed $165B, or 0.7%, to the U.S. GDP in 2021. Meanwhile, when considered alongside adjacent industries such as food, beverage, textile, and apparel, agricultural production affects nearly $1.264T, or 5.4% of U.S. GDP in the same year **(Figure 2).**

For the purposes of this report, we will focus largely on the economic and environmental impacts of agriculture at the farm level. For context, a "Farm" is defined by the United States Department of Agriculture (USDA) Economic Research Service (ERS) as "any place that produced and sold—or normally would have produced and sold—at least $1,000 of agricultural products during a given year."[1]

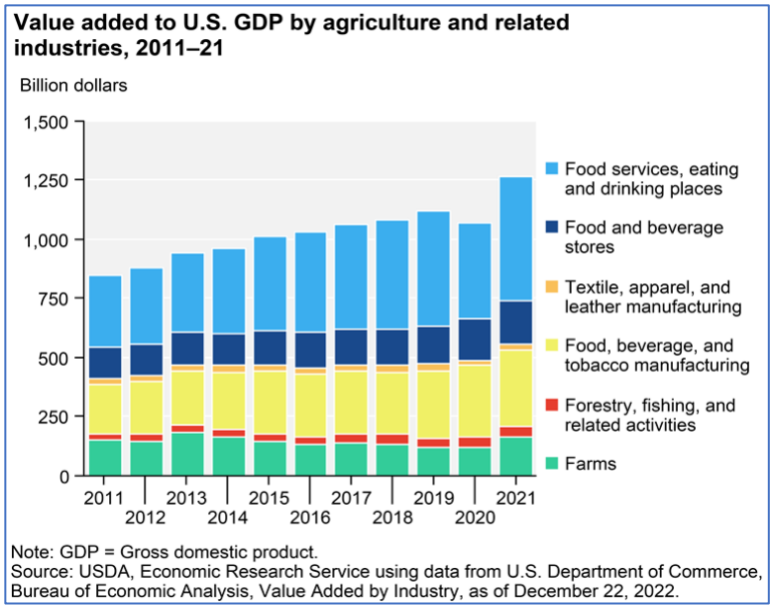


Figure 2 Agricultural Industries Affect U.S. GDP

This report focuses on the Great Lakes Region (GLR), a region of the Northern United States known for its abundant resource in freshwater supplies. **The GLR is the source of 84% of North America's surface freshwater and 21% of all freshwater globally.** Historically, this abundant freshwater source has created powerful economic opportunities. As a result, the GLR represents close to 15% of the U.S. GDP, including a heavy presence of industries such as manufacturing; agriculture; education and health; shipping and logistics; mining and energy; and tourism. Within the region, agriculture produces $14.5B in sales of crops and livestock, and the total asset value of agricultural land that flows into the Great Lakes watersheds is close to $160B.[2]

[1] (USDA Economic Research Service, 2022)
[2] (USDA National Agricultural Statistics Service, 2017)

AGRICULTURE'S PHYSICAL FOOTPRINT

U.S. Agriculture is highly industrialized, incorporating large agricultural equipment to cultivate lands and produce crops. This industrialization has made farming in the U.S. highly efficient, however, it has also resulted in intense land use and many resulting environmental consequences which are explored in this report.

As of 2010, agriculture represented 12% of land usage in the U.S.[3] – within the Great Lakes, this figure is a much higher 27.9% (**Figure 3**).[4]

Heavy agricultural land use, abundant fresh water, and efficient production capabilities make the GLR one of the most productive U.S. regions of agricultural production. Within the region, corn, soybean, and wheat are prevalent, with the GLR accounting for 36% of national production of corn and soybeans, and 14% for wheat (**Figure 4**). To put in perspective the scale of production, the amount of corn produced in the region is equivalent to the total annual demand of ethanol used to produce E10 (or E85) blended gasoline in the U.S.

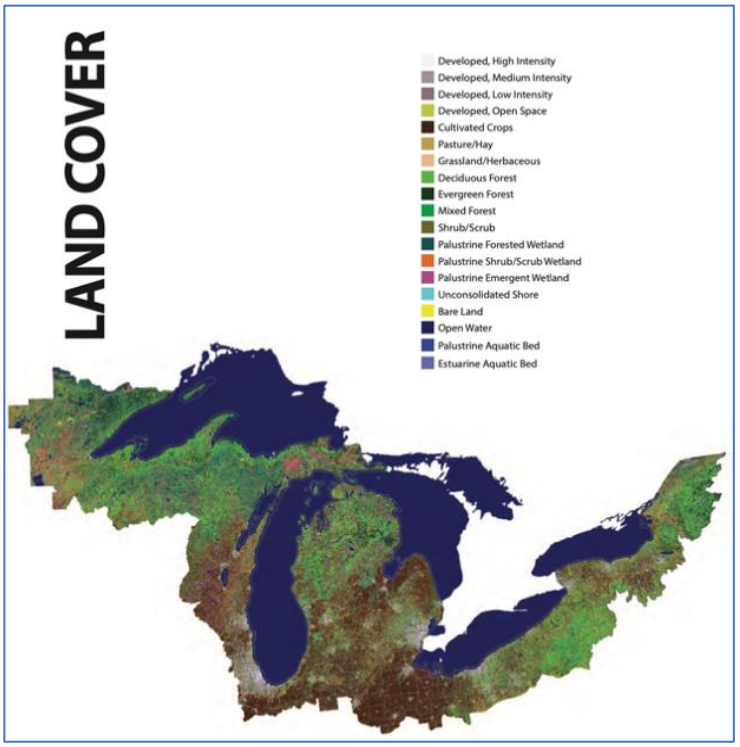


Figure 3 Land Use Within the Great Lakes Region

Grain Production in the GLR region (Unit : 1 mil bushels)

2022	CORN	SOYBEANS	WHEAT
MICHIGAN	336	105	34
ILLINOIS	2,268	677	44
WISCONSIN	545	116	19
OHIO	595	282	37
PENNSYLVANIA	118	25	15
NEW YORK	81	15	7
MINNESOTA	1,461	370	74
Total	5,403	1,590	230
Total U.S.	15,074	4,465	1,646
GLR share (%)	35.8%	35.6%	14.0%
source : USDA			

Figure 4 Grain Production Within the Great Lakes Region

[3] (USDA, 2019)
[4] (NOAA)

FARMER DEMOGRAPHICS

Although U.S. agriculture has become technologically advanced and industrialized, most U.S. farms are still run by individual families, accounting for 88% of farming operations nationally (**Figure 5**). These farms, characterized by a gross cash farm income below $350,000, hold 46% of the total farmland asset value and are responsible for 20% of the country's agricultural sales, showcasing their impact on the nation's food system.[5]

Table 1
Profile of U.S. Farms, by Type, 2012

	U.S. Total	Family Farms			Nonfamily Farms
		Small	Midsize	Large	
		percent of U.S. total			
No. of farms	2.1 million	88	6	3	3
Farmland	915 mil. acres	48	20	20	11
Value of land and buildings	$2.3 trillion	47	20	25	8
Agriculture sales	$394.6 billion	20	19	45	16
Net farm income	$78.6 billion	5	26	56	13

Source: USDA NASS, 2012 Census of Agriculture.

Within the Great Lakes Region, there are 129 U.S. counties that flow into Great Lakes watersheds, and nearly 150,000 individual farming operations within these counties.[6] The average size for these operations is only 200 acres, consistent with the definition of a small farm given by USDA.

Figure 5 Prevalence of Small Farms in US

MARGINALIZED FARMER COMMUNITIES

Recently, there has been an increased awareness of the role that systemic discrimination has played in the U.S. agriculture system. For example, Black agricultural producers comprise approximately 1.3% of all producers, managing around 4.7 million acres of farmland.[7] This represents a significant decline from historical farmland ownership by Black families, with one study estimating that Black farmers lost roughly $326 billion of land value during the 20th century, in large part due to discriminatory lending practices from among private industry as well as the U.S. Department of Agriculture (USDA).[8]

Disproportionate agricultural lending practices continue to this day, with recent studies showing that Black farmers continue to receive far lower rates of direct loan approvals from the USDA compared to farmers of all other races **(Figure 6).**[9]

[5] (United States Department of Agriculture, 2016)
[6] (USDA NASS, 2017)
[7] (Agriculture, 2019)
[8] (Douglas, 2022)
[9] (Bustillo, 2023)

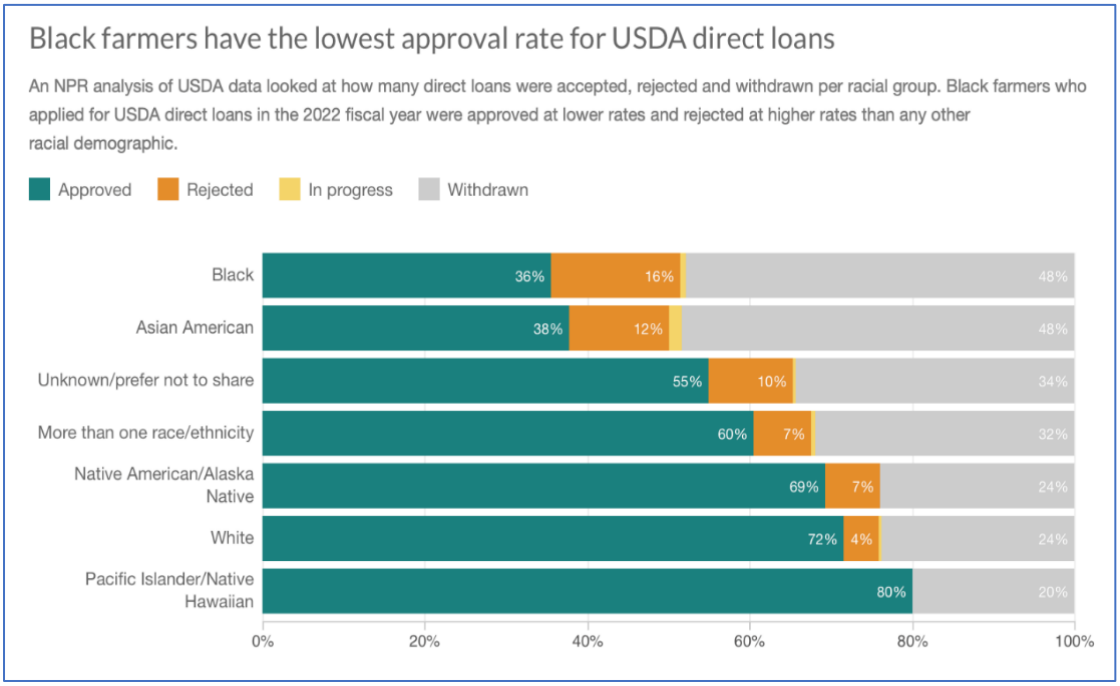


Figure 6 Loan Discrimination Against Black U.S. Farmers

KEY ENVIRONMENTAL OUTCOMES FOR AGRICULTURE

Though agriculture plays a key role in the U.S. economy, the industry's Greenhouse Gas (GHG) emissions are even higher in proportion to its economic footprint. In addition, as an industry entirely reliant on natural resources, agriculture is uniquely at risk of disruption and failure due to changing climate patterns. For these reasons, it is essential to view agriculture's economic impact in tandem with its environmental footprint. While agriculture and related industries account for 5.4% of U.S. GD, they emit 10.6% of national GHG (CO2 equivalent)[10] (**Figure 7**), including the following defined by the EPA:

> *"Anthropogenic activities from agricultural activities, such as Livestock & Manure (e.g., cow belching), and Agriculture Soils (e.g., plowing). Agriculture sector excludes related fuel combustion (e.g., emissions from diesel tractors), and some land management practices (e.g., conversion of land").*[11]

Fuel combustion, which is not included under the "Agricultural sector" consisted of 3.3% of the GHG emissions in 2018.[12] Other land management practices (e.g., forestation of land) are considered a net sink (GHG negative).

[10] (United States Environmental Protection Agency, 2022)
[11] (United States Environmental Protection Agency, 2022)
[12] (University of Michigan, 2021)

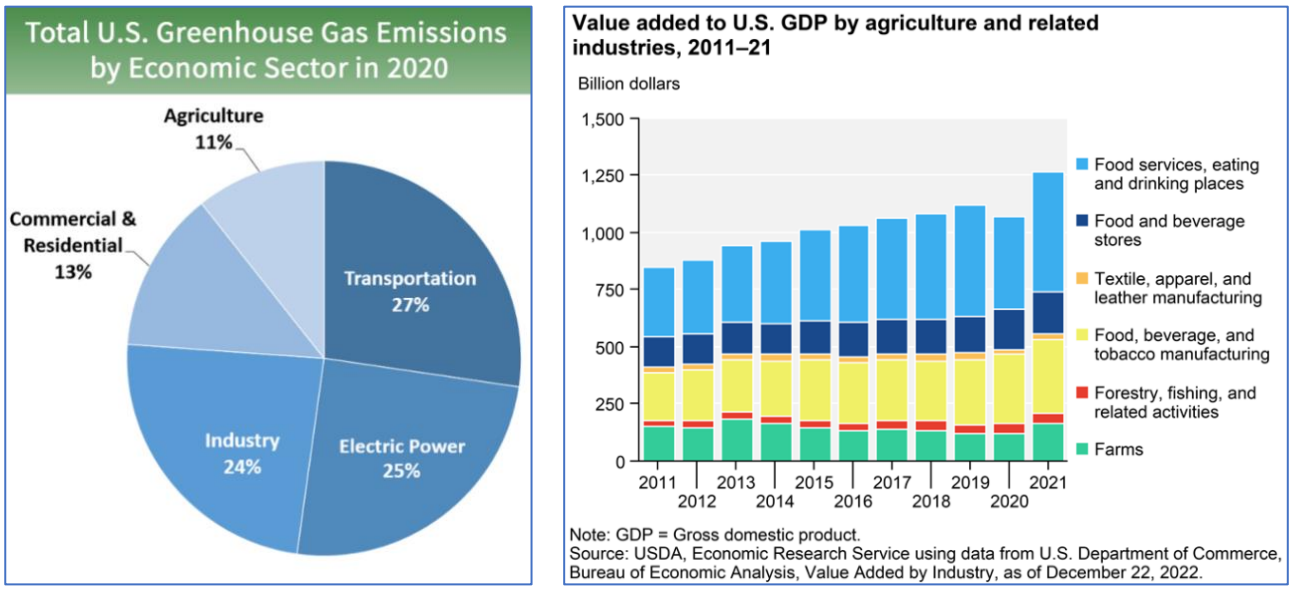


Figure 7 Agricultural Emissions Compared To GDP

WATER QUALITY

Due to the presence of the vast Great Lakes Basin freshwater ecosystem, environmental concerns within the GLR center largely on the preservation and usability of water resources. This involves the management of nutrient runoff into the Great Lakes, the management of invasive species, and the preservation of thriving aquatic ecosystems. Key indicators of Great Lakes health are featured in **Figure 8.**[13,14]

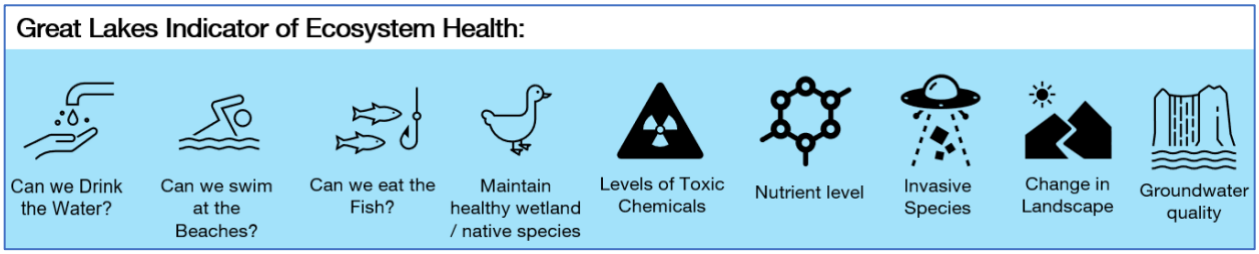


Figure 8 Great Lakes Freshwater Ecosystem Health Indicators

Many of these indicators have a direct relationship to the heavy agricultural production within the region, as nutrient runoff from agricultural land pollutes the streams and rivers that flow into the Great Lakes. Primary environmental issues include flows of nutrients and pathogens, soil runoff, and land transformation's impact on biodiversity (the latter of which is outside the scope of this project).

[13] (United States Environmental Protection Agency, 2022)
[14] (Alliance for the Great Lakes, n.d.)

Synthetic fertilizers contain Nitrogen and Phosphorous—which are applied to increase agricultural productivity on farms—and eventually leave the farm through runoffs into rivers, streams, and other local waterways.[15] This runoff results in Algae and bacteria, for example with large blooms occurring often in Lake Erie due to nearby concentrated industrial activities.[16,17] Runoff is primarily caused by nitrogen-based fertilizers, which produce potent greenhouse gases and can overload waterways with dangerous pollutants. Chemical pesticides, including but not limited to insecticides and herbicides, also carry varying toxicological effects and can contaminate air, water, and agricultural products.

SOIL CARBON

Nationally, a focus on improved soil health and soil carbon sequestration has become a prime environmental strategy for the agriculture sector. Soils are "the largest organic carbon pool on the land surface"[18] and as such have been identified as a key opportunity for sequestering carbon and providing mitigation of agriculture's large GHG emissions profile. Within the Great Lakes region, soil carbon sequestration serves as a promising co-benefit to improving the regional water quality concerns. Emerging methods to capture the economic value of improved soil health are described throughout this report.

SUSTAINABLE AND REGENERATIVE AGRICULTURAL PRACTICES

Environmental indicators such as water quality and soil carbon sequestration are influenced by management practices on the farm. There is a renewed focus within the U.S. agriculture industry to support farmers in adopting regenerative and conservation practices on farms, integrating new technologies that can better support precision agriculture methods and updating farm infrastructure to improve water quality and other concerns. Adopting key farmland practices can allow nutrients and soil to remain on the land, restoring and protecting the health of the Great Lakes basin ecosystem.

The MAP team has conducted primary research as well as informational interviews to define common agricultural practices which are relevant to the GLR. There are no silver bullet solutions, and it is considered critical that farmers incorporate multiple, site-specific practices and technologies to achieve the best environmental and economic outcomes. **For further information on the economic and environmental benefits of the practices below, refer to Appendix D: Sustainability-Linked Loan Model.**

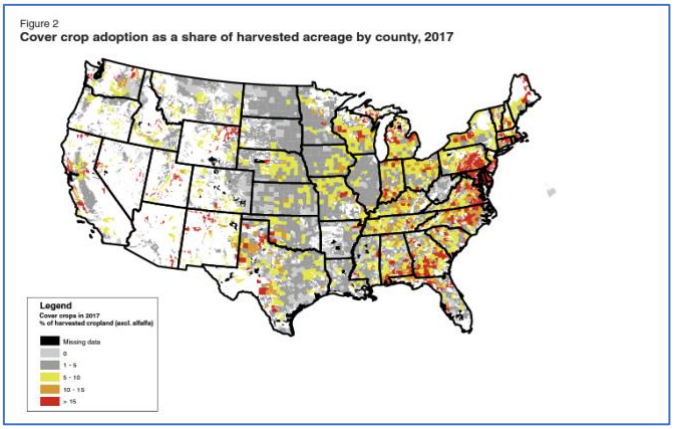
COVER CROPS [19]

Cover crops are considered one of the most effective practices for achieving environmental sustainability based on their capability to increase soil health and prevent soil erosion. Resulting increases in soil health take several crop seasons to appear, but once the soil health improves, farmers

[15] (United States Environmental Protection Agency, 2022)
[16] (National Centers for Coastal Ocean Science, 2022)
[17] (State of the Great Lakes, n.d.)
[18] (Field to Market: The Alliance for Sustainable Agriculture, 2022)
[19] (Steven Wallander, 2021)

require less application of additives to achieve an equivalent or better yield, resulting from increased nutrient and water absorption of the soil. The resulting lowered costs improve the farmer's financials, making cover crops attractive both economically and environmentally.

Despite these benefits, the cover crop adoption rate is still limited in the GLR. According to the 2017 Agricultural Census, cover crop adoption rate is 4% (**Figure 9**). Potential reasons for low adoption rates include increased labor, a perceived decrease in flexibility of what crop to grow, increases in capital expenditure for asset purchases, and behavioral difficulties in shifting practices in tight farmland communities.



	Cover Crop Coverage
MICHIGAN	7.00%
ILLINOIS	2.62%
WISCONSIN	4.27%
OHIO	5.12%
PENNSYLVANIA	8.19%
NEW YORK	4.36%
MINNESOTA	2.27%
Total	**4.00%**

source: USDA 2017 Ag Census

Figure 9 Cover Crop Adoption Within the Great

CONSERVATION TILLAGE [20]

Tillage is a mechanical modification of soil structure. Traditionally, U.S. farmers conduct what is known as "full tillage", which prevents weeds and allows for easier seed planting with looser soil. However, this results in the release of soil carbon into the air and long-term soil erosion due to looser soil condition. To prevent carbon release and soil erosion, conservation (or reduced) tillage or no tillage are recommended. Similar to cover cropping, conservation tillage and no tillage provides benefits to farmers by reducing inputs and maintaining soil on land. However, while adoption rate is higher than cover cropping, conservation tillage and no till adoption rate still is limited (**Figure 10**).

Transitioning to conservation tillage requires a significant upfront capital expenditure, sometimes into the six figures, and may be constrained due to behavioral pressures from neighboring farmers. Potential conservation tillage techniques include:

- **Conservation/Reduced Tillage:** plowing a certain portion of the land, minimizing carbon release and soil erosion

[20] (USDA Economic Research Service, 2020)

- Vertical Till: Used in farmlands that have limited topsoil content; requires additional equipment.
- Strip-till: Tills only where seeds will be planted. Requires additional equipment

- **No Tillage:** Does not plow land at all, minimizing carbon release and soil erosion

	Conservation Tillage (incl. No-Till)	Conservation Tillage (incl. No-Till)
MICHIGAN	23.9%	16.3%
ILLINOIS	35.0%	24.0%
WISCONSIN	19.9%	15.6%
OHIO	22.2%	30.6%
PENNSYLVANIA	6.7%	22.2%
NEW YORK	11.5%	5.0%
MINNESOTA	32.2%	4.3%
Total	**26.0%**	**16.8%**
source: USDA 2017 Ag Census		

> "Switching planting equipment, for no-till or for strip-till, either way **you're looking at six figures."**
>
> *Patrick Doran*
> *The Nature Conservancy Michigan*

Figure 10 Conservation Tillage Adoption Within the Great Lakes

DIVERSE CROP ROTATIONS[21]

Multiple, diversified crop rotation prevents certain types of pests or diseases from lingering in the field, preventing additional usage of pesticides and increasing crop production. According to the Nature Conservancy, an ideal crop rotation would contain 5 different crop species. However, considering the difficulty of incorporating 5 different crops under the current market-driven commodity pricing scheme, the Nature Conservancy considers having 3 different crop types as a diverse crop rotation. Edge of field practices are those that are not directly related to the management of cash crops, but rather install protective barriers and conservation strategies on farmland that is not in production. This promises benefits not just to improved water quality through reduced runoff, but also co-benefits impacting soil carbon, biodiversity, and other natural resource concerns.

EDGE OF FIELD PRACTICES

Edge of field practices contain a wide umbrella of techniques depending on the unique farmland, regional soil types and natural resource concerns (Figure 11). However, these practices are frequently difficult to implement due to high upfront costs, a lack of positive impact on profitability, and the need to involve or coordinate with broader community stakeholders beyond the farm gate. In many cases, the farmer essentially needs to convert part of their farmland, resulting in decreased revenue and increased maintenance cost of the converted land. Despite these barriers, edge of field practices have an important role to play in protecting water quality and should be considered in terms of broader market capital and blended finance strategies.

[21] (USDA Economic Research Service, 2020)

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

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

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

Figure 11 Edge of Field Practices Economic and Environmental Benefits

UPDATING INFRASTRUCTURE

There are also methods to mitigate runoffs of nutrients and soil by managing the water flow itself. One problem that is especially prevalent in the GLR faces is the implementation of tile drainage systems. Such systems allow water to flow easily to rivers and streams creating an environment with high runoff rates (**Figure 12**).[22] Some key practices that the MAP team defined through industry specialists were saturated buffers, drainage water management, slag filter, and vegetated floating wetlands.

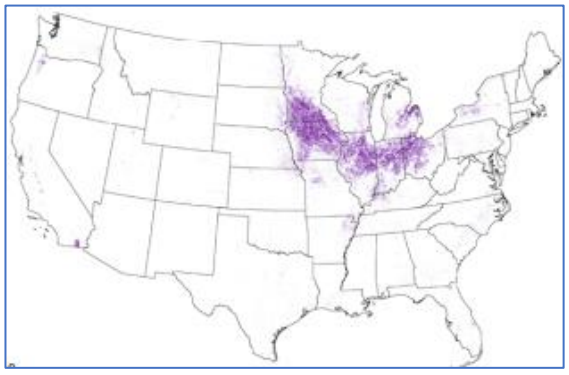


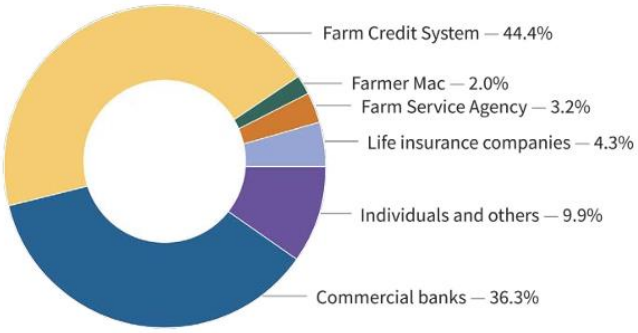
Figure 12 Implementation of Tile Drainage Is High in the GLR

[22] (Valayamkunnath, 2020)

FARM CREDIT MARKET

The farm credit market provides loans and other financial services to farmers and other agricultural producers. The market is typically dominated by a few large lenders. These lenders often operate as cooperative associations or banks, owned by their customers or members.

Figure 13 Market Share of U.S. Farm Business Debt as of Dec 31, 2020



Source: FCA's Office of Data Analytics and Economics, based on February 4, 2022, data from USDA's Economic Research Service.

This market plays an important role in providing financing and other financial services to farmers and other agricultural producers, particularly in times of economic uncertainty or hardship. This can include providing working capital loans to cover operating expenses, financing the purchase of equipment and land, and offering risk management tools like crop insurance. The farm credit market is often seen as a vital component of the broader agricultural industry, and given its importance to the agricultural sector, it has the potential for facilitating changes in agricultural practices through its lending initiatives.

Figure 13 shows the estimated market share of U.S. farm business debt as of December 31, 2020 The Farm Credit System held the largest share of debt, reported at over $373 billion in 2022.[23]

FARM CREDIT SYSTEM

The Farm Credit System is a private, government-sponsored enterprise with a federal charter and a statutory mandate to serve only agriculture-related borrowers. It is regulated by the Farm Credit Administration and consists of four banks (AgriBank, CoBank, Farm Credit Bank of Texas, and Farm Credit Services of America) and 67 regional credit associations. **Figure 14** shows the four banks' territories[24] and **Figure 15** shows the regional credit associations of AgriBank, the main Farm Credit Bank in the Great Lakes Region.[25]

Farm Credit Banks are cooperative institutions that were designed to meet the credit needs of farmers, ranchers, rural cooperatives, and others who are eligible to borrow from the system. The four Farm Credit Banks are cooperatively owned by the regional associations and other borrower-owned cooperatives. The Farm Credit System is also responsible for developing and executing federal laws related to farming, forestry, and food.[26]

[23] (Farm Credit System, 2023)
[24] (Farm Credit Administration, 2022)
[25] (AgriBank, 2023)
[26] (Farm Credit System Funding Corporation, 2023)

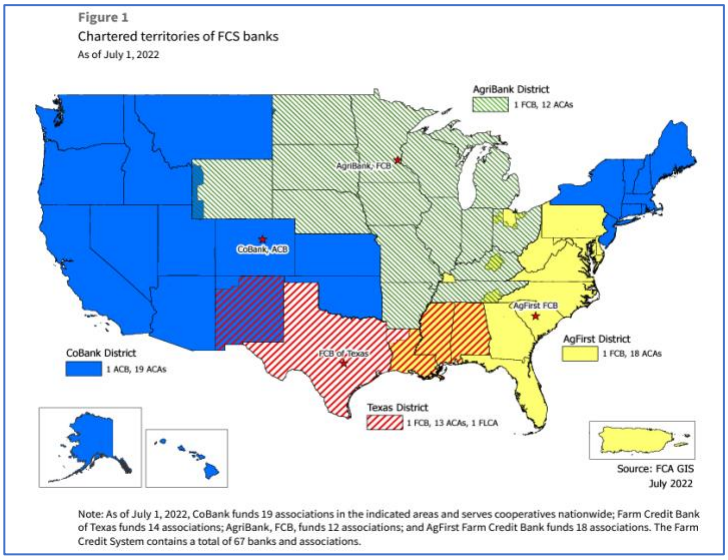


Figure 13 National Farm Credit System

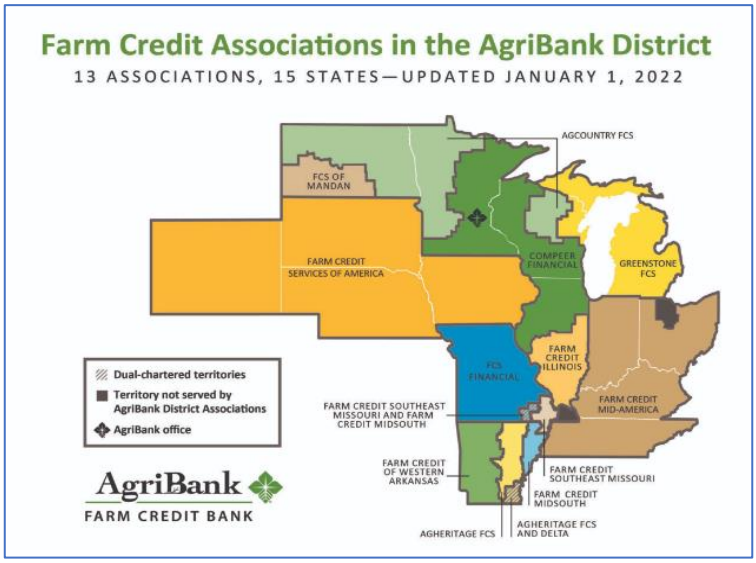


Figure 14 AgriBank Farm Credit Bank Midwest Territories

OTHER GOVERNMENT-SPONSORED LENDERS

The USDA Rural Development offers loans and grants to farmers and rural communities. USDA Farm services agency is a lender of last resort because it makes direct farm ownership and operating loans to family-sized farms that are unable to obtain credit elsewhere. In addition, Farmer Mac is another privately held government-sponsored entity that provides a secondary market for agricultural loans by reselling these loans to private investors. Farmer Mac held $25.9 billion in loans outstanding as of 2022.

SUSTAINABILITY LINKED LOANS

A sustainability-linked bond is a type of bond where the terms of the borrowing are based on the issuer's ability to achieve certain sustainability or ESG (environmental, social, and governance) metrics within a specified timeframe. Essentially, the issuer promises to improve its sustainability performance and can benefit from discounted interest rates on the bond as a result. However, if the issuer fails to meet these sustainability goals, there will be a penalty in the form of higher interest rates paid to investors. This type of bond provides a performance-based incentive for companies to improve their sustainability practices, as well as a financial benefit for doing so.

Sustainability-linked loans offer a way to incentivize farmers and financial institutions to adopt sustainable agricultural practices. The market size and viability of these loans can be seen through the $500 conversion of Bermuda sovereign debt to sustainability-linked debt, which resulted in estimated savings of 30-50 basis points. However, concerns about greenwashing may limit adoption, and the success of these loans depends on having verifiable ESG metrics. Compliance and reporting regulations, such as TCFD, can help establish a link between interest rates and sustainable practices by creating material, verifiable measurements of ESG metrics. Sustainability-linked loans differ from green bonds by connecting interest payments to sustainability or ESG metrics rather than being 'use of proceeds' bonds.

The number of sustainability-linked bonds has grown exponentially in recent years, from $4.3 billion in 2019 to $28.4 billion in 2021. However, sustainability-linked bonds are relatively new in the agricultural

sector. Two nascent examples of such loans in the agricultural sector are the FBN Regenerative Agriculture Finance Fund and the Indigo & Farmer Mac Sustainable Agriculture Incentive Program.

The FBN Regenerative Agriculture Finance Fund is a joint initiative between Farmers Business Network (FBN) and the Environmental Defense Fund (EDF), launched on January 11, 2022. This innovative financing program rewards farmers who meet soil health and nitrogen efficiency standards with access to lower rates and fees, as well as agronomic insights to optimize the on-farm benefits of regenerative practices. The $25 million pilot fund currently enrolls 30-40 farmers growing a combination of corn, soybeans, and/or wheat, who will each receive one-year lines of credit of up to $5 million. The RAFF aims to originate loans from a diverse group of farmers and provide underwriting and monitoring for the portfolio at a discounted rate.[27]

The Indigo & Farmer Mac Sustainable Agriculture Incentive Program is a collaborative effort between Indigo Ag, a leading sustainability partner in the agriculture industry, and the Federal Agricultural Mortgage Corporation (Farmer Mac), the nation's secondary market for increasing the accessibility of financing for American agriculture and rural infrastructure. Announced on March 28, 2023, the program offers interest rate rebate payments to participating U.S. farmers with eligible Farmer Mac farm mortgages for performing sustainable practices and providing annual agronomic data. Farmers who are accepted into this sustainable farming program will be eligible to access a three-year 0.25% interest rate rebate payment on the principal balance of qualifying Farmer Mac farm mortgages. This joint program aims to support and accelerate sustainable practice adoption by offering growers multiple incentives for sustainable farming practices.[28]

CARBON CREDITS

Carbon credits are an emerging opportunity for farmers to earn extra income by adopting sustainable farming practices such as those earlier in this report. Among common sustainable practices, no-till farming has the lowest breakeven price, making it an attractive option for farmers. However, establishing standardized frameworks by regulatory bodies is a challenge, and project-specific concerns such as permanence, additionality, and leakage need to be addressed.

While farmers are excited about the new revenue opportunity and the potential to improve soil health, reduce expenses, and increase crop resilience, they also have concerns. The complex contract terms, record-keeping requirements, and additional workload in the fall can be daunting for farmers. Additionally, data verification charges and the inability to commit to long-term contracts are also concerns. Some farmers are uncomfortable with the level of data required to make the marketplace transparent and valid, which may limit participation. Further, participating in carbon credit programs also requires a long-term commitment, typically ranging from 5 to 10 years, which can be a challenge for farmers who may be hesitant to commit to such a long-term arrangement.

[27] (Environmental Defense Fund, 2022)
[28] (Indigo Ag, 2023)

Despite the challenges, carbon credits offer a promising avenue for farmers to benefit from sustainable practices while contributing to carbon sequestration. The potential benefits of carbon credits, including additional income to farmers through the sale of carbon credits, make it an avenue worth exploring for farmers interested in adopting sustainable farming practices. Although the current carbon credit market is somewhat limited, considerable growth opportunities lie ahead. Projections suggest that the total carbon credits market could reach $50 billion by 2030. Soil carbon is expected to constitute approximately 10% of this market, which translates to $5 billion.[29]

GOVERNMENT INCENTIVES

FARM BILL CONSERVATION PROGRAMS

Historically, the bulk of funding available for farmers to adopt conservation practices at the field level has been made available through the Farm Bill, a large Congressional funding vehicle last authorized in 2018. The Farm Bill traditionally funds three key working lands programs: the Conservation Reserve Program (CRP), the Environmental Quality Incentives Program (EQIP), and the Conservation Stewardship Program (CSP). According to the American Farm Bureau, these programs made up "7% of the $428 billion 2018 farm bill…about $29.96 billion over the bill's five-year life span."[30]

Farmers who wish to take advantage of the nearly $6 billion in conservation support annually must apply through state-level administrators of the USDA's Natural Resource Conservation Service (NRCS). Each program has diverse application and eligibility requirements and variable funds available at the state level, meaning that available conservation funding is highly individual **(Figure 15).**

	IRA Incentives	USDA NRCS Conservation Programs	Example State Level Incentives
Cover Crops	$25/acre, up to 1,000 acres	EQIP: variable $ by watershed CSP: $350 per resource concern per year, with stringent requirements	MD: $60 - $80/acre Chesapeake bay IN: $5/acre crop insurance discount
Conservation Tillage	*Increased funding for EQIP/CSP. No direct incentives offered.*	EQIP: variable $	SD: Conservation Tillage loans
Edge of Field Practices	*Increased funding for EQIP/CSP. No direct incentives offered.*	EQIP: variable $ WREP: wetland development grants	MN: buffer requirement NE: buffer incentive program

Figure 15 Sampling of Government Incentives Available for Sustainable Practice Adoption

[29] (McKinsey, 2021)
[30] (Myers, 2023)

INFLATION REDUCTION ACT

In addition to annual conservation program funding made available through the Farm Bill, U.S. agriculture has seen an influx of additional funding through the Inflation Reduction Act (IRA) authorized by Congress in 2022. In total, the bill contains $20 billion in funding for sustainable agriculture initiatives, providing a mix of new funding for existing USDA conservation programs as well as new direct incentives. Most notably, the IRA includes a provision for direct-to-farmer incentive payments for the planting of cover crops, paying $25 per acre up to 1,000 acres for cover crops planted through the 2026 crop year. It also includes incentive measures for non-operating landowners.[31]

FINANCIAL DISCLOSURE AND REGULATION

TCFD[32]

The Task Force on Climate-related Financial Disclosures (TCFD) is an initiative established in 2015 by the Financial Stability Board (FSB) to encourage companies and financial institutions to disclose their climate-related risks and opportunities in their financial reporting. TCFD was created in response to the increasing recognition that climate change poses a significant threat to global financial stability.

Figure 16 Taskforce for Climate-Related Financial Disclosures Framework

The TCFD's key recommendation is for companies and financial institutions to disclose their climate-related risks and opportunities in four areas: governance, strategy, risk management, and metrics and targets. This information can help investors, lenders, and insurers make informed decisions about allocating capital, and help companies better manage risks and opportunities related to climate change.

Since the TCFD was established, it has gained significant momentum, with support from regulators, investors, and companies around the world. In 2017, the TCFD released its final recommendations, which have been endorsed by over 1,500 organizations, including major financial institutions and companies as noted in **Appendix A.** In some countries, regulators are now requiring companies to disclose their climate-related risks and opportunities in their financial reporting. For example, the European Union has introduced regulations that require large companies and financial institutions to disclose their climate-related risks and opportunities in their annual reports. Similarly, in the United Kingdom, the Financial Conduct Authority has introduced new disclosure requirements for listed companies and asset managers.

[31] (Cover Crop Strategies, 2022)
[32] (TCFD, 2023)

US TCFD LANDSCAPE

The Securities and Exchange Commission (SEC) is expected to propose an upcoming rule that would require public companies to provide additional climate-related disclosure. The framework of the proposed rule is similar to or based on the recommendations of TCFD. However, recent reporting from the Center for American Progress reveals skepticism that companies will voluntarily initiate a reporting system for agriculture. [33] The proposed rule would only apply to large companies with at least $75 million in equity shares available to the public and requires disclosure of Scope 3 emissions only if they are significant or if the company has made a commitment to reduce them. Furthermore, the rule provides a special safe harbor to reduce legal liability in case of improper calculations. Recent reports suggest that the SEC could scale back or eliminate Scope 3 emissions reporting requirements.[34]

RELATED VOLUNTARY FRAMEWORKS

There are several voluntary frameworks that have emerged in recent years aimed at guiding organizations toward more sustainable and responsible business practices. Many global corporations already publish data related to their climate risk through these initiatives, which can be considered potential existing data sources for TCFD-compliant reporting:

- **Science-Based Targets Initiative (SBTi):**[35] The SBTI is a collaboration between several organizations, including the United Nations Global Compact, CDP, World Resources Institute, and WWF, that helps set science-based targets to reduce their greenhouse gas emissions and limit global warming to well below 2°C above pre-industrial levels. SBTI provides companies with a framework for setting targets and measuring progress aligned with the latest climate science.
- **Climate Disclosure Project (CDP):**[36] CDP is a non-profit organization that has become the most widely used disclosure system for investors, companies, and municipal and federal governments to report and disclose environmental and climate impacts. CDP is often referred to as the "gold standard" of climate and environmental disclosure and reporting.
- **Net Zero Asset Managers Initiative:**[37] The Net Zero Asset Managers Initiative is a collaboration between asset managers around the world who are committed to achieving net-zero greenhouse gas emissions by 2050. The initiative provides a framework for asset managers to develop and implement strategies for reducing the carbon footprint of their investments.
- **United Nations Environment Programme Finance Initiative** [38] The UNEPFI is a partnership between the United Nations Environment Programme and the global financial sector. It aims to promote sustainable finance and responsible investment practices. The initiative provides a

[33] (Center for American Progress, 2022)
[34] (National Law Review, 2023)
[35] (Science-Based Targets Initiative, n.d.)
[36] (CDP, n.d.)
[37] (Net Zero Asset Managers, n.d.):
[38] (United Nations Environment Programme Finance Initiative, n.d.)

platform for collaboration between financial institutions, governments, and other stakeholders to develop sustainable finance strategies and practices.

CLIMATE DISCLOSURE & TECHNOLOGY

New technology innovations are providing increasingly sophisticated tools for monitoring, verification, and reporting (MRV). Because TCFD and similar frameworks require data on Scope 1, 2, and 3 emissions, there is increasing demand to streamline data collection and disclosure, including:

- **Climate Data Collection:** Increasingly available physical technology such as weather stations, satellites, and remote sensors can be used to collect and analyze climate data and help companies assess exposure to climate-related risks and opportunities.
- **Scenario Analysis:** Software can be used to run climate scenario analysis to assess the impact of various climate-related scenarios on a company's operations and financial performance.
- **Risk Management:** Similarly, technology can be used to manage climate-related risks by providing tools for risk assessment, monitoring, and mitigation. This can help companies reduce their exposure to climate-related risks and improve their resilience.
- **Reporting:** Reporting and verification platforms such as Triangle System's AssetOS can be used to streamline and automate reporting processes and ensure that TCFD disclosures are accurate, complete, and timely.

OTHER KEY STAKEHOLDERS

While farmers receive financing and support from institutions like Farm Credit and private banks, they are also supported significantly through the physical agricultural supply chain, both their downstream customers as well as their upstream input providers **(Figure 17).** Though they are not central to the work of the MAP team, these stakeholders are key influencers of farming decision making, as well as key recipients of farmer data and climate financial disclosure reporting.

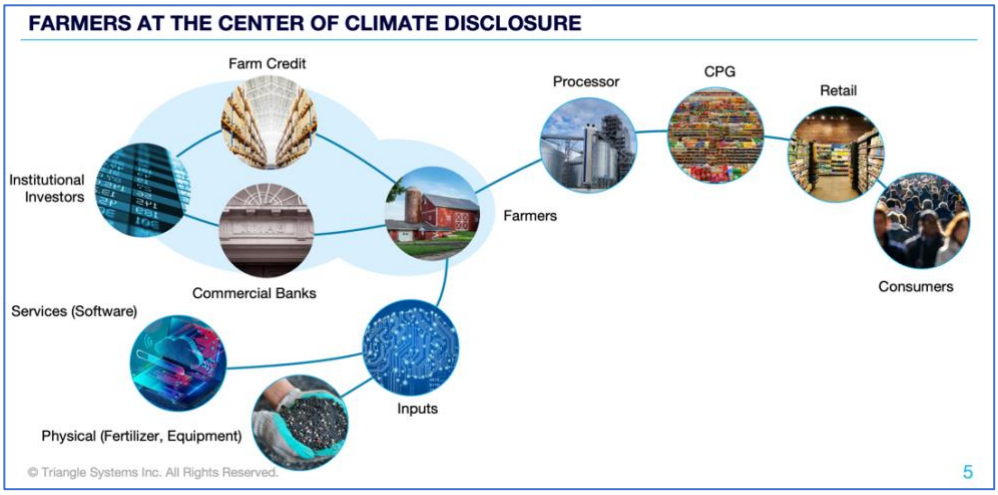


Figure 17 Farmers and the Physical and Financial Supply Chain

THE PHYSICAL SUPPLY CHAIN

Downstream customers of farmers include grain processors and aggregators, ingredient manufacturers, consumer processed goods (CPG) companies, retailers, and ultimately day-to-day food, fuel, and textile consumers. Farm-level emissions are relevant to these stakeholders as part of their Scope 3 supply chain emissions accounting. In this lens, the data that are sought after and relevant to the physical supply chain are often the same as what would be used for climate disclosure by financial institutions, making large companies such as CPG and retailers key partners in incentivizing sustainability-linked financial mechanisms. Furthermore, launching sustainability-linked financial instruments alleviates pressure on large food companies such as Walmart or Kellogg to fund on-farm sustainable agriculture initiatives purely as part of their own private sustainability initiatives.

Awareness and interest in connecting the physical supply chain with the financial supply chain for sustainability initiatives is growing. For example, at least 15 major U.S. food and agriculture companies have signed on as TCFD supporters **(Figure 18),** while many others are reporting on voluntary climate financial disclosure frameworks such as CPD and SBTI. Similarly, many of these companies are joining cross-sector, pre-competitive sustainability initiatives such as Field to Market: The Alliance for Sustainable Agriculture and the U.S. Farmers and Ranchers in Action, which are explored in further detail later in the report.

Figure 18 Food and Agriculture TCFD Supporters

TECHNOLOGY AND INPUT PROVIDERS

Technology and input providers are essential partners in incentivizing sustainable agricultural practices. Farmers collaborate with a variety of technology and input providers, with those most relevant to the GLR including:

- **Input providers such as fertilizer companies, seed companies, and ag retailers** provide farmers with chemical and biological inputs to boost crop growth and yield and protect against pests. These companies have a vested interest in continuing high sales through the application of

nitrogen fertilizers and other chemical products, but they are also trusted advisers who could be mobilized to help partner with farmers on frameworks which can temper fertilizer application.[39]

- **Agricultural technology companies** offer a range of products and services such as precision agriculture, drone mapping, and IoT sensors. The next section of this report examines that software adoption remains low among farmers, making this industry a nascent but emerging opportunity to partner with farmers on sustainability.
- **Financial technology companies** provide farmers with digital platforms and tools to access financial services such as loans, insurance, and payment solutions. While adoption of digital farm record keeping remains low as examined later in this report, fintech platforms are a promising opportunity to help farmers manage their finances and evaluate the financial feasibility of adopting new sustainable agriculture practices.
- **Equipment dealers** have traditionally sold farming equipment, such as tractors, combines, and planters, and are increasingly involved in the integration of software services into equipment. Equipment dealers are promising partners in increasing operational efficiency and sustainability.
- **Other trusted advisers such as agriculture extension** provide farmers with technical advice and support on farming practices, crop management, and market information. These individuals are the most trusted and effective conservation experts across the country and are key partners in incentivizing new technological and practice adoption. [40]

Technology and input providers can help monitor and verify the effectiveness of sustainability practices, ensuring transparency and credibility in promoting environmentally friendly agriculture. They are also key partners to interested stakeholders in both the physical and financial supply chains who are seeking farm-level data to manage climate-related disclosure and reporting and ensure regulatory compliance.

RECOMMENDATIONS

STAKEHOLDER MESSAGING AND ENGAGEMENT

Creating sustainability-linked financial products which meet the reporting requirements of global and national standards such as TCFD will require linking a complex web of identified stakeholders through robust and transparent data sharing. As part of their MAP engagement with TS, the MAP team identified key risks, opportunities, and messages which can be leveraged to meet the needs of farmers and financial stakeholders in developing and implementing these types of products.

KEY MESSAGES FOR FARMERS

The MAP team identified the following four recommended messages when approaching farmers with sustainability-linked financing options:

1) **Connect the dots** between sustainability, financial planning, and farm record keeping.

[39] (Sustainable Agriculture Research and Education (SARE), 2022)
[40] (USDA, 2019)

2) **Streamline and simplify** data collection from existing sources.
3) **Offer blended support** that integrates financial incentives, social science, and technical assistance.
4) **Deliver products through trusted advisers,** and don't recreate the wheel of farmer communication.

The MAP team developed these recommendations after researching key risks and opportunities in their research, both through existing farmer survey data as well as stakeholder interviews. For example, prominent agricultural media company Farm Journal's Trust in Food initiative has conducted three recent national farmer surveys showcasing perspectives on data sharing and sustainability initiatives.

DATA RISK: FARMER PRIVACY

Data privacy is a key concern for farmers. Survey results from 2021 show "65% [of farmer respondents] said their customers do not have a right to know how the crop was produced, " and that the large majority of respondents don't trust either private companies or the government with their data. [41]

DATA OPPORTUNITY: MARKET INCENTIVIZATION

While farmers share real concerns with sharing data beyond the farm gate, they also respond that they are significantly more willing to share data when offer financial or market incentives to do so. For example, 65% of surveyed farmers indicate an interest in receiving lower financial rates from an institution through collecting and sharing on-farm data **(Figure 19).** Similarly, nearly half (49%) of Iowa farmers in a 2021 survey conducted by the Environmental Defense Fund and partners reported that they would be interested in a program that offered below-market interest rates for sustainability practices.[42]

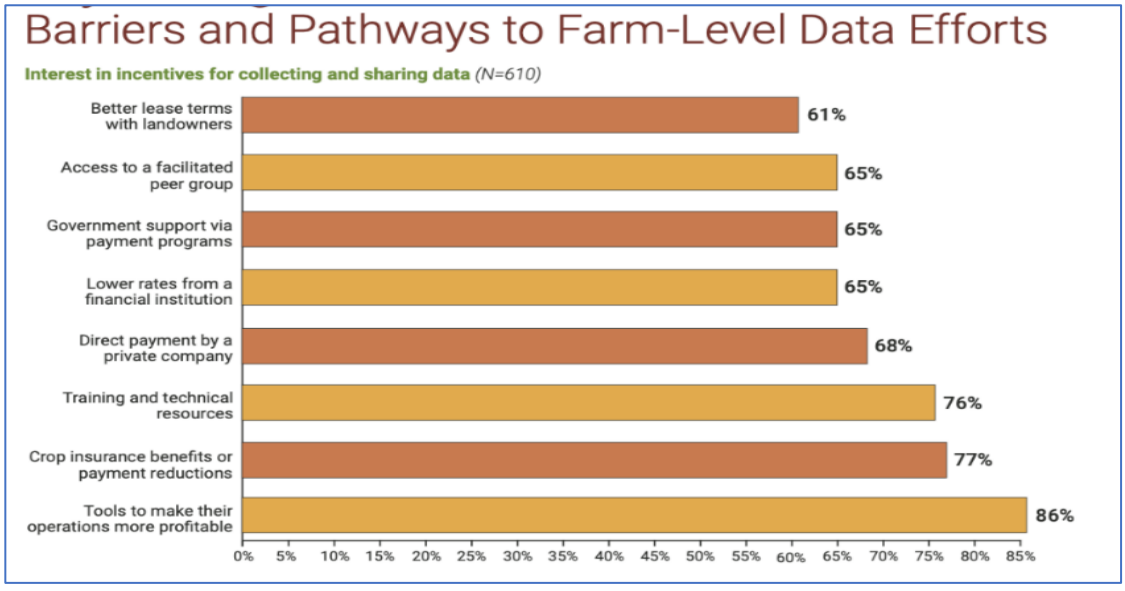


Figure 19 National Survey Shows Farmers are Open to Data Sharing For Financial Return

[41] (Slattery, Rayburn, Slay, & and Garcia-Moore, 2021)
[42] (Monast, Gauthier, Fishbein, Weaver, & Richmond, 2021) (Monast, Gauthier, Fishbein, Weaver, & Richmond, 2021)

DIGITAL RISK: DIGITAL RECORD KEEPING

In addition to concerns about data privacy, there is also a logistical concern due to the lack of existing digital record-keeping and infrastructure on the farm. In one survey, "more than half of all respondents (62%) said they don't rely on Farm Management Information Systems (FMIS) exclusively. Almost a third of respondents (28%) said their primary data storage method is paper or other non-digitized method." In addition, nearly half of farmers (44%) responded that "poor data network was a barrier to collecting digital data."[43]

> "Outside the sustainability umbrella, it is notable that challenges in recordkeeping are endemic across ag systems, even where records are a matter of market access or price premiums. This barrier cannot be underestimated."
>
> *Farm Journal's Trust in Food Initiative*

DIGITAL OPPORTUNITY: STREAMLINED RECORD KEEPING

Financial institutions, as well as supply chain actors, are actively seeking data from farms in order to comply with voluntary or regulatory climate disclosure requirements. There are real opportunities to streamline and automate data collection for multiple stakeholders from existing sources. For example, the existing required financial tax document Form F discloses the amount of fertilizer purchased by a given operation in a year, which could be used to model applied nitrogen for climate disclosure purposes by a bank during a loan approval process. Similarly, farmers are increasingly adopting Farm Management Software (FMS) such as John Deere's Operations Center, Truterra Insight Engines, and FarmLogs, which contain both agronomic data fields and sustainability metrics. While it will require significant industry coordination, there are opportunities to reduce data entry burdens on already skeptical farmers.

FINANCE RISK: LINKING SUSTAINABILITY AND FINANCE

Many farmers report that sustainability and farm profitability are not linked in their minds, with two-thirds of farmers reporting they "have never calculated the economic benefit(s) provided by adopting conservation agriculture practices." [44]

[43] (Slattery, Rayburn, Slay, & and Garcia-Moore, 2021)
[44] (Slattery D. , et al., 2022)

FINANCE OPPORTUNITY: LEVERAGING TRUSTED FINANCIAL ADVISERS

A notable opportunity within this space is that farmers consider their financial lenders to be among key trusted advisers. For example, while the vast majority of farmers do not trust private companies with their data, 71% trust their lenders with this data **(Figure 20).** [49]

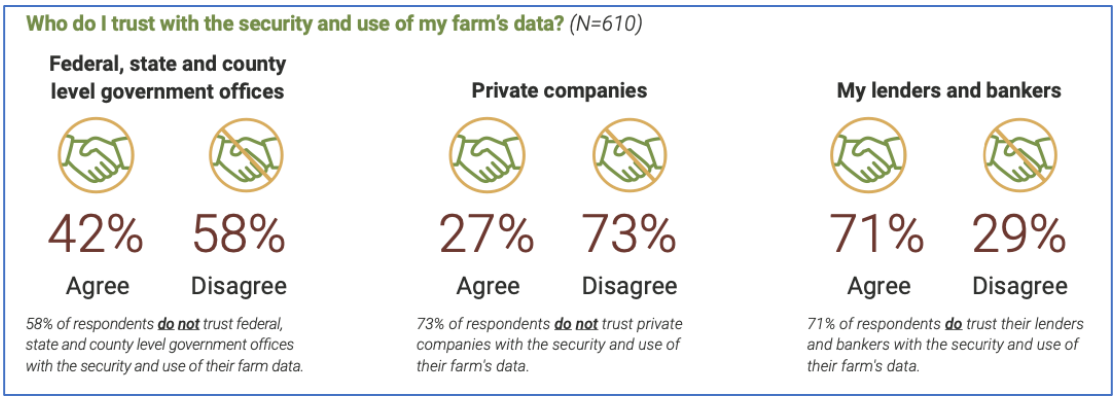


Figure 20 Farmer Trust in Data Sharing

KEY MESSAGES FOR FINANCIAL SECTOR

The MAP team identified the following recommended messages for Triangle Systems to leverage in approaching financial institutions with products for the agricultural sector:

1) **Agriculture is primed for sustainable transition,** but collecting Scope 3 emissions data from farmers comes with unique cultural and logistical barriers that need to be overcome
2) **Asset managers can access data from a blend of verification technologies**, including in-field sensors, satellite data, and environmental models, to overcome data gaps and meet reporting requirements.
3) **Financial institutions should pilot new products through existing public and private sustainability initiatives.** Utilizing existing partners and sources of data will lower barriers to farmer recruitment, engagement, and data collection.

Similar to the farmer analysis, the MAP team identified several risks and opportunities for financial stakeholders while conducting informational interviews.

MEASUREMENT RISK: OUTCOMES VS PRACTICES

A common theme that emerged in informational interviews was a tension between verifying outcomes and encouraging practices. For example, in order to comply with Scope 1, 2, and 3 emissions reporting requirements for TCFD, financial institutions are primarily concerned with measurable and verifiable outcomes such as direct GHG emissions. However, due to the significant difficulties outlined above in directly measuring outcomes on the farm level, agricultural stakeholders often focus on a practice-first approach. From this lens, NGOs and farm advisers focus on the uptake of science-backed practices such as cover crops or edge of field practices across agricultural acres.

> "Goldman Sachs doesn't want to evaluate the practices that farmers are adopting on their farms. **Capital markets only care about outcomes."**
>
> *Jack Roswell, Perennial*

MEASUREMENT OPPORTUNITY: DIVERSE MEASUREMENT, REPORTING, AND VERIFICATION (MRV) SOLUTIONS

Financial institutions may need to increase their flexibility of measurement, reporting, and verification when it comes to the agricultural industry. Unlike verifying the climate profile of assets such as solar panels, it may be years or decades before there is widespread adoption of on-farm sensor technologies that allow for real-time emissions or runoff verification. However, there are opportunities to source TCFD-compliant data through a diverse MRV toolkit. This may include existing data sources such as farmer tax returns, in-field measurement techniques where they have been adopted, remote and satellite sensing, and finally environmental modeling to fill in apparent data gaps.

SUPPLY CHAIN RISK: LACK OF SUPPLY CHAIN TRANSPARENCY

The supply chain actors described above are seeking climate disclosure data just like financial institutions. However, agricultural supply chains (particularly those involving commodity crops) are long and opaque and lack traceability and transparency into the physical properties of grain passed through a commodity system.

SUPPLY CHAIN OPPORTUNITY: INCREASED INDUSTRY AWARENESS

While this presents a significant barrier both in terms of robust data collection, there is an emerging opportunity due to the increased interest in both the financial and physical supply chains that serve farmers. With 14 U.S. food and agriculture companies signed on as TCFD supporters, and many others reporting on complementary voluntary frameworks such as SBTI, CPD, and more, financial institutions should seek opportunities to collaborate with supply chain actors in search of transparent and robust farm-level data collection.

MARKET RISK: COMPETING MARKET FORCES

Currently, farmers make agronomic decisions based on market economics and government subsidies. In short, they follow the money when deciding what and how to grow. Currently, these incentives and subsidies are not well aligned with emerging investor priorities in sustainability.

MARKET OPPORTUNITY: STACKED CAPITAL AND INCENTIVES

Bolstered by regulatory tailwinds such as an emerging SEC ruling on climate financial disclosure as well as increased funding from the Inflation Reduction Act, capital markets may soon be able to leverage a stacked capital model that works in better tandem with government incentives.

PRIORITIZATION ROADMAP

Through its research, the MAP team discovered that influential industry coalitions are convening major corporations including banks and CPGs to investigate and pilot sustainable finance solutions. As a first priority for Triangle Systems in integrating into the agricultural sector, the MAP team recommends that TS should explore joining one of the following cross-sector initiatives **(Figure 21)**. These groups are actively convening on pilots and partnerships that can better align financial, technological, and agricultural stakeholders to incentivize sustainable agriculture.

- Field to Market: The Alliance for Sustainable Agriculture
- Good Food Finance Network
- U.S. Farmers and Ranchers in Action

Figure 21 Sustainable Agriculture Finance Industry Initiatives

For further details on key contacts and recommended partners, please refer to **Appendix A: Stakeholder List.**

SUSTAINABILITY-LINKED LOAN PRODUCT

RECOMMENDATIONS

The MAP team created a financial model to calculate the incentive stack for a farmer based on subsidies, interest savings from a basis-point reduction in a sustainability-linked loan, and the impact of conservation practices. Based on this model, it is clear that large farms are the most likely to adopt a sustainability-linked loan application. For this reason, the MAP team recommends the following targeting strategy for these products:

1. **Target large farms**
2. **Leverage government subsidies and carbon markets** to optimize bps discount of **cover cropping and reduced tillage**

EXAMPLE APPLICATIONS

To examine these recommendations, we have explored a few example applications of the financial model. The model inputs are farm size, the conservation practice implemented (cover crop, reduced tillage, no-tillage, edge of field, and crop rotation), the maturity of the loan, and a high, low, and base case for practice performance.

The financial model uses a discount rate of 4.57%, which is the discount rate for the Farm Credit System bank, AgriBank, based on the IRS Section 2032A.—Valuation of Certain Farm, Etc., Real Property, Rev. Rul. 2022-16. The average maturity of a farm credit system loan is 3 years. Subsidy information is taken from conservation payments in the 2018 Farm Bill for cover crop and tillage practices in the NRCS working lands programs. The average loan size is calculated based on the USDA's annual report, *Farms and Land in Farms*.

The model calculates the subsidy payments that a farmer can receive for a given conservation practice. It further calculates the interest savings from a basis-point reduction in a sustainability-linked loan. The model assumes that the loan amount is equal to the cost of implementing the conservation practice, plus any existing debt the farmer had outstanding. The interest rate reduction is assumed to be 54 basis points.[45]

[45] (Hsien, Chung, & Adriaens, 2023)

Figure 22: Net Present Value to farm on a per-acreage basis of implementing various conservation practices with a sustainability-linked loan

	Medium Farm (1,200 acres)			Large Farm (2,000 acres)		
	Cover Cropping	Conservation Tillage	No-Till	Cover Cropping	Conservation Tillage	No-Till
Loan Value	$ 4	$ 6	$ 6	$ 26	$ 27	$ 27
Practice Value	$ 26	$ 4	$ 4	$ 26	$ 42	$ 42
Subsidy Value	$ 193	$ 65	$ 55	$ 193	$ 65	$ 55
Total Value	$ 224	$ 75	$ 65	$ 246	$ 135	$ 125

Assumptions: 3-year sustainability-linked loan with 54 basis-point reduction on interest payments for implementing the practice.

The financial model results show that the incentive stack for a farmer varies depending on the conservation practice type, farm size, loan maturity, and practice performance. Cover crop and reduced tillage practices provide the highest incentive stack for farmers, while edge-of-field and crop rotation practices provide the lowest incentive stack. There are greater benefits from an interest-rate reduction to a larger farmer than a smaller farmer. Finally, for most farmers, the largest share of the incentive stack will be from subsidies.

Figure 23: Net Present Value per acre of a basis-point reduction for medium and large farms

	Basis Point Reduction		
	54 Points	100 Points	150 Points
Medium Farm (1,200 acres)	$ 6	$ 10	$ 15
Large Farm (2,000 acres)	$ 27	$ 50	$ 76

Assumptions: Farms obtain a 3-year sustainability-linked loan to purchase conservation tillage equipment.

INCENTIVE STACKING

The incentive stacking model is a way of combining various financial incentives to create a larger pool of funding for farmers who are transitioning to sustainable agriculture practices. These include sustainability-linked loans, carbon credits, and government incentives. Today's market reality for farmers shows that the majority of financing available comes from government incentives, largely from the USDA Conservation Program, and is bolstered through additional temporary incentives in the Inflation Reduction Act. Currently, sustainability-linked loans offer up to $125,000, based on a single piloted product from Farmers Business Network and Environmental Defense Fund. Carbon credits, estimated at $45 million, are an emerging market with limited uptake. This is based on 11 carbon credit programs. Government incentives for sustainable agriculture are estimated at $10 billion annually, with programs from the USDA and the Inflation Reduction Act **(Figure 24).**

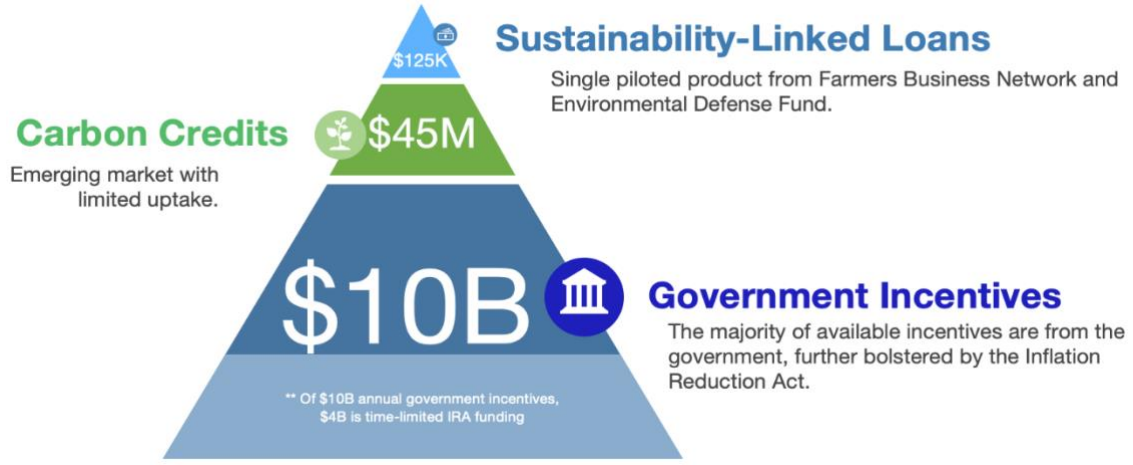


Figure 24 Current State of Sustainable Agriculture Incentive Mechanisms

However, after introducing sustainability-linked loans, the incentive stack can be larger and more balanced **(Figure 25).** For example, carbon credits can be estimated at $5 billion annually, based on research by S&P Global. Government incentives are estimated to be $6 billion from the USDA Conservation Program, as IRA incentives are phased out.

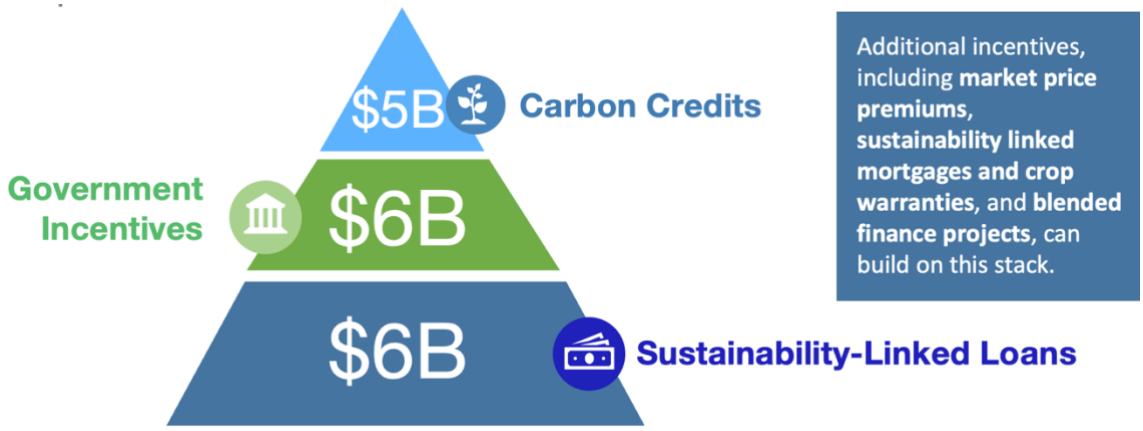


Figure 25 Ideal Future State of Sustainable Agriculture Incentive

Overall, the incentive stacking model aims to create a more comprehensive approach to financing sustainable agriculture by combining various incentives to create a more significant pool of funding. This model can help incentivize farmers to transition to sustainable practices and create a more sustainable future for agriculture.

INNOVATIVE FINANCING MODELS FOR SMALL AND DIVERSE FARMS

The MAP team's sustainable-linked loan model creates a recommendation to target large farms. However, in order to address the issues of inclusion and discrimination affecting Black farmers and other

marginalized groups in agriculture, it is essential to explore innovative financial instruments that can provide more equitable access to funding and resources, for example:

- **Flexible Asset Financing:** Flexible asset financing offers an alternative to traditional agricultural loans by providing banks with the opportunity to offer agri-loans, such as Pace Loans. These loans enable farmers to have ownership and equity in their farming operations while spreading the costs over time. This approach can help marginalized farmers overcome financial barriers, as it allows for manageable repayment schedules and may reduce the impact of discriminatory lending practices.
- **Cashflow-based Models:** Cashflow-based models focus on revenue-based repayment, which allows farmers to repay loans according to their actual income rather than on a fixed schedule. This flexible plan can better accommodate the fluctuations inherent in agricultural production and reduce the burden on farmers during low-income periods, making financing more accessible to marginalized farmers.
- **Group Financing:** Group financing encourages joint equipment purchases by farmer collectives, which can help distribute costs and support smaller farms. This collaborative approach can reduce the financial burden on individual farmers, making it more feasible for marginalized farmers to access necessary resources. Additionally, group financing can foster collaboration and knowledge sharing among farmers, leading to improved farming practices.
- **Subscription Services:** Subscription services offer equipment leasing options, which can help farmers reduce upfront costs and make necessary investments in their operations. This model provides scalability and seasonal flexibility, allowing farmers to access equipment when needed without incurring the full cost of ownership. Subscription services can be particularly beneficial for marginalized farmers, who may struggle to afford large capital investments.

By implementing these innovative financial instruments, the agriculture industry can work towards a more inclusive and sustainable future. These models have the potential to break down barriers to entry and help marginalized farmers access resources and opportunities. It is essential that policymakers, financial institutions, and other stakeholders work together to promote and implement these financing models in order to address the systemic discrimination and challenges faced by Black farmers and other underrepresented groups in agriculture.

DATA INTEGRATION AND IOT

This report has explored conservation practices that farmers are implementing to address key environmental concerns in the GLR. Increasingly, farmers are using IoT devices and sensors to make informed decisions about resource use and inputs, resulting in more efficient use of resources and reduced waste. In the GLR, the global agricultural sensor market was valued at USD 4.74 billion in 2021 with the expectation to reach USD 16.83 billion by 2023.[46] According to the UDSA, between 1998 and 2013 guidance systems had the highest adoption rate of identified technologies **(Figure 26),** used in

[46] (Straits Research, 2022)

about half of planted acres for crops like corn, rice, and peanuts. However, GPS soil mapping and variable-rate input applications lagged, with adoption rates under 25% of planted acres.[47]

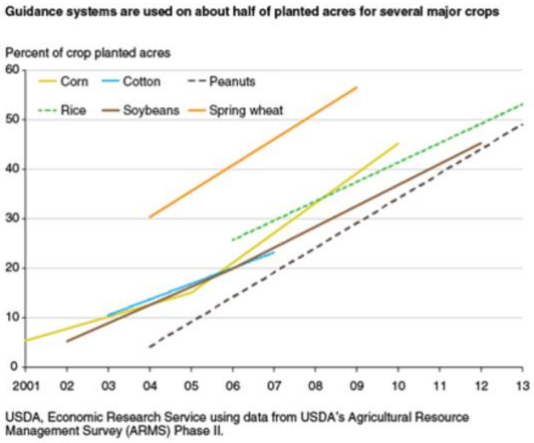


Figure 26 Adoption of Guidance Systems

Within the last decade, barriers to adoption have been reduced due to technological advancement and reduction in upfront cost. Farmers can use sensors and IoT devices to monitor crop parameters in real time, allowing them to detect and respond to issues like pests, diseases, and nutrient deficiencies promptly. This results in improved crop health, higher yields, and reduced crop loss due to weather-related events. IoT devices are also used to optimize water use, fertilizer, and pesticide inputs, resulting in more precise and efficient resource use, reduced waste, and compliance with water use regulations. Sensors and IoT devices have the potential to automate many farm tasks, reducing the need for manual labor and leading to lower labor costs and increased efficiency **(Figure 27).** This could be especially beneficial for small and medium-sized farms in the region that may struggle to attract and retain labor, though consideration is needed to examine the upfront costs and ROI as the technology market continues to mature.

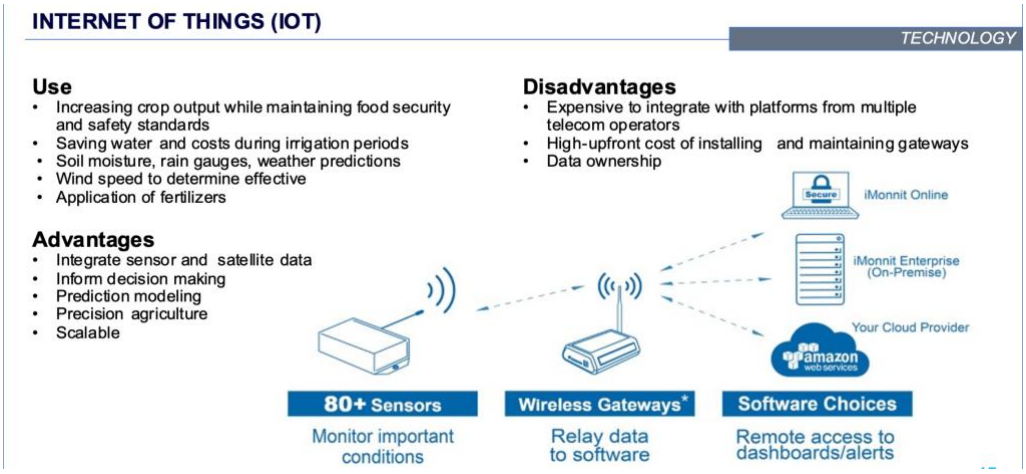


Figure 27 IoT Applications For Agriculture

[47] (Economic Research Service, USDA, 2016)

INTEGRATION WITH ASSETOS

This report has explored the emerging market linking environmental sustainability at the farm level with a need to disclose and report on farm-level outcomes by both the physical and financial supply chain. In order to fully leverage emerging monitoring and IoT technologies, these supply chains will need to rely on a streamlined MRV solution that can integrate available data into TCFD-compliant climate disclosure reports. The MAP team sees tremendous potential for Triangle System's AssetOS to meet this emerging market demand for the agriculture sector.

First, AssetOS should leverage diverse monitoring technologies and connect to existing third-party data sources to streamline data collection of TCFD-compliant Scope 1, 2, and 3 emissions data. Some of the key data sources that AssetOS can leverage include:

- **Primary Data Sources**
    - Form F (Money Spent on Fertilizers)
    - IOT Sensors & Devices (Fertilizer Usage)
    - Farm Management Software (Crop Type & Yield)
- **Secondary Data Sources**
    - Satellite Imagery (Carbon Sequestration)
    - National & Regional Agriculture Databases (Farm Size)

As a Big Data platform, AssetOS can organize these data points and deliver key metrics to stakeholders across the agriculture supply chain including, but not limited to, carbon market project developers, asset managers, farm credit institutions, CPG and retailers, and government. The flow of data through AssetOS is further explored in **Appendix C: TCFD Reporting Requirement Template.**

FURTHER RECOMMENDED RESEARCH

This MAP team engagement is the first phase of a multi-year research grant, funded jointly by the Great Lakes Protection Fund (GLPF) and the Foundation for Food and Agriculture Research (FFAR), and involving Triangle Systems, the University of Michigan, and several other partners. At the conclusion of seven weeks of research, the MAP team recommends future research including:

- **Integrate research conducted by School for Environment and Sustainability (SEAS) student team** linking nitrogen runoff to carbon within the Great Lakes Region
- **Incorporate additional factors relevant to on-farm financial decision making into basis point reduction models**, including:
    - Depreciation of equipment and other assets into financial decision making on farm
    - Diversified revenue streams such as solar assets, and new technology landscapes including smart and electrified equipment
    - Farming practices relevant to livestock management and animal agriculture

- **Explore confounding social variables that are relevant to the uptake of sustainable agriculture**, including:
    - Quantifying the social cost of harm of agricultural runoff into the Great Lakes region
    - Researching the unique needs and historical discrimination against Black farmers, Tribal nations, new and beginning farmers, and other marginalized farm groups
    - Incorporating unique considerations for farmers that rent land, farmers that own land, and non-operating landlords

  Monitor and integrate upcoming regulatory rulings by the SEC into findings

APPENDICES

APPENDIX A: STAKEHOLDER LIST

List of key stakeholders involved in sustainable linked financing initiatives (link)

APPENDIX B: INSTITUTIONAL INVESTOR LIST

List of investors in farm credit bonds (link)

List of investors in sustainability-linked bonds (link)

Note: Bank investors exclude custodian accounts

APPENDIX C: TCFD REPORTING REQUIREMENT TEMPLATE

The MAP team created an Excel template that lists all the stakeholders involved in the agriculture industry and their TCFD reporting requirements across the four TCFD pillars: Governance, Strategy, Risk Management, and Metrics & Targets (link)

APPENDIX D: SUSTAINABILITY-LINKED LOAN MODEL

The MAP team developed a model to estimate the financial incentive available to farmers through sustainable agriculture practices. The components of the incentive stack include a basis-point reduction on interest payments from debt, the financial implications of implementing the sustainable practice, and financial payments from government incentives.

Excel Model

APPENDIX E: INFORMATIONAL INTERVIEW SUMMARIES

The MAP team carried out comprehensive interviews with a diverse range of stakeholders, the insightful perspectives of which have been compiled and presented below.

Link to all informational interview summaries

- Banks
  - Mike Ruddock – First Interstate Bank
- Ag Tech
  - Jack Roswell – Perennial
- Ag Research
  - Michelle Selzer – Michigan Dept. Of Ag
  - Jeremiah Asher – MSU Institute of Water Research
- Policy/Think Tanks
  - Eric Finns / Clinton Britt – Grove Climate Group

    - Patrick Doran – The Nature Conservancy
- Investors
    - Max Lulavy – Alliance Bernstein
    - Richard Fontes – State Street

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