OCTOBER 2026

PRICING IN RESILIENCE:

The Future of Financial Services for Soil Health

How agricultural finance, markets, and policy can unlock productive soils and a more resilient future.



TIFS
TRANSFORMATIONAL INVESTING IN FOOD SYSTEMS
TRIANGLE
UNIVERSITY OF MICHIGAN

CONTENTS

Executive Summary 4
by Dr. Peter Adriaens, Professor, Engineering, Entrepreneurship & Finance. The Center for Digital Asset Finance at the University of Michigan.

Overview 7
Integrated Soil-Centered Ag Finance And Reporting Innovations 7
Innovations Listed in Report 8

Contributors 9
Researchers 9
Reviewers 9
Organizations 10

Introduction 12
Building the Bridge Across the Missing Middle 12
Missing Middle of Finance, Data and Infrastructure 13
Financial Innovations Unfolding Now 15

Part 1: The Compliance Wall for Companies 16
Five Forces Driving Structural Carbon Demand 17

Part 2: The Financial Innovations Enabling the Largest Re-Pricing of Risk in Recent History 21
1. Scope 3: Enhanced Digital Measurement, Reporting, and Verification (D-MRV) with Visibility for Global Investors and Regulatory Requirements for the Global Commodity Markets 23
2. Biofuels: 45Z and Carbon Intensity Scoring 25
3. Crop Insurance and the Centering of Soil Health for Risk and Premium Reduction 26
4. AI Field Practices and Environmental Credits 28
5. Insurance-Backed Environmental Credits: Enabling Collateralization 29
6. The Carbon Warrant: Regulated Credit Instruments in Environmental Assets 30
7. The Higher Yield Baseline: Ag Credit Underwriting and Lowering the Cost of Capital on Soil Centered Farms 33

Conclusion - The Market Maturity and Capital Transition Leading to a Major Re-Write in Risk Pricing 35

References 39



EXECUTIVE SUMMARY

By Dr. Peter Adriaens, Professor and Director, University of Michigan. Center for Digital Asset Finance.

For more than 20 years, capital has supported regenerative agriculture through Farm Bill subsidies for operations and insurance, philanthropy, and voluntary carbon credits. With an eye on exploding US debt, the subsidy practice is not sustainable. Soil-centered subsidies reach a fraction of farmers due to funding limitations, administratively burdensome rules, limited staff capacity and technical assistance, and lack of farmer interest in inflexible government programs. While this has gone on, the continued market practice of using synthetic fertilizer alongside tilling programs has created a long-term decay of carbon in soils, and the resilience and longevity they represent. The goal of the food industry writ large is to deliver a constant supply of cheap food, which forces agriculture to focus on yield maximization on every acre, resulting in a depletion of our soils and groundwater. In a world where climate risks are increasing, past practices have led to a severe decline in resilience and increased exposure to shocks, as we experienced during the pandemic. At the same time, input costs are squeezing farm profitability and putting farm loans at risk of default. In short, the aspirational shift to help de-risk corporate agricultural supply chains through regenerative practices was funded by expensive public dollars, when we should have been building a centralized and regulated commodity market.

While all of this has happened, regenerative agriculture has gained significant momentum globally, and as its practices become more accepted, the underlying economic framework for evaluation has started to change. Instead of "what's your yield (revenue)," the conversation with leading farmers has shifted to "what's your profitability," a shift born of necessity as much as conviction. That means reducing input costs by reducing tillage, precision nutrient application, using cover crops for weed suppression, or providing biological inputs that improve soil health, enhance nutrient cycling, and increase carbon sequestration.

For years, carbon markets have been out of reach for many farmers: unrealized, illiquid, volatile, and priced for buyers looking to offset their own emissions, not for the farmer who bears the financial burden of building soil carbon and takes on the transition risk. Banks have not built the risk pricing of their loans on actuarial systems that account for soil-health risk mitigation, nor have they valued the attribution opportunity (the link between the investment and the intended result) that carbon storage offers. The message from farmers is clear: they are not financially appreciated for what they do to help address the problems of others downstream in the supply chain, let alone for building their own farms' resilience to flood, drought, and the other shocks that climate volatility brings.

The next decade of agricultural repositioning, while accounting for climate and nature risk and water quality/quantity impacts, won't be won with grants or subsidies alone. It will need to be delivered through a capital market solution, inside the lending structure. Every farmer in America negotiates credit every year. Very few apply for a conservation grant or create an environmental attribute on a carbon registry. The opportunity lies not only in financing the transition, but also in capturing the operational gains, including lower input costs, improved resilience, and more stable yields, that strengthen farm profitability.

EXECUTIVE SUMMARY

This is an unrealized capital distribution channel that can be built to reach every acre in the country. A channel that can re-price a loan and its profitability against verified outcomes on a cycle that matches how farms operate. Innovations such as carbon warrants (linked to commercial and farm credit loans and bond instruments), soil-centered crop insurance, and more, have the potential to turn the on-farm economic environmental performance into lower cost of capital, with the upside split between farmers and lenders. A new model can do two things: 1) align the incentive along the money flows: the financial value chain from bond markets to banks to farmers, and 2) let food and supply chain companies focus on what they do instead of trying to solve the problem with grant and incentive programs that are sub-scale for the problem.

The old model didn't solve the counterparty risk during regenerative transitions between the lender and the farmer, and climate volatility has only sharpened those risks. Under a traditional format, the transition years are the most uncertain on a farm balance sheet; equipment costs and a potential yield dip hit up front, the payoff may take several growing seasons, and the farmer is left carrying that risk.

A credit-based financial instrument that addresses transition risk from both sides at once ensures that the farmer gets paid, through yield stabilization, cost reduction, and environmental credit creation, during the transition, not after it. The lender gets a borrower whose soil, income, resilience and default risk are all improving in lockstep, thus de-risking the operations and the loan with today's underappreciated assets — carbon credits and soil nutritional improvements. Insurers, water utilities, and downstream buyers all have stakes in the same outcome. They look to move from the current subsidy stack to a flywheel of yield stabilization, environmental co-benefits, and a shift towards higher farm profitability. We demonstrate some of these flywheel elements in Part Two of this report.

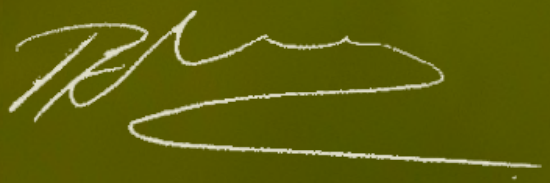
The old playbook no longer works; there is a need to transition financing along with advances in agricultural practices. The instruments and discussion in this report, including loan discounts priced on verified regeneration, carbon rights split at origination, and risk transferred to the balance sheets built to price those risks, are key components of a market that does not require re-funding every budget cycle and renegotiation under shifts in policy priorities. Grants and philanthropy still matter as the first-loss capital to get this off the ground, but not as the permanent operating model.

The argument this report posits is aligned with the principles of a future where soil health risk and resilience is priced in, and that we are at the inflection and breakthrough moment where this is occurring. Regenerative transitions at scale need to be financed the way other major industrial shifts have been financed, i.e., through conditioned capital markets (capital that is only available when certain conditions are met) that generate velocity. This implies perpetual risk-adjusted refinancing and repricing as regenerative processes and practices improve, yields stabilize, and adoption across counties, farm credit service areas, and types of farm commodities scales.

EXECUTIVE SUMMARY

What makes this moment different is that the infrastructure to do this is being built. Central banks and international standard-setting bodies are actively collaborating to build interoperable infrastructures, harmonize digital asset rules, and deploy unified ledgers for the next generation of digital finance. Advances in digital finance may be able to catalyze something no earlier instrument has been able to achieve: improving liquidity to investors, risk underwriters, and farmers alike. Combining the soil health movement alongside the financial innovation that is maturing in real time has the potential to stimulate an acceleration of capital velocity (i.e., how quickly capital is deployed, generates value and returns, and is redeployed) that will positively improve regenerative agriculture lending practices, loan repricing, and carbon markets liquidity. With the right governance structures, stakeholder engagement, and market structures in place, these developments may benefit farm balance sheets and deliver financial incentives that catalyze the shift to regenerative practices at scale.

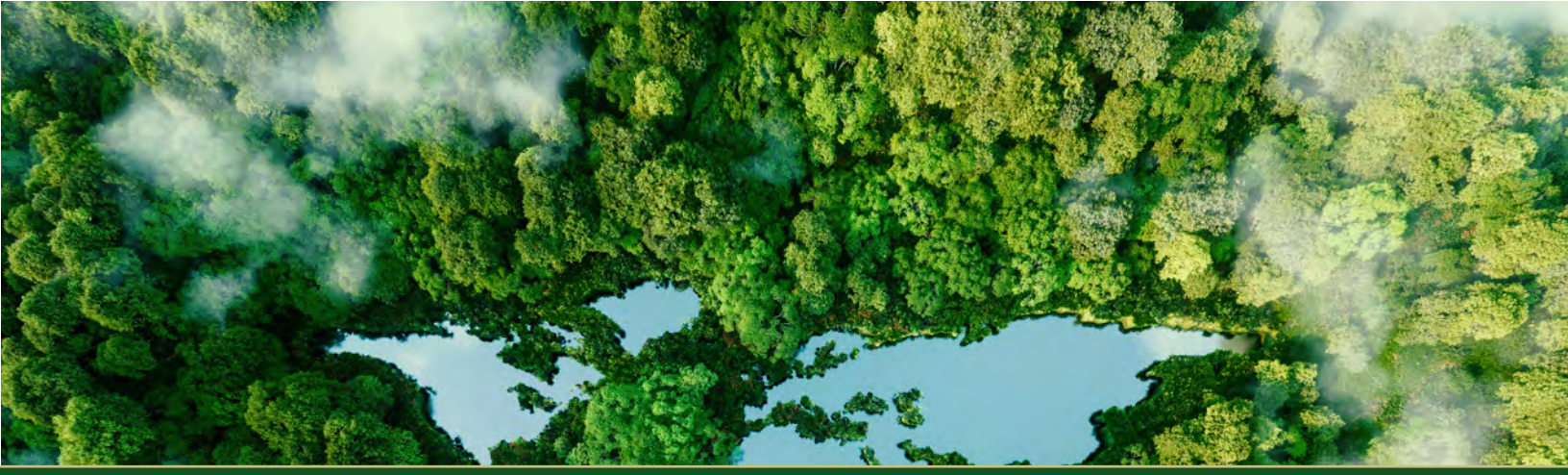
We are living through a moment of profound change for the foundational elements of capital in agriculture, digital finance, and the repricing of risk, similar to the changes that resulted from the creation of the Chicago Board of Trade in the 1840s which marked a significant development in the trading of commodities and laid the foundation for future exchanges or the passage of the 1933/1934 Securities Act, which established the Securities and Exchange Commission (SEC). This report articulates a pathway for financial capital to move the agricultural transition from an aspiration we fund (push') into a market we build (pull').



INTEGRATED SOIL-CENTERED AG FINANCE AND REPORTING INNOVATIONS



Read together, the innovations described in this paper form a systems framework linking soil health, agricultural practice, finance, insurance, carbon markets, and corporate reporting. The graphic above maps how these tools work together to recognize, measure, finance, insure, and ultimately increase the value of soil health practices.



THE INNOVATIONS THAT ARE DESCRIBED IN THIS REPORT INCLUDE:

1. Enhanced Scope 3 measurement, reporting, and verification: using improved digital systems to measure and verify agricultural emissions and outcomes.
2. Biofuels, 45Z and carbon-intensity scoring: connecting soil and farm practices to carbon-intensity scores and commodity markets.
3. Soil-centered crop insurance: developing insurance products that incorporate soil health and nitrogen management.
4. AI field practices and ecosystem-services validation: using technology to validate farm practices and ecosystem-service outcomes.
5. Insurance-backed environmental credits: using insurance mechanisms to create more reliable, investable ecosystem-service products.
6. Carbon warrants and regulated credit instruments for environmental credits: developing financial instruments around verified ecosystem-service value.
7. Higher-yield baseline credit underwriting: using improved productivity and risk information to support agricultural credit and potentially reduce financing costs.

These innovations together build on the evidence that soil health is an underlying economic asset and source of financial value. The innovations are situated within regulatory and market developments that make it possible for soil-health practices to become the foundation for a new integrated financial and reporting ecosystem.

One of the primary barriers to growth of regenerative systems has been missing confidence that regenerative financing will fit financiers' current risk and reward standards. This paper is demonstrating why we are at a conversion moment across both soil and financial systems as it relates to financial innovations.

CONTRIBUTORS



Dr. Peter Adriaens
Professor and Director
University of Michigan Center for Digital Asset Finance



Andrew Greeley
Managing Director, Finance & Operations
Triangle Digital



Lis Huang
PhD Candidate
University of Michigan



Tina Owens
Regenerative Agriculture Systems & Investment
TIFS

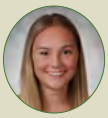


Rex Raimond
Director
TIFS



Darren Wolfberg
Co-Founder, Chairman, & CEO
Triangle Digital

RESEARCHERS



Amalie Stoker
Research Intern
TIFS



Laura Thompson
Communications & Partnerships
TIFS

THANK YOU TO OUR REVIEWERS



David Bennell
Managing Director of Investor Relations
TIFS



Tim Crosby
Principal
Thread Fund



Mary Fales
Director
US Agriculture, Winrock International



Jean Rogers, PhD
Founder and former CEO, SASB;
Senior Operating Advisor, Riverstone Earth LLC



Travis Stewart
SME Expert
Aon's Agriculture Resilience Center



Michael Tiboris
Agriculture and Policy Director
River Alliance of Wisconsin

This document is published by Transformational Investing in Food Systems (TIFS) for informational purposes only and does not constitute an offer or solicitation to buy or sell any security, financial instrument, or other asset, nor investment, legal, tax, or accounting advice. Descriptions of pending legislation, regulatory guidance, and projected figures are forward-looking and subject to change; actual outcomes may differ materially. TIFS, Triangle Digital, University of Michigan and their contributors make no warranty as to the accuracy or completeness of this information and disclaim liability for reliance on it. All trademarks and third-party content referenced herein belongs to their respective owners; readers should consult their own advisors before acting on this document.

© 2026 TIFS Inc. (Transformational Investing in Food Systems). All rights reserved. No part of this document may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of TIFS or as otherwise allowed by applicable copyright law.

ORGANIZATIONS

TRANSFORMATIONAL INVESTING IN FOOD SYSTEMS

Since 2020, TIFS (Transformational Investing in Food Systems) has operated as a catalyst to put systemic investing strategies and financial innovations into action. We equip leaders, institutions, and intermediaries to bridge capital, producers, and markets in addressing the Missing Middle of data, finance, and infrastructure for regenerative agriculture and food systems.

RALIC

RALIC (Resilience in Agriculture Lending & Insurance Coalition) is an initiative developed by TIFS that brings together state conservation districts, state Departments of Agriculture, insurance companies, farmer coalitions, and other stakeholders. Running from 2025 to 2028, the initiative aims to promote a significant transformation in private insurance systems for crop insurance, focusing on soil-centered practices and converting anecdotal information into formalized actuarial data. The resulting data will have broader implications for underwriting, supply chain risk analysis, institutional wealth management, and more.

TRIANGLE DIGITAL

Triangle is a financial infrastructure company for the resilience and transition economy. It brings technology, sustainability, and finance together to put environmental markets on rails, so they are faster, more transparent, more valuable with greater velocity.

Triangle helps companies and project developers turn data into trusted and regulated credits (ICVCM-aligned), part of modern finance that can be added to the balance sheet as prepaid inventory, added to funds, and held in custody by banks and used as collateral, for lending and structured products. Through these financial instruments, auditability, verifiability and digital MRV that uses real-time data, remote sensing, and automated analytics to improve asset quality. Structuring regulated financial pathways using modern finance to monetize environmental assets delivers value to participants, while also helping organizations scale and manage climate impact while meeting regulatory, investor, and buyer expectations.

THE UNIVERSITY OF MICHIGAN

The Center for Digital Asset Finance (CDAF) at the University of Michigan integrates smart infrastructure with data science, finance, and policy to solve modern financing challenges for public and societal infrastructure. Housed within the Department of Civil and Environmental Engineering, the center was founded in 2018 with seed funding from the blockchain company Ripple.



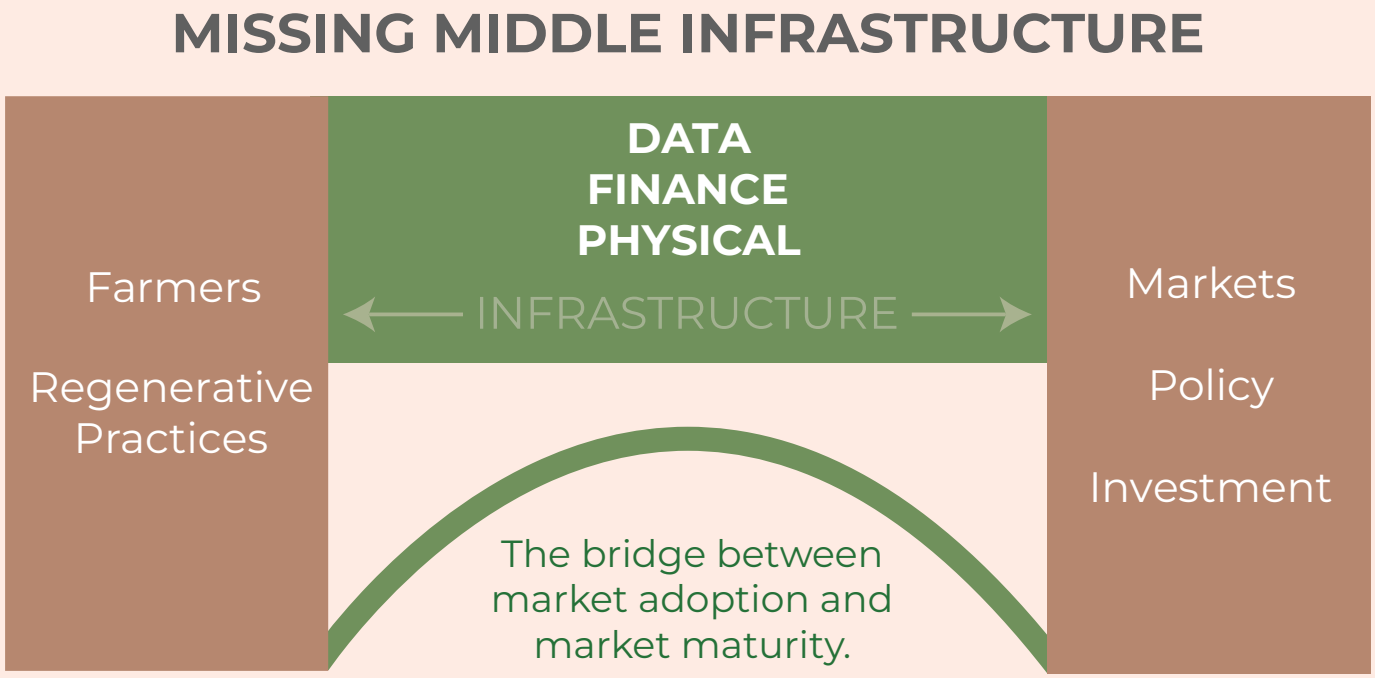
INTRODUCTION

Building the Bridge Across the Missing Middle

Enabling regenerative agriculture at scale requires a series of conditions that characterize a mature market. A market reaches financial maturity when three conditions converge. First, a legal and regulatory foundation exists that treats the asset class as investable. This requires clear jurisdiction, defined custody rules, and enforceable disclosure. Second, demand for the asset becomes structural rather than discretionary. In other words, buyers are compelled to participate by regulation, compliance, or contractual obligation, not merely personal inclination. Third, the financial instruments needed to price, collateralize, and trade the assets at scale exist and are in use. Readers should hold all three in view together: the fact that all three are arriving at once makes this a maturity moment rather than an incremental development.

This report is organized around key developments that are establishing those three market maturity conditions for environmental credits. Part One describes the legal foundation and traces the demand-side forces that are turning carbon and environmental credit purchases from discretionary to structural (the first two conditions). Part Two catalogs the instruments that make the asset class tradable, including crop insurance repricing, the carbon warrant, collateralized lending, and ag credit underwriting (the third condition). A market doesn't need every component perfected before capital can start moving; it needs the components improving together, predictably, with shared investment language. The regenerative movement should be aware of these developments and contemplate the positive and negative implications for the movement as the farm credit and investment capital shift their focus to include integration within agricultural finance.

The arrival of an important maturity moment for environmental credit markets has the potential to narrow the "Missing Middle," which is the gap between available capital and investable opportunities in Indigenous, agroecological, and regenerative food and soil health systems. These diversified systems are part of the long-term goal, rather than the first wave, because a bridge must be built between existing and future resilient systems. Today's gap sits between early-stage, grant-funded experimentation and the scale that attracts commercial or institutional investment. There is not a shortage of capital nor interest to facilitate a resilience transition: it is a failure of architecture and market signaling because the instruments, risk data, and intermediary capacity needed to channel that capital into regenerative systems do not yet exist at scale. However, the architecture and market signals are being developed in real time in the financial sector.





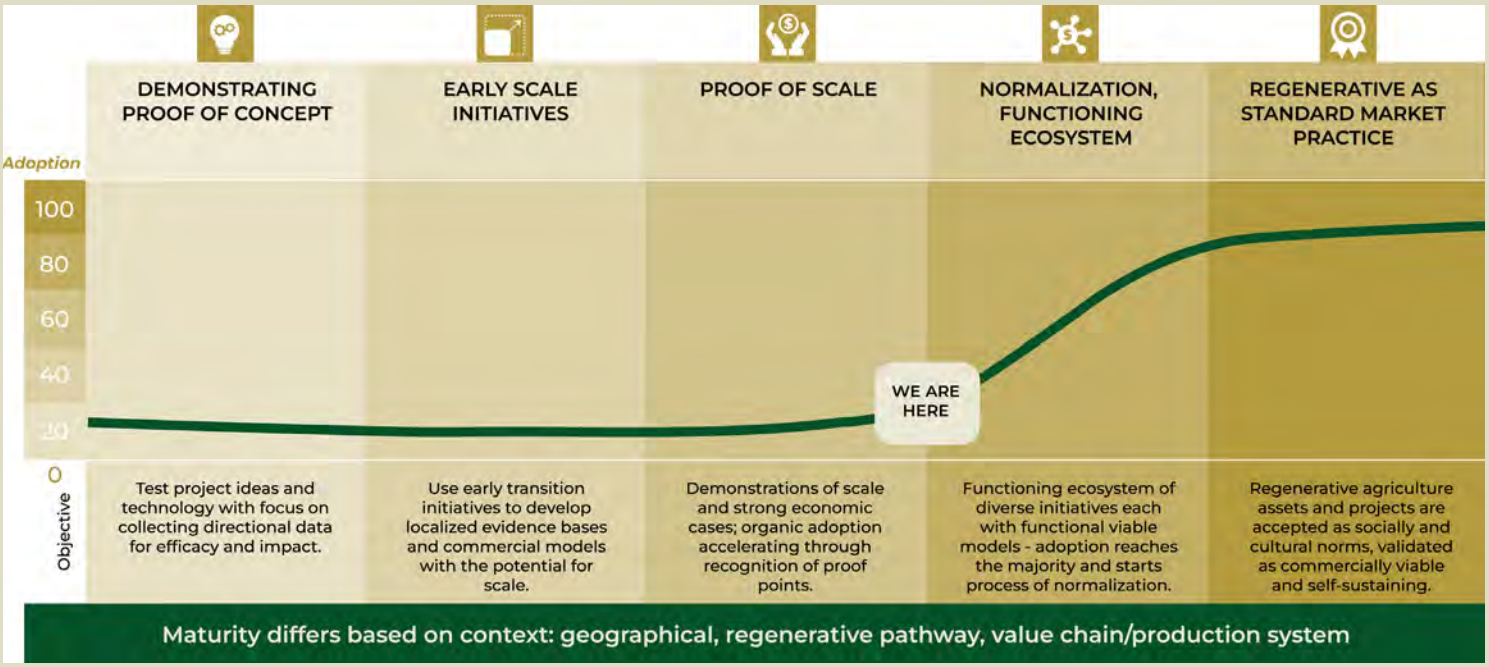
Missing Middle of Finance, Data and Infrastructure: A New Foundation for Ag Finance

Observers seldom recognize, in the moment, that they are witnessing historic transformation rather than the routine functioning of a relatively static system grounded in decades of accumulated data. Rarer still is the simultaneous reconstruction of financial market foundations, actuarial science, currency systems, and commodity markets. Yet the current trajectory of soil-centered systems has brought us to the next wave of innovation and market maturity: actuarial science development based on a foundation of peer-reviewed data and proven pilot outcomes.

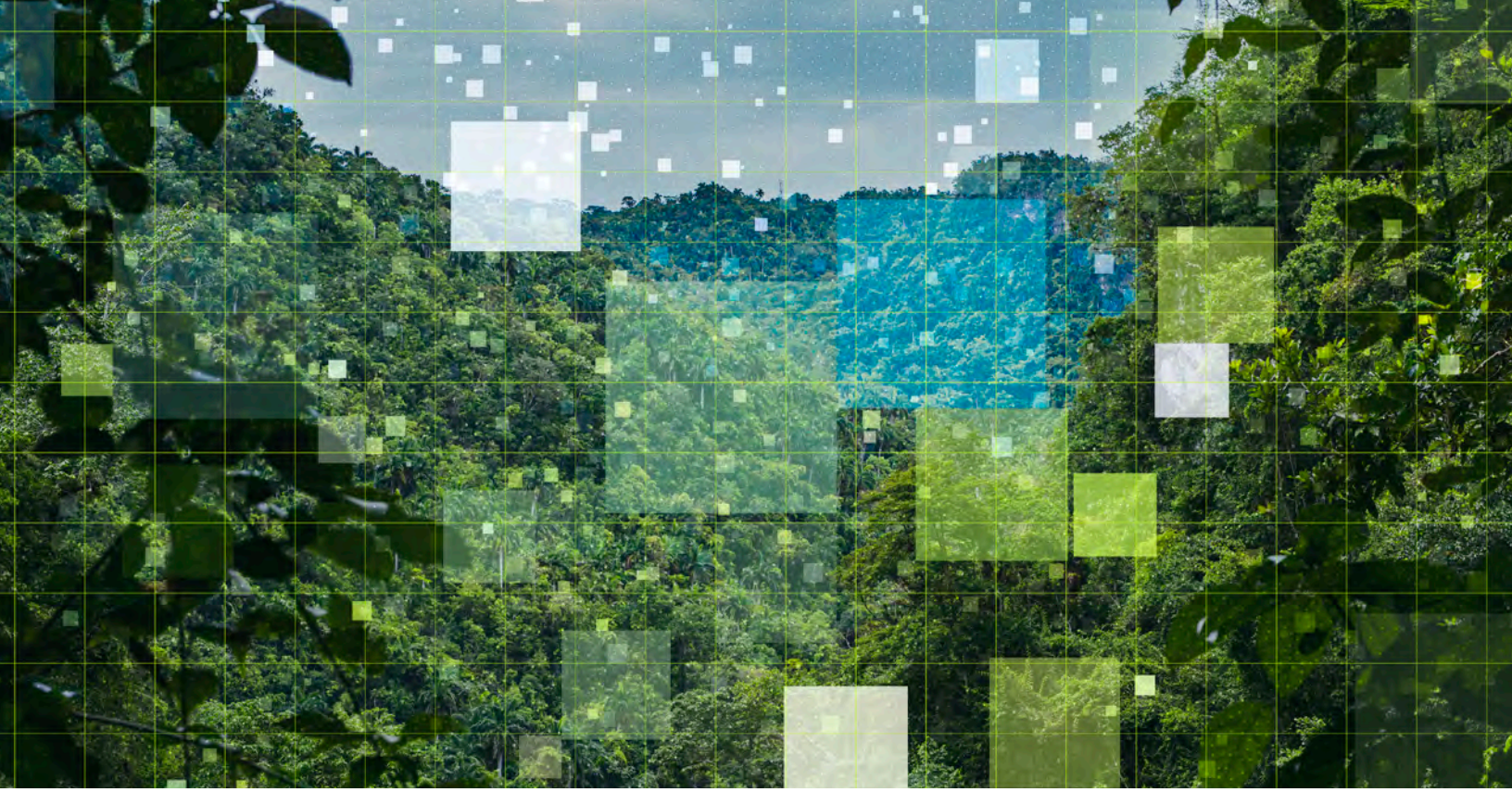
The regenerative agriculture and soil-centered movements have unfolded on the edges of the philanthropic, academic, and government-funded research and capital investment markets for more than a decade. The initial intention was to scale based on existing supply-and-demand dynamics: the premise that consumers would be incentivized to purchase a product based on a value proposition, or that farmers would be incentivized to adopt based on increased profitability. What emerged instead was a fragmented approach to on-farm conversion. Farmers grow rotations of crops, but commodity and production-system players source them through unique, segregated channels optimized for cost at scale, disconnected from one another and from the farm-level rotation they depend on. There is little incentive to break this dynamic when the immediate impact is adverse pricing, which in turn affects margin and profitability, especially for publicly traded companies.

Consumer-centric demand, designed to work from store shelves back to the farm, runs into a quagmire of missing middle elements: physical infrastructure, farmer financing needs, the case for a market premium, and the data systems that scaled, established commodity systems already have, but regenerative supply chains still lack. Meanwhile, corporate commitments on regenerative agriculture have shifted toward a specific focus on Scope 3 emissions reporting and Monitoring, Reporting, and Verification (MRV), or more narrowly, toward shoring up risk in singular high-exposure supply webs. As a result, farmers and mid-level processors are left to find their own way through critical financial services and complex reporting requirements, with little attention paid to the bigger picture: how farmers access whole-farm credit, insurance, and financial services in the first place.

The regenerative agriculture movement has built a chorus of reasons why focusing on soil health is the right thing to do. And yet the basic foundations that govern farmer decision-making — operating capital, insurance, risk reduction, and more — remain relegated to the realm of Farm Bill policy: always a few years away, and still not focused on this market-maturity moment for soil health adoption and enablement.



Reflecting on the state of the agriculture sector, global agrifood systems have been pushed to the limit, potentially past the point where certain core elements can self-correct and recover naturally. Industrial agriculture continues to cause damage that jeopardizes our food supply, irreparably harms biodiversity, threatens our water supply, and increases climate risk and is increasingly cited for negative health outcomes which further impacts the debt load to society and government. It is also increasingly associated with negative health outcomes, further shifting costs to society and government through increased healthcare, environmental remediation, and public assistance expenditures. That elevated risk translates into higher borrowing costs for farmers, annually rising insurance premiums, and more variable, less predictable yields, all of which feed into higher inflation, commodity price volatility, and diminished climate resilience. Left unchecked, this trajectory will erode food security, agricultural stability and, over time, turn food systems into a critical infrastructure concern, exposing countries to greater impacts from market, and geopolitical shocks.



Financial Innovations Unfolding Now (2026) and Beyond

In 2024 and 2025, a shift occurred in actuarial sciences used to measure existing and future risk. That shift has continued to build into both unique and interconnected sets of financial innovations that look like the data and capital deployment needs of institutional investors. These innovations take what was once relegated to the realm of conservation approaches and values-based agricultural production systems and convert the outcomes into market-based risk data, with clearer roles for regulators, investors, and commodity supply sheds.

WHY COMPANIES AND INVESTORS SHOULD CARE ABOUT NATURE

$44 trillion

Economic value generation dependent on nature

World Economic Forum

46% GDP

Global GDP coming from high-water risk regions by 2050

WWF Water Risk Factor

$10 trillion

Cumulative GDP loss from nature loss by 2025

WWF Global Futures

Overall, the threshold for adoption of deploying regenerative agriculture range between 15-25%, and based on recent adoption are creating as high as 120% ROI.

One of the primary barriers to growth of regenerative systems has been missing confidence that regenerative financing will fit financiers' current risk and reward standards. That gap is being addressed across integrated financial services, such as the carbon warrant (discussed in Part Two). In this paper, we provide investors and agricultural stakeholders from multiple disciplines a clear view of the **inter-related categories** of actuarial science, financial market activities, and institutional impacts of soil-centered financial innovations that are quickly unfolding into a future standardized marketplace.

PART 1

THE COMPLIANCE WALL FOR COMPANIES

Five converging forces are transforming carbon credit demand from discretionary to structural.

FIVE FORCES DRIVING STRUCTURAL CARBON DEMAND



Below we share non-exhaustive examples of how each of these five converging forces are creating a Wall of Compliance for companies. There are many other instances of in-place and unfolding compliance elements that could be listed in addition to these notable efforts.



Regulatory Demand

Regulation is reshaping corporate interest in carbon credits, especially for hard-to-abate emissions and Scope 3 exposure. The Task Force on Climate-related Financial Disclosures (TCFD), established by the Financial Stability Board in 2015, has evolved into IFRS/ISSB* standards now embedded in mandatory disclosure regimes covering roughly 55% of global GDP outside the United States, creating a significant demand signal. For any company with material emissions (Fortune 1k represent 53% of global GHG emissions), that obligation creates a direct line to the carbon market: a company that discloses a transition plan must show credible, measurable progress against it, and previously unreported carbon liabilities become visible to employees, investors, and communities, turning carbon exposure into an actively managed enterprise risk.

The EU's forthcoming Digital Product Passport (DPP) requirements extend this same logic to the product level. By embedding standardized environmental data into supply chains, DPPs will let companies identify, quantify, and communicate the emissions tied to specific products and materials, giving them the granular data needed to manage residual emissions with high-quality credits, and giving buyers a more reliable basis for evaluating credit quality against verified product data.

Standardization creates fungibility by making units of a good, an instrument, or a legal status interchangeable, so a buyer no longer needs to inspect or negotiate each one before trading it. The Chicago Board of Trade, established in the 1840s, solved this in the most literal sense: it graded corn and wheat into defined classes (No. 2 Yellow Corn, for example) so a futures contract written against that grade was identical regardless of which farm or elevator the grain actually came from. That physical fungibility is what lets a futures contract become a tradable instrument in its own right rather than a one-off bet

*International Financial Reporting Standards (IFRS) and International Sustainability Standards Board (ISSB)

on a specific shipment. Carbon credits are moving toward a similar mechanism of scalable asset delivery — standardized enough, once verified, to trade the same way regardless of which acre or project generated them.

The Securities Acts of 1933/34 couldn't make one company's stock fungible with another's — each security is still a distinct claim on a distinct business — so they standardized the informational envelope instead: uniform registration statements, and later 10-K/10-Q filings, gave every issuer a comparable disclosure format, letting investors price and compare risk across companies on equivalent terms even though the underlying assets weren't interchangeable. The later dematerialization of securities, and the resulting creation of the Depository Trust & Clearing Corporation (DTCC), was a similar innovation, paving the way for the asset velocity markets rely on today. Tokenization represents an asset's ownership and transfer digitally rather than on paper. Tokenization is opening a comparable new chapter for both public and private assets.

Pending U.S. digital-asset legislation reaches for a third, more abstract kind of fungibility, namely regulatory-categorical fungibility. By sorting tokens into defined buckets (security vs. digital commodity) and certifying blockchains as "mature," tokens that clear the same bucket face the same custody, disclosure, and trading rules. Unfolding legislative elements in the U.S. are targeting the same chokepoint: many banks, asset managers, and pension funds simply aren't permitted, under their own compliance and current market-operating and custody rules, to transact in or hold an asset whose legal status and venue registration are unresolved. A defined jurisdictional split and a registered-exchange category would let that capital treat tokenization the same way it already treats equities and commodities.

Each step up this ladder has taken longer and required heavier machinery, yielding more velocity for finance and operations to scale on a risk-adjusted basis. In every case, though, the sequencing is the same: fungibility, or its regulatory equivalent, must exist before institutional-scale capital can follow. For a farmer, the same fungibility that lets institutional capital hold a digital asset without bespoke due diligence also lets a carbon credit, a crop-insurance discount, and a loan-rate adjustment move as freely through the financial system as a bushel of graded corn.

U.S. regulatory frameworks and global regulatory demand are just beginning to pave the way towards both the ongoing compliance requirements and the standardization of environmental credits that institutional capital needs before they can move from a fragmented, project-by-project credit basis into a fungible, tradable asset class.



Voluntary Corporate Commitments

Corporate alignment with a 1.5°C pathway has become the de facto global standard for climate ambition. As of September 2026, nearly 12,000 companies have validated science-based targets through the Science Based Targets initiative (SBTi), with thousands more in the commitment pipeline. These commitments create structured, long-term demand, since SBTi-aligned companies must reduce their own emissions first and use credits only for residual emissions that cannot yet be abated. That same public commitment leaves companies exposed to greenwashing accusations, and several major corporations have paused credit purchases following scrutiny of offset quality. Companies are seeking to rebuild the trust infrastructure beneath voluntary markets: credits measured continuously by satellite and sensor, verified by unconflicted third parties, recorded immutably and independently rated, improve the quality of the offset. Most recently, SBTi Standard 2.0 adopted in June of 2026 states for the first time that residual emissions (Scope 3 that represent 70-90% of enterprise emissions) can use purchases to offset their footprint.

That update matters more than a single standard revision. It is the first time the world's dominant corporate climate framework has formally acknowledged that some emissions can't be eliminated on any near-term timeline, and that credits are a legitimate tool for the remainder. Because Scope 3 represents 70–90% of most companies' total footprint, opening it to residual-emissions credits doesn't just add a new category of demand, it validates credits against the largest, hardest-to-abate share of corporate emissions that voluntary markets exist to serve. The catch is that SBTi 2.0 only works as a

demand driver if the trust infrastructure described above is actually in place. A standard that greenlights offsetting for higher-integrity credits is also a standard that raises the bar for what counts as an offset. We address the need for a Carbon Warrant program in Part Two of this report.

For food and agriculture producers there are also mandatory reporting requirements that continue to escalate in scope between the world's largest food and ag companies and the downstream users of their product. Namely, grocery retailers. Some of the world's largest consumer-facing organizations have required the largest food companies to share water, greenhouse gas, and other Scope 3 emissions measurements for more than a decade, with new requirements being added as technology and standardized methods of reporting allow deeper insight into the risks associated with conventional agricultural production systems relative to supply chain disruption and an associated loss of sales revenue.



Trade and Tariff Demand

Beginning in 2026, the EU's Carbon Border Adjustment Mechanism (CBAM) will impose tangible pressure on carbon-intensive industries and their supply chains as the European Union (EU) moves to address carbon leakage, placing a mandatory carbon price, in line with the EU Emissions Trading System (ETS), on imports of steel, cement, aluminum, fertilizers, hydrogen, and electricity. As CBAM's scope expands, and as the UK, Japan, and Canada consider similar mechanisms, carbon intensity is becoming a trade variable: firms able to demonstrate low-carbon production gain a competitive advantage. In the U.S., the Foreign Pollution Fee Act frames a comparable carbon tariff as a geopolitical tool.

This level of reporting detail is set to become the standard in future global trade requirements. Commodities used for Sustainable Aviation Fuel (SAF) production in the United States have already begun to take notice, realizing that these requirements will stretch beyond SAF to the base commodity for any imported/exported use case, and that biofuel commodities are most likely to go first in compliance with global standards.



Compliance with Market Demand

Compliance markets are the most financially credible segment of the carbon ecosystem.

The EU Emissions Trading System (ETS), the world's largest carbon market, covers over 40% of EU greenhouse gas emissions and is undergoing its most ambitious reform to date, tightening its cap and, through the Carbon Removals and Carbon Farming Regulation (CRCF), building the architecture for eventual interface with certified removals. In North America, the linked cap-and-trade systems of California, Washington, New York, and Québec under the Western Climate Initiative form the most liquid compliance market outside Europe. What compliance markets offer, and voluntary markets currently cannot, is regulatory oversight and a government-enforced demand floor: institutional investors building positions in high-

quality voluntary credits today are positioning ahead of a demand profile that regulatory convergence could lift within their investment horizon.

Within the U.S., compliance markets have remained at the state or watershed level through nutrient trading regulations. Unlike voluntary carbon or biodiversity credits, which are driven by corporate sustainability commitments that companies can scale up or abandon at will, nutrient trading only exists because a regulator has set a hard limit and a permit holder must meet it.

Global compliance markets will create demands that other countries must rise to meet if they are to continue participating in export markets, but there are local benefits to both producers and permit holders in driving behavioral change at the sources of nutrient management.



Sovereign and Municipal Demand

Under Article 6.2 of the Paris Agreement, countries may transfer Internationally Transferred Mitigation Outcomes (ITMOs) to other nations for use toward Nationally Determined Contributions. For sovereign buyers, the integrity of underlying credits is a matter of diplomatic and legal consequence, requiring the highest available standard of data quality and independent verification. At the municipal level, New York City's Local Law 97, operative since 2024, imposes direct financial penalties — up to $268 per metric ton — on large buildings exceeding declining emissions limits, Cost of Equity, Cost of Debt (Green Premium – or greenium - matters for Farm Credit), and insurance premium, making high-quality, verified carbon credits/environmental assets a potential compliance tool for owners who can't get there through retrofits alone. At 60m MTs of emissions out of New York City, there is a tremendous opportunity for farmers that adopt regenerative agriculture practices in New York state to sell their carbon attributes to property owners and tenants in the city to meet and maintain their compliance.

A related dynamic: stacked incentives. The five forces above work on demand. A separate lever works on supply — making more projects financeable in the first place. Combining public incentives with private carbon-credit revenue can turn marginal decarbonization projects into ones that pencil out: federal tax incentives and voluntary credit sales are complementary revenue streams that, together, reduce financing risk, support lower-cost capital, and push projects that would otherwise fall short of investment thresholds over the bankability line. That stacking only works with rigorous safeguards — sound MRV, clear ownership of environmental attributes, and protection against double counting — but done right, it expands the pool of projects the market can actually finance.

PART 2

THE FINANCIAL INNOVATIONS ENABLING THE LARGEST RE-PRICING OF RISK IN RECENT HISTORY

Part 2: Financial Innovations

Part One demonstrated the global nature of regulatory compliance requirements. Part Two turns to what is becoming standardized and traded within these new and developing structures: environmental credits, contracts, collateral, and data that could fit the financial sector's interests in investing in, and sustaining, soil health-centered outcomes. Each section below builds toward fungibility, or its regulatory equivalent, sufficient to let institutional capital invest in soil health at volume and the systemic outcomes for the farm, agriculture, and financial sectors.

Integrated Soil-Centered Ag Finance & Reporting Innovations



01

SCOPE 3: ENHANCED DIGITAL MEASUREMENT, REPORTING, AND VERIFICATION



Scope 3: Enhanced Digital Measurement, Reporting, And Verification (D-Mrv) With Visibility For Global Investors And Regulatory Requirements For The Global Commodity Markets

The next generation of environmental markets requires an upgrade to the underlying information rails connecting physical assets, environmental outcomes, and financial markets. Enhanced digital measurement, reporting, and verification (D-MRV) integrates IoT devices, digital twins, AI, blockchain, information oracles, and other digital technologies to transform fragmented operational, economic, and environmental information into continuous, standardized, auditable, and interoperable data streams. By assigning assets and projects persistent Digital IDs (i.e., Europe's Digital Product Passport), data can be linked to a common identity and maintained with verifiable provenance across the asset lifecycle, enabling near-real-time monitoring of emissions, operational performance, and environmental outcomes.

This architecture reduces manual reporting and reconciliation, improves data integrity and comparability, and creates a shared information layer capable of serving project developers, supply chains, financial institutions, regulators, insurers, and investors simultaneously. More importantly, institutional-grade data expands the range of financing channels available to environmental assets: verified performance data can support credit underwriting, collateralization, insurance and risk-transfer products, sustainability-linked financing, asset-backed structures, and the creation and settlement of digital environmental assets.

By moving from periodic, document-based reporting toward continuously updated and independently verifiable information, D-MRV can reduce information asymmetry, improve risk assessment, lower costs, and provide the data infrastructure necessary to connect measurable environmental performance with institutional capital at scale.

Today, the burden of monitoring, reporting, and verification reporting schemes do not fit the realities of functional farm operations. It can be completely out of reach for, or overwhelm, diversified farms and smallholders without delivering meaningful benefits. As a result, current valorization mechanisms lean heavily on modeled or estimated data and reduce everything to a single commodified metric: carbon equivalence tonnage. This mismatch leaves highly impactful and fully transitioned regenerative farmers forced to fit complex, dynamic land management into narrow financial instruments that simply were not designed to capture farmers' best practices.

To truly unlock the potential of regenerative agriculture, we need to fundamentally redesign financial instruments, data transfer, and market mechanisms, aligning climate finance with the holistic, farmer-centered principles to effectively value the full extent of farmers' sustainability and resiliency practices, meet global GHG emissions disclosure requirements, and satisfy institutional investors' compliance and risk-management needs. It is possible to create concrete outcomes leveraging data farmers already produce like their Schedule F, Geographic Information System (GIS) and field shape file/combine data.



01
SCOPE 3: ENHANCED DIGITAL MEASUREMENT, REPORTING, AND VERIFICATION

In Market

Implementing Enhanced Digital MRV: Deploying real-time digital MRV systems can significantly reduce administrative burdens for farms that already generate digital field and machine data (today, mostly larger commodity row-crop operations) by enabling automated, consolidated data flows. This outcome-based lending model is distinct from traditional structures such as R/C PACE (Property Assessed Clean Energy), shifting the focus from prescribed actions to measurable results. While continuous MRV introduces additional servicing costs, it also enhances loan data integrity, mitigating greenwashing risks, which is increasingly critical to securing lower borrowing costs through capital markets.

Blending High-Quality Carbon Credits: Incorporating high-quality carbon credits into the loan structure as a warrant lowers risk, attracts investment, and reduces borrowing costs for farmers. The warrant enables innovative structuring that aligns farm credit lender and borrower preferences while introducing a critical monetization feature for soil health and regenerative agriculture.

Valorizing Co-Benefits: Identifying, valuing, and investing in the additional co-benefits generated by farmers' soil health practices, in areas such as biodiversity, water stewardship, super pollutants (microplastics and PFAS), UN SDGs, and resilience, individually, or bundled together, to maximize financial returns to farmers. This work is just starting to unfold in inter-operable systems of agriculture and will be the work of the next several years to unfold and standardize. Multiple initiatives have already brought these elements together into novel, institutional-grade funding mechanisms, making it possible to price efforts to strengthen resilience, deliver confidence in carbon markets while ensuring land stewards are fully compensated for their essential role in building a thriving, resilient agrifood system that is more stable and sustainable.

02

BIOFUELS, 45Z AND CARBON INTENSITY SCORING

In Market

Biofuels: 45Z and Carbon Intensity Scoring

Section 45Z Clean Fuel Production Credit, a tax credit tied to a fuel's carbon intensity score, and voluntary carbon credits, which monetize emissions reductions directly. As the EU's CBAM and comparable mechanisms elsewhere tie carbon intensity to trade access, U.S. producers with lower-scoring, verifiable carbon intensity stand to gain a durable market advantage.

As more trading partners adopt mandatory Scope 3 emissions reporting, the USDA's Carbon Intensity scoring method is positioned to become the default standard measurement that non-U.S. buyers reference for biofuel export-type crops, meaning the carbon intensity of crops like corn, soy, and canola will matter directly for baseline export requirements wherever emissions reporting is mandatory. This ties directly to on-farm management – not just for Sustainable Aviation Fuel (SAF) – but for all commodity agriculture.

Supply and demand market dynamics will determine whether this tax transfer mechanism results in better economics and environmental outcomes. The European Union, Canada, Australia, Brazil, and multiple Asian countries, such as Japan and South Korea, have existing and robust commitments to either growing their biofuel sector or requiring Scope 3 emissions reporting for imports, or both. These factors will compel U.S. growers to develop the scoring method not only for feedstocks used in domestic biofuel production, but likely on the full commodity itself for any intention of accessing export markets by 2030 or beyond.



03

SOIL CENTERED AND NEXTGEN CROP INSURANCE

In Market

Crop Insurance and the Centering of Soil Health For Risk and Premium Reduction

Recent advances in data analytics have demonstrated to private crop insurers that there is a significant difference in payouts between farmers practicing conventional agriculture (business as usual) and those integrating soil-centric practices. **After roughly three years of adopting cover crops, diverse crop rotations, and no- or low-till systems, farmers experience significantly lower crop losses than their conventional counterparts — a difference in measured risk comparable to the long-established distinction between insuring smokers and non-smokers in health insurance.** It's a powerful indication that healthy soils aren't simply an environmental benefit, but a measurable financial asset and important lever for on-farm resilience to climate shock.

This realization marks an inflection point for the agricultural insurance industry. It presents an opportunity to stabilize revenues by pricing crop insurance more accurately, and it reveals the unsustainable long-term trajectory of indemnity payments of payouts under the current system.

Most importantly, crop insurance remains a primary barrier to farmers' ability to undertake soil health transitions. Current systems lock farmers into existing practices based on backward-looking data that is no longer fit for purpose in predicting future costs and outcomes. To adopt soil health practices, many farmers have chosen to operate outside crop insurance systems altogether, fearing penalties for departing from conventional norms. Early adopters and changemakers are willing to take that risk, but the soil health movement needs to become mainstream — for farmers and their insurance providers alike. Adoption will scale only when soil health systems are integrated into everyday business practice across all cropping systems, rather than treated as an exception that falls outside standard insurance coverage.



The U.S. is not alone in facing this mismatch. The EU's own comparative analysis of agricultural insurance (Insurance and Risk Management Tools for Agriculture in the EU) finds a 70-80% insurance protection gap across the EU-27, with only 20-30% of climate-related agricultural losses currently insured through public, private, or mutual systems. According to the report, drought alone drives more than half of EU agricultural climate risk, and the report projects crop losses could rise 42-66% by 2050 under current emissions trajectories. The EU study reaches a conclusion that echoes the premise of TIFS' Resilience in Agriculture Lending and Insurance Coalition (RALIC) on this side of the Atlantic: climate risk financial regulations are pushing lenders to quantify and manage climate-related risk more rigorously, which, without better data and adaptation support, risks restricting credit access and raising costs for farmers precisely when they most need adaptive capital.

That dynamic compounds into a correlated risk problem.

> When governments continue subsidizing rising cost and risk rather than letting markets price this risk, reinsurers respond rationally by directing capital to the known, already-profitable acres rather than extending capital to farmers who are lowering their risk by investing in soil health practices.

To-date, actuarial data has not given reinsurers a signal for where that lower-risk land is, and just as importantly, it can't explain why some acres hold up better under climate stress than others. This gap exists because agricultural risk has historically been measured through cultivar yield and climate exposure alone, with no accounting for the underlying asset generating that yield: the land, **and specifically the soil.**

Risk capital prices what a field produces, not what its soil is capable of producing, and data shows that healthy soil can produce more. Soil health is also linked to long-term farm profitability and asset value, yet lenders and insurers have no common way to measure it. Grain markets faced a similar gap before the Chicago Board of Trade introduced standard grades in the 1850s. Without a common grade, buyers stuck with shipments they knew rather than risk an unfamiliar one. Agricultural risk capital faces that problem today at the level of soil, with no equivalent grade for resilience to trade against. The Resilience in Agriculture Lending & Insurance Coalition's (RALIC) actuarial and data-standards work, described below, is designed to close this gap.

RALIC is TIFS' vehicle for this work: a multi-year initiative that brings together crop insurers, conservation NGOs, state agriculture departments, and soil-health researchers around a single insight. The data needed to price the risk-reducing benefits of regenerative practices does not yet exist in a form insurers and lenders can use. RALIC's work has three parts: (1) using actuarial tools to quantify that risk reduction; (2) developing data standards that connect farm-level measurement with institutional risk assessment; and (3) testing farmer membership in captive insurance pools to give soil-centered producers more accurate coverage during the transition period. The long-term goal is an actuarial foundation strong enough to shift private insurance markets and inform future Farm Bill policy.

Crop insurance reform is typically left to Farm Bill discussions, but in this case the private sector is pulling ahead. Private insurers are building stronger data insights, using AI for risk pricing and verification, and offering lower premiums to farmers who are transitioning to soil-health practices or already farming regeneratively. Risk capital has already aligned itself with the investment case to be made for increased resilience, lower risk, and lower insurance premiums based on soil health.

04

AI FIELD PRACTICES AND ECOSYSTEM SERVICES VALIDATION



In Market

AI Field Practices and Environmental Credits Validation

Farmers overwhelmingly depend on advisors — for practice recommendations, seed selection, input decisions, financing, and insurance — but the same advisor relationship that provides guidance is also, structurally, a sales relationship. That is a feature of the prescription-based farming system the industry has built, where incentives are structurally aligned with input utilization rather than outcome optimization. The result is a persistent information asymmetry: farmers make consequential decisions about inputs, practices, cultivar, and finance without full independent access to the data and modeling that would let them evaluate advice with additional context and insights.

Advances in AI, paired with the ability to fuse agricultural, climate, soil, and remote-sensing data into working system models, are beginning to close that gap. These tools give farmers independent modeling and inference capability alongside — not in place of — their trusted advisors and service providers, correcting an asymmetry where sophisticated modeling and intelligence have historically been concentrated with advisors and input suppliers rather than the farmers making the decisions.

The key mechanism is now being referred to as an "open factory" approach: initial inference is derived remotely, from satellite and system-model observation of the acre, before any farmer-submitted data is ingested. Farmer-provided data then verifies and refines that independent baseline, rather than serving as the sole source of truth. That sequencing produces a directionally correct, independently derived read on carbon intensity scores, soil health, yield response, in-season field-level conditions, and the performance of a given practice, cultivar, or field system, before the farmer's own reporting enters the picture. It's the same independent-verification function covered in this report's Section 1, regarding digital MRV infrastructure performing at the market level, applied in this instance at the point of on-farm decision-making.

Combining these three inputs — remote observation, system and climate models, and verified farmer data — into a single intake lets the system do more than describe current conditions: the latest agronomic systems can now recommend specific interventions and model their impact forward over a ten-year horizon, arriving at an implied land value and yield potential that reflects the operation's trajectory rather than a single-year snapshot. That forward-looking capability is what would let the underwriting and valuation work described in this report's Section 7 rests on independently modeled projections instead of self-reported or advisor-supplied estimates. It also takes into account the climate variability in ways that have never before been included in the pricing, resilience, risk and return models used by large financial investment systems.

These new Agronomic AI systems can also provide real-time profitability scenarios to farmers who are enabled to model their own changes in soil health practices, application of inputs, changing crop rotations, and more.

Sections 1-4 above described financial innovations that are already unfolding in agriculture and financial sectors. Below sections 5-7 are being constructed and tested with industry stakeholders as they move toward implementation.



Insurance-Backed Environmental Credits: Enabling Collateralization

Operating loans from the Farm Credit System typically require farmers to carry federally backed or private crop insurance before financing any on-farm activity within a given crop year. This linkage forces both individual and collective decisions about the risk of maintaining status-quo practices. Because Farm Credit System institutions collectively hold over 40% of all U.S. farm business debt — making the System the single largest lender to U.S. agriculture — the underwriting standards embedded in this insurance requirement carry outsized influence over on-farm practices nationwide. Those standards, however, were built from decades of data collected across different economic periods, largely before today's understanding of soil health's far-reaching effects on risk and resilience.

High-quality carbon credit collateral derived from the insurance backing of environmental credits offers a way to update that risk calculus. Environmental credit revenue, improved yields, and reduced input costs together improve profitability, which reduces the probability of default and loss for lenders, directly improving the risk-adjusted return profile of lending portfolios, while improving the climate resilience of the ag borrowers. This de-risking effect lets lenders price capital more efficiently and expands climate-lending mandates without loosening prudent capital allocation practices. It is this underwriting logic — collateral quality translating into lower default risk and more efficient capital pricing — that connects RALIC's insurance-sector work, described above in Section 3, to a broader (Farm Credit) collateralized ecosystem-services structure. In effect, digitized collateral does what the Board of Trade Clearing Corporation did for grain futures in 1925: it removes the need to assess every counterparty's creditworthiness bilaterally, letting capital move at volume rather than one relationship-based deal at a time.

The same digital rails that link financing to verified emissions outcomes can support a broader class of lending and insurance solutions. At its core is a persistent, auditable digital identity for each project, asset, or underlying activity, paired with a continuous stream of high-quality asset performance and emissions data. These digital IDs establish provenance across the asset lifecycle, linking project characteristics, monitoring systems, verification records, and observed emissions performance within a common data layer. **The result is a more granular, more timely measure of the delta between a business-as-usual emissions trajectory and actual performance, letting insurers and other risk capital providers underwrite against verified changes (as certified by third parties already in place: Verra, Gold Standard, etc.) in underlying risk rather than relying solely on periodic reporting or historical, assumptions-based models.**

As the quality, frequency, and integrity of this data improve, insurers can better assess performance risk, quantify uncertainty, and structure coverage around specific environmental and operational risks, potentially developing products whose pricing or coverage responds directly to verified outcomes. In this way, digital IDs and continuous D-MRV transform environmental performance data from a compliance reporting requirement into an underwriting asset, creating a more transparent basis for risk transfer and enabling institutional investors, lenders, and insurance capital to participate in financing and scaling measurable decarbonization outcomes.

06

THE CARBON WARRANT: REGULATED CREDIT INSTRUMENTS IN ECOSYSTEM SERVICES

Emerging

The Carbon Warrant: Regulated Credit Instruments in Environmental Assets

Triangle Digital's Carbon Warrant is an example of an innovation that enables regenerative agriculture's incorporation in digital loan or bond instruments. The Carbon Warrant is a standardized, regulated carbon credit represented as a digital asset, establishing a consistent foundation for a transparent, verifiable, and auditable carbon credit contract.

This feature was recognized at COP30 as winner of the global blended finance competition put on by the Brazil Central Bank, and core to the Triangle Digital / University of Michigan financing mechanism with the Great Lakes Protection Fund (GLPF) / Foundation for Food and Agriculture Research (FFAR) program.

Historically, the voluntary carbon market has functioned like a "farmers' market" — highly inefficient, opaque, and inconsistent. Because every carbon project is different, buyers and sellers must negotiate each contract individually, in full cash, one transaction at a time. This makes the market slow and unpredictable.

The Carbon Warrant solves this by converting carbon credits into a standardized digital asset. By doing so, it introduces three major upgrades to the market

- **Institutional Standards:** It creates a transparent, auditable contract that gives major financial institutions the confidence to participate.
- **Balance Sheet Integration:** Because the asset is regulated and uniform, it can be held by banks, added to corporate balance sheets, or included in asset management fund portfolios.
- **Financing & Collateral:** Clean price signals allow banks to accept these digital credits as collateral. This de-risks the investment for lenders and lowers borrowing costs for the farmers generating the credits.

This standard is intended to instill the confidence needed for the market's expansion and to generate price signals reliable enough to blend carbon credit value directly into a lending structure, lowering the farmer's cost of financing and de-risking investment for lenders.

A key deliverable for this regulated instrument is an asset suited to modern finance — one that can be added to an enterprise's balance sheet, held in an asset manager's fund portfolio, held at a bank, and used as collateral for lending and structured products. Triangle is built to move the carbon market away from its current farmers'-market character, where every transaction is negotiated in full, in cash, one buyer and one seller at a time, toward a high-velocity institutional market with standardized instruments, pooled liquidity, and financing built in.

Triangle's Carbon Pool: Idiosyncratic carbon projects and their credits are often too risky, too large, or too operationally burdensome to support point-of-sale microtransactions. A carbon pool solves this the same way the CBOT solved it for grain: instead of trading each farm's idiosyncratic corn crop, the CBOT graded output into standardized classes like No. 2 Yellow Corn. A carbon pool aggregates verified credits above a defined minimum rating into a diversified inventory spanning



06

THE CARBON WARRANT: REGULATED CREDIT INSTRUMENTS IN ECOSYSTEM SERVICES

Emerging

multiple project types (which could include agriculture, transportation, or infrastructure carbon credits), an analogue to securitization. Consolidating supply into a single managed liquidity structure creates sufficient market depth to fractionalize exposure, enabling small amounts of carbon liability to be offset seamlessly at checkout, and allowing tokenized credits to retire automatically at the moment of transaction, including entire categories of corporate Scope 3 spend.

Co-benefits and Stackable Credits: A carbon credit that ignores water quality, biodiversity, and soil health measures only one narrow output of a much richer system and prices the rest at zero. Stackable co-benefit credits correct this by disaggregating environmental value into its component parts — carbon sequestration, water stewardship, biodiversity restoration — and assigning each independent market value. These components can be bundled for buyers seeking a comprehensive sustainability instrument or unbundled for investors funding a specific ecological outcome. The result is not just higher credit prices for farmers, but a fundamental expansion of the investable universe for climate finance, making previously invisible ecological value legible to capital markets.

Carbon Warrant: The carbon warrant closes the loop between climate performance and capital cost. The warrant is structured as a forward-delivery option: the right, but not the obligation, to acquire future carbon credits at a predetermined strike price. Thus, the warrant embeds anticipated environmental performance directly into the lending architecture at origination. For a farmer transitioning to soil health and regenerative practices, the warrant converts future credit generation into present-day financial relief; for the lender, it is a structured hedge against transition risk that appreciates as regulatory carbon pricing tightens.

06

THE CARBON WARRANT: REGULATED CREDIT INSTRUMENTS IN ECOSYSTEM SERVICES

Emerging



A Simplified Example from Triangle Digital:

In practice, a farmer transitioning to no-till and biological inputs might finance equipment and inputs with an operating loan. By pledging future registered credits as a warrant, the farmer gives the lender a verifiable asset with upside tied to carbon prices, which can justify a lower interest rate. The farmer gains credit revenue and cheaper capital during the difficult early years; the lender gains a hedge against transition risk. Triangle's modeling of such structures suggests benefits compound over time as yields and input savings build alongside carbon revenue.

07

THE HIGHER YIELD BASELINE: AG CREDIT UNDERWRITING AND LOWERING THE COST OF CAPITAL ON SOIL CENTERED FARMS

Emerging

The Higher Yield Baseline: Ag Credit Underwriting and Lowering the Cost of Capital on Soil Centered Farms

The potential impact for Farm Credit underwriting seeks to capture and monetize the full breadth of economic, environmental, and productive value created through regenerative agriculture, translating those outcomes into an institutional-grade financing structure. It builds upon the actuarial sciences being developed under crop insurance programs (#3 above) centered on soil health, land grant university research that shows higher yields achieved beyond conversion, and the fact that Farm Credit utilizes yields as a proxy for risk and value.

Rather than treating carbon as the sole source of value, future frameworks will recognize a broader portfolio of benefits — biodiversity, water stewardship, soil health, resilience, and improved farm productivity — as measurable economic assets. By connecting these outcomes to independently verified data and the underlying land and agricultural activities, the model creates a more comprehensive basis for financing while enabling farmers to participate in multiple sources of value creation.

The Farm Credit underwriting framework can be designed to create a dual economic impact for producers: increasing top-line revenue while expanding profit margins through lower costs. Improved soil health practices can contribute to stable or higher crop yields, enhanced land values, and differentiated crop offtake premiums, while improved data, farm resilience to climate shocks and risk management, and environmental performance can support lower interest expense and reduced operating costs. As long-term soil recovery stabilizes and strengthens yields, a farm's



07

THE HIGHER YIELD BASELINE: AG CREDIT UNDERWRITING AND LOWERING THE COST OF CAPITAL ON SOIL CENTERED FARMS

Emerging



economic outlook strengthens with it, translating into higher land appraisal values and more favorable loan-to-value (LTV) ratios. Favorable LTV ratios can, and should, translate into lower interest rates; even where the rate reduction itself is marginal, access to operating credit at a lower capital cost matters disproportionately to a farm's cash flow and solvency. Carbon and co-benefit credits provide additional revenue streams on top of that, while the aggregation and standardization of verified outcomes improve the efficiency and scalability of financing overall. The result is a financing model in which environmental performance and farm-level productivity reinforce one another — creating greater economic value while reducing the risk associated with capital deployment.

At the financial-market level, the objective is to preserve a direct and auditable connection between the underlying agricultural assets and the financial instruments derived from them. Independent verification, continuous monitoring, and institutional-grade data can support the aggregation, nesting, and repackaging of project-level outcomes into scalable financing structures, including insurance, loans, bonds, and asset-backed securities. Modular enhancements such as carbon and co-benefit monetization, sustainability-linked financing, risk-transfer mechanisms, and digital measurement and verification can be combined according to the needs of a given financial engagement. This creates a repeatable, network-based architecture capable of expanding financing channels for regenerative agriculture while giving institutional investors greater transparency, measurable performance data, and confidence in the underlying assets.

CONCLUSION: THE MARKET MATURITY AND CAPITAL TRANSITION LEADING TO A MAJOR RE-WRITE IN RISK PRICING



Conclusion

The arguments and examples included in this report are unfolding well beyond just U.S. agriculture. The Asian Infrastructure Investment Bank (AIIB), the European Bank for Reconstruction and Development (EBRD), and Paulson Institute's Nature as Infrastructure framework each call on governments and financial institutions to treat ecosystems the way toll roads and airports are already treated: as investable infrastructure that requires long-term planning, a capital-expenditure mindset, and patient capital deployed at landscape scale, rather than conservation funded episodically.

> Guarantees, (like the Carbon Warrant), insurance, and environmental credits are named as the three most underused levers for engaging private capital as an ongoing transition partner rather than a source of one-off funding.

This report describes a scenario that applies directly to agriculture's soil transition: private capital is waiting for a signal only governments can provide — the regulatory frameworks and incentives that make soil-centered risk investable — before it moves at scale.

J.P. Morgan's research reaches a parallel conclusion from the agricultural finance side. Regenerative practices already show positive returns across most methodologies and crops, with several studies finding gains of $20-$60 per acre in normal years and upward of $100 per acre in drought years. Yet private capital funding for sustainable food and agriculture peaked in 2021 and has since fallen to less than a third of that level. Capital has not disappeared so much as become more selective, rebalancing over the past three years back toward proven productivity gains rather than newer, unproven technologies. Where public and private capital are beginning to combine, such as the U.S. Regenerative Pilot Program announced by the U.S. Department of Agriculture in December 2025, which pairs $700 million in federal funding with private co-investment. On September 29, 2026 the USDA expanded this program to $1B in funding for 2027. The effect is to de-risk early movers so private capital can follow at scale.



The EU's own analysis arrives at the same conclusion from the insurance and subsidy approach. Closing that region's 70-80% agricultural insurance protection gap will take more than better data; it will require access to risk capital markets, including reinsurance and catastrophe bonds, to supplement domestic insurance systems in catastrophic years. That is the same logic behind the insurance backing of environmental credits and RALIC's work described earlier in this report. Capital's job in the transition is not only to fund it, but to absorb and redistribute risk that today falls almost entirely on the farmer.

Read together, these collective signals describe an important market maturity shift: capital's role is moving from funding isolated, one-off interventions toward underwriting a durable, farm-wide transition. The shift is enabled by governments setting the rules, insurers and lenders getting better data, and public capital willingness to go first.

But the instruments must be built for the right shape of farm, not just the right amount of capital. Today's financing channels for regenerative agriculture — carbon markets, crop insurance, and conventional ag credit alike — share a common structural flaw: they were built to reward scale and simplicity, not the complexity of diversified, soil-centered operations. **Carbon markets make the flaw in the current system visible:** they channel investment toward large, easily standardized operations while structurally excluding smaller, diversified farms, despite the latter often delivering greater per-acre ecological and economic benefit, and they impose verification and reporting burdens that are prohibitive for many regenerative producers.

Left unaddressed, this same misalignment risks entrenching further agricultural consolidation and pitting small diversified producers against large commodity operations rather than rewarding the holistic, long-term outcomes soil health practices produce. The pooled and stackable structures described in this report are built to answer that scale problem. By stacking these key elements, diversified operations can access markets that so far have been available mainly to large, single-output producers. The pooled and stackable structures described in this report are designed to answer that scale problem over time. Realistically, these systems are likely to be built and proven first on commodity row-crop operations, where standardized data, crop grades, and market infrastructure already exist. As they mature, the same elements could extend to smaller and diversified operations, including farms of 50 to 100 acres, that have so far been largely shut out of these markets: a carbon pool that aggregates verified credits across many small operations the way the CBOT once aggregated grain; co-benefit credits that let a



diversified farm monetize water stewardship and biodiversity alongside carbon; a warrant that prices transition risk into the loan. Getting there will depend on lower data and verification costs and on deliberate design choices by the institutions building these instruments.

The financial innovations outlined in this report — crop insurance, carbon intensity scoring, environmental credit creation and collateralization, land valuation, Scope 3 reporting, and ag credit underwriting — are converging on the same conclusion: **soil health is becoming a financial metric that can now be foundational to the financial system.** These innovations result in re-writing of all risk pricing, applied all the way down to an individual acre.

The market maturity moment is now. None of this report's mechanisms work in isolation. A 45Z credit depends on carbon-intensity scoring, which depends on MRV infrastructure that is still getting cheaper. A crop-insurance discount depends on actuarial data that is still accumulating but is already being enacted in the marketplace. A carbon warrant depends on a credit market whose pricing is still thin next to compliance markets.

Each piece, on its own, is still unfolding, but they have a shared trajectory: MRV costs are falling, actuarial datasets are expanding, credit markets are deepening. That convergence, more than any single mechanism's completeness, is why this is the moment where scaling and market maturity become visible. A market doesn't need every component perfected before capital can start moving; it needs the components improving together, predictably, with shared investment language.

REFERENCES

Asian Infrastructure Investment Bank, European Bank for Reconstruction and Development, & Paulson Institute. (2025). *Unlocking private finance for nature as infrastructure: A public-private partnership*. https://www.paulsoninstitute.org/wp-content/uploads/2025/11/Unlocking-Private-Finance-for-Nature-as-Infrastructure11.15.pdf

Boston Consulting Group. (2023). Regenerative agriculture: Improving farmer profitability in the US. https://www.bcg.com/publications/2023/regenerative-agriculture-profitability-us-farmers

Environmental Defense Fund, The Nature Conservancy, & Beck Ag. (2021). *Banking on soil health: Farmer interest in transition loan products.* https://www.edf.org/sites/default/files/content/Banking-on-Soil-Health.pdf

European Bank for Reconstruction and Development. (2020). *Environmental and social assessment training programme: PR6 biodiversity conservation and sustainable management of living natural resources, Task 1* [Training materials]. https://www.ebrd.com/content/dam/ebrd_dxp/assets/pdfs/environment---sustainability/consultant-training-materials/guidance-application-ebrd-prs/module-2/pr6/Task1-ENG-PR6.pdf

European Commission, Directorate-General for Climate Action. (n.d.-a). *About the EU ETS*. https://climate.ec.europa.eu/areas-action/carbon-markets/about-eu-ets_en

European Commission, Directorate-General for Climate Action. (n.d.-b). *EU Emissions Trading System (EU ETS)*. https://climate.ec.europa.eu/areas-action/carbon-markets/eu-emissions-trading-system-eu-ets_en

European Commission, Directorate-General for Climate Action. (n.d.-c). *Carbon Removals and Carbon Farming (CRCF) Regulation.* https://climate.ec.europa.eu/areas-action/carbon-removals-and-carbon-farming/carbon-removals-and-carbon-farming-crcf-regulation_en

European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. (n.d.). *Digital Product Passport.* https://single-market-economy.ec.europa.eu/single-market/digital-product-passport_en

European Commission, Directorate-General for Taxation and Customs Union. (n.d.). *Carbon Border Adjustment Mechanism*. https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

European Investment Bank. (2025). *Insurance and risk management tools for agriculture in the EU*. fi-compass. https://www.fi-compass.eu/library/market-analysis/insurance-and-risk-management-tools-agriculture-eu

Gold Standard. (2026, July 9). *Gold Standard publishes two methodologies to channel climate finance towards underserved communities.* https://www.goldstandard.org/news/published-methodologies-to-channel-climate-finance-towards-underserved-communities

Huttche, C., Rincones, M., & Iqbal, S. (2026, August 18). Building nature into infrastructure: Turning biodiversity commitments into better investments. *AIIB Blog.* https://www.aiib.org/en/news-events/media-centerblog/2026/building-nature-into-infrastructure-turning-biodiversity-commitments-into-better-investments.html

REFERENCES

IFRS Foundation. (2024, May 28). *Jurisdictions representing over half the global economy by GDP take steps towards ISSB Standards.* https://www.ifrs.org/news-and-events/news/2024/05/jurisdictions-representing-over-half-the-global-economy-by-gdp-take-steps-towards-issb-standards/

Internal Revenue Service. (n.d.-b). *Clean Fuel Production Credit (Section 45Z)*. https://www.irs.gov/credits-deductions/clean-fuel-production-credit

Kapnick, S. (2026). *Agriculture, soil and trade: The fates of food in a warming world.* J.P. Morgan. https://www.jpmorgan.com/content/dam/jpm/cib/documents/Agriculture_Soil_and_Trade_The_Fates_of_Food_in_a_Warming_World.pdf

Larcker, D. F., & Watts, E. M. (2020). Where's the greenium? *Journal of Accounting and Economics,* 69(2–3), Article 101312. https://www.sciencedirect.com/science/article/abs/pii/S0165410120300148

Manski, S., Socolar, Y., Goldstein, B., Pizzo, G., Ahmed, Z., Connor, L., Cross, H., Fettes, K., McLaughlan, A., Pham, L., Viens, F., & Bowles, T. M. (2024). *Diversified crop rotations mitigate agricultural losses from dry weather.* agriRxiv. https://doi.org/10.31220/agriRxiv.2024.00244

Michigan Department of Agriculture and Rural Development. (n.d.). *NextGen Crop Insurance Pilot.* https://www.michigan.gov/mdard/business-development/grantfund/nextgen-crop-insurance-pilot

NYC Accelerator. (n.d.). *Local Law 97*. https://accelerator.nyc/building-laws/ll97

Pollination Group, Transformational Investing in Food Systems, & The Rockefeller Foundation. (2024). *Financing for egenerative agriculture*. The Rockefeller Foundation. https://www.rockefellerfoundation.org/reports/financing-for-regenerative-agriculture/

Roxburgh, T., Ellis, K., Johnson, J. A., Baldos, U. L., Hertel, T., Nootenboom, C., & Polasky, S. (2020). *Global futures: Assessing the global economic impacts of environmental change to support policy-making* [Summary report]. WWF. https://www.wwf.org.uk/globalfutures

Science Based Targets initiative. (n.d.). *Companies taking action.* https://sciencebasedtargets.org/companies-taking-action

Science Based Targets initiative. (2026). *Corporate Net-Zero Standard (Version 2.0).* https://sciencebasedtargets.org/corporate-net-zero-standard-v2

TEEB. (2018). *TEEB for agriculture & food: Scientific and economic foundations.* UN Environment. https://www.unep.org/topics/teeb/teeb-agriculture-and-food-teebagrifood/teebagrifood-evaluation-framework

Trencher, G., Nick, S., Carlson, J., & Johnson, M. (2024). Demand for low-quality offsets by major companies undermines climate integrity of the voluntary carbon market. *Nature Communications*, 15, Article 6863. https://www.nature.com/articles/s41467-024-51151-w

REFERENCES

United Nations Framework Convention on Climate Change. (n.d.). *Article 6.2 – Paris Agreement.* https://unfccc.int/process-and-meetings/the-paris-agreement/article-6/article-62

University of Michigan, Department of Civil and Environmental Engineering. (2022, October 4). *Smart infrastructure finance actively seeks innovative ways of funding and financing projects.* https://cee.engin.umich.edu/2022/10/04/smart-infrastructure-finance-actively-seeks-innovative-ways-of-funding-and-financing-projects/

U.S. Department of Agriculture. (2025, December 10). *USDA launches new Regenerative Pilot Program to lower farmer production costs and advance MAHA agenda* [Press release]. https://www.usda.gov/about-usda/news/press-releases/2025/12/10/usda-launches-new-regenerative-pilot-program-lower-farmer-production-costs-and-advance-maha-agenda

U.S. Department of Agriculture, Office of the Chief Economist. (n.d.). *USDA Feedstock Carbon Intensity Calculator (USDA-FD-CIC)*. https://www.usda.gov/about-usda/general-information/staff-offices/office-chief-economist/office-energy-and-environmental-policy/technical-guidelines-production-regenerative-agricultural-biofuel-feedstocks/usda-feedstock-carbon-intensity-calculator-usda-fd-cic

U.S. Securities and Exchange Commission, Division of Corporation Finance. (2019, April 3). *Framework for "investment contract" analysis of digital assets* [Withdrawn]. https://www.sec.gov/about/divisions-offices/division-corporation-finance/framework-investment-contract-analysis-digital-assets

For more information, contact Tina Owens,
Regenerative Agriculture Systems and Investment,
at tina.owens@tifsinitiative.org.