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Project Shed Inventory: A Scalable GHG Inventory Accounting Framework for the Agriculture & Food Sector

October 2025

This methodology represents the culmination of work developed over the past year in collaboration with more than 25 experts across the food and agriculture value chain. We are grateful for their insights and support. This version is forward-looking, incorporating anticipated guidance from the draft GHG Protocol Land Sector and Removals Standard. As global standards continue to evolve, we are committed to updating our methodology to align with new guidance as appropriate. We thank all those who contributed feedback to earlier drafts, helping to strengthen this foundation.

Background

The food system contributes one-third of global greenhouse gas (GHG) emissions[1]. This includes emissions from crop production, land-use change, and food waste. Even excluding the food waste contribution, the agriculture sector alone contributes over one-fifth of total GHG emissions[2]. If the Paris Agreement goal of limiting global warming to 1.5°C by 2050 is to be met, the food system must undergo a transformative shift towards sustainability.

The urgency is stark. Only five harvests remain to meet the interim goal of halving global emissions by 2030. Many climate scientists in the UN's Intergovernmental Panel on Climate Change now believe the 1.5°C goal is out of reach[3]. According to the World Meteorological Organization, 2024 was the warmest year on record[4]. In the fall of 2024, nearly half of the Continental US experienced drought, impacting over 300 million acres of cropland[5]. Such conditions pose a direct threat to the long-term viability of the nation's growers and the broader food supply chain.

Regenerative agriculture offers a significant opportunity to reduce the GHG emissions of the food system[6]. Best management practices that can help cut emissions, sequester carbon, and enhance soil health and crop resilience, include crop rotation, no-tillage or reduced tillage, cover cropping, and reduced fertilizer use. However, the absence of a standardized definition of "regenerative agriculture" makes it challenging to assess its adoption.

Estimates range from as low as 1.5% of U.S. agricultural land when considering holistic regenerative practices[7] to as high as 70% when including farms adopting at least one regenerative practice[8]. Regardless, a significant gap remains to realize the full potential that regenerative practices can deliver for both decarbonization and crop resilience to extreme weather events.

Barriers to scaling regenerative practices are multifaceted and interdependent. Farmers are often hesitant to change familiar practices due to significant financial risks, lack of technical support, and uncertainty in the benefits of change. In addition, the cost of implementation of new practices can be untenable in a system that operates on thin margins. While the technology is evolving to estimate the outcomes from the implementation of regenerative ag practices, the costs of measurement, reporting, and verification are still cost-prohibitive. Further, complex regulatory systems for GHG accounting exacerbate confusion. The result is inaction within the value chain.

[1] Crippa et al, Nature Food 2, 198-209 (2021).
[2] US Environmental Protection Agency, (2024). https://www.epa.gov/ghgemissions/global-greenhouse-gas-overview
[3] World's top climate scientists expect global heating to blast past 1.5C target. The Guardian. https://www.theguardian.com/environment/article/2024/may/08/world-scientists-climate-failure-survey-glob al-temperature
[4] World Meteorological Organization. State of the Climate 2024 Update for COP29. https://wmo.int/publication-series/state-of-climate-2024-update-cop29
[5] NIDIS. https://www.drought.gov/current-conditions
[6] Project Drawdown, https://drawdown.org/solutions/regenerative-annual-cropping
[7] The farmers trying to restore life to America's stressed soils as climate change bites. Reuters (2022). https://www.reuters.com/business/sustainable-business/farmers-trying-restore-life-americas-stressed-soil s-climate-change-bites-2022-09-14/ 2
[8] Voice of the US farmer 2023–24: Farmers seek path to scale sustainably. McKinsey (2024). https://www.mckinsey.com/industries/agriculture/our-insights/voice-of-the-us-farmer-2023-to-24-farmers-s eek-path-to-scale-sustainably

Current State of Regulatory and Accounting Frameworks

In theory, corporate sourcing decisions should serve as a powerful lever for promoting regenerative practices in food production. Downstream entities can incentivize the production of lower-emission commodities, creating a market that motivates farmers to adopt sustainable practices. However, for this market to succeed, it must be underpinned by a regulatory framework that is clear, rigorous, practical, and consistent.

Currently, the GHG regulatory ecosystem for managed agricultural lands consists of multiple certification frameworks, methodologies, and reporting schemes that lack harmonization. Approved methodologies for accounting and reporting Scope 3 emissions in the food and agriculture sector remain absent[9]. This gap has resulted in a patchwork of ad hoc methodologies, increasing costs and complicating program implementation. Addressing this issue is essential to scaling regenerative practices and achieving meaningful reductions in agricultural emissions.

Today, there are two basic mechanisms and GHG accounting frameworks for incentivizing the implementation of regenerative practices:

1. procurement of lower emissions commodities through sourcing decisions based on inventory accounting principles (corporate GHG inventories);
   or
2. directly investing in projects to implement new practices within a project region based on intervention accounting principles.

Both of these mechanisms have the potential to reduce on-farm GHG emissions and have a role to play in a holistic approach to food system transformation. However, the two accounting systems are not easily interconverted today. Unfortunately, both of these approaches are burdened by the onerous requirements of current GHG reporting standards, which are cost-prohibitive given the current state of global carbon pricing. Further, the frameworks are restrictive and often too prescriptive in nature and largely do not address complexities inherent in farm management decisions and crop rotations. Finally, the accounting approaches for corporate inventories and interventions are completely different and not easily integrated.

Inventory accounting is rather straightforward, and procurement may be less costly than the implementation of on-farm interventions. For these reasons, to date inventory accounting seems to be the preferred strategy for companies in the value chain[10]. This is supported by a recent USDA survey that showed only approximately 3% of US producers were planning to enroll in carbon program offerings[11]. Given the scarcity of acres currently under regenerative practices, relying solely on sourcing lower-emissions commodities will not yield sufficient GHG reductions in time to meet our climate goals.

To close this gap, rapid scaling of regenerative agriculture is essential not only to satisfy the growing demand for lower-emissions commodities in corporate inventories, but also to deliver meaningful climate impact. Yet, this scaling effort faces dual headwinds: an ag economy under financial strain[12] and constrained corporate sustainability budgets. On top of that, current accounting frameworks often operate in silos, separated by incompatible boundary conditions and baseline methodologies. This complicates integration and weakens the business case for investment in regenerative programs. For companies, this fragmentation impairs their ability to quantify impact, justify expenditures, and efficiently scale solutions that could otherwise deliver both environmental and economic value.

While it is laudable to have the most credible and rigorous system in place for GHG accounting and reporting to help prevent greenwashing and a false sense of progress, we are trapped in a state of letting the perfect be the enemy of the good. Most involved agree that the current system is difficult to implement at scale. Here, we propose a simplified framework, Project Shed Inventory, to enable the scaling of regenerative ag practices that is farmer-focused and allows for a simpler accounting for reduced emissions into corporate inventories. The methodology is designed to uphold the highest standards of scientific rigor and transparency while prioritizing efficiency and simplicity to promote real progress toward transforming the food system to a more resilient and sustainable state.

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[9] Currently Verra, one of the world's largest GHG standards bodies is working to create a Scope 3 program that will include methodologies for the food and ag sectors. https://verra.org/programs/scope-3-standard-program/

[10] Food companies tackling Scope 3 emissions despite weak SEC rule: expert. https://www.fooddive.com/news/sec-climate-rule-scope-3-emissions-carbon-footprint-pepsico-howgood-tr acking/708947/

[11] A General Assessment of the Role of Agriculture and Forestry in U.S. Carbon Markets. https://www.usda.gov/sites/default/files/documents/USDA-General-Assessment-of-the-Role-of-Agriculture -and-Forestry-in-US-Carbon-Markets.pdf

[12] USDA-ERS. https://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/farm-sector-income-forecast/

Proposed Solution: Project Shed Inventory Framework

Overview

The Project Shed Inventory approach is not an intervention program and it does not subscribe to the rules of intervention accounting. Instead, it is a framework for creating and sourcing commodities with lower GHG emissions profiles, and thus follows guidelines for inventory accounting and reporting. The approach intends to drive the scale of regenerative practice adoption while taking advantage of the relative simplicity of inventory accounting. It simplifies GHG accounting while providing flexibility and an incentive for farmers to maintain and adopt regenerative practices, reduce GHG emissions, and create a more sustainable and resilient food system. **Key benefits include:**

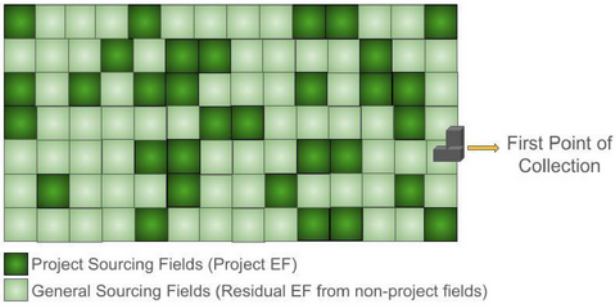
- Seamless integration with corporate GHG emissions reporting
- A clear market signal for low carbon commodity production
- Allowing for the tracking of improvements best suited for specific farm fields rather than limiting to a restrictive list of prescribed practices
- Allowing for tracking improvements within the supply shed boundary, but not directly incentivized by the downstream sourcing company in addition to those directly sourced by the downstream sourcing company
- Allowing early adopters of regenerative practices to participate
- Reducing contractual burdens and providing flexibility for farmers
- Reducing the data collection burden
- Enabling attributes to be passed through the value chain and in between food and fuel production

The key to this approach relies on defining the project boundary. The project boundary is defined as the geographic sourcing region where sustainable practices will be incentivized by a downstream company. The purpose of this producer incentive payment is to
1) produce lower-emission commodities (lower emissions factors) and
2) license the exclusive right to report primary data for crop production on that field.

The project owner has flexibility in how to incentivize farmers and provide technical assistance. In the simplest enablement of the program, a CPG would pay for access to the data needed to calculate the reduced emissions factor associated with the purchased commodity as this is what is needed for reporting in their corporate inventory. Growers maintain flexibility to holistically approach sustainability according to their unique business needs, enabling growers to adopt practices aligned with their unique needs.

The project boundary becomes a “project shed” from which commodities are sourced with measurement, reporting, and verification (MRV) aligned to established guidance, such as the Greenhouse Gas Protocol Land Sector Removals Standard (LSRS)[13] or the Science-based Targets Initiative Forest, Land, and Agriculture Guidance (SBTi FLAG)[14].

Traceability from farms to the first point of collection is required but manageable. Agreements with farmers, including a “right to report” clause, help prevent double counting. These requirements are at least as rigorous as those used for intervention programs in the current market. Permanence monitoring and uncertainty reporting, as per LSRS requirements, are also integrated. Notable, this approach also appears to align with the “stratified emissions factor” framework proposed by the Value Change Initiative, supporting streamlined and effective implementation.[15]



Schematic of the Project Shed Inventory Approach

- A company identifies a sourcing region from which it procures commodities near a first point of collection, the "general sourcing region."
- Within this general sourcing region, the company identifies farmers that have implemented or are willing to implement regenerative ag practices. These farmers are enrolled in the "project sourcing fields".
- At the end of the growing season, an emissions factor is estimated for the "project sourcing fields" using the HabiTerre SYMFONI platform and an emissions factor is reported for the amount of commodity sourced from those project fields.
- For any other commodity sourced outside project sourcing farms and within the general sourcing region, a separate EF is reported for the amount of remaining commodity sourced from non-project fields. This EF can be calculated through various databases or the HabiTerre platform.

Implementation Steps

1. Identify a region from which to source low emission commodities.
2. Work with farmers to develop a plan to decrease the on-farm emissions related to the production of the commodity of interest. Farmers that already adopt regenerative practices and thus have lower emissions commodities are allowed to participate given that this is a modified inventory accounting framework.
3. Establish a mechanism to incentivize the farmers' participation. In the first iteration of the framework, a simple pay-for-primary-data approach may be appropriate, with eligibility offered only to farmers growing the specific commodity using certain regenerative best practices. In later iterations, eligibility and compensation structure could be transitioned to more directly incentivize specific practice adoption or lower emission factors.
4. Enroll farmers in the Project Shed Inventory Program including a binding agreement for the "right to report" the emissions factor associated with the purchased commodity.
5. Collect primary data according to HabiTerre's data standard.
6. Model the cradle to farmgate emissions and determine the appropriate emissions factor to be used for corporate reporting.

MRV Specifics

HabiTerre provides advanced MRV solutions fully complying with the GHG Protocol LSRS guidance for accounting and reporting methods. Key components include:

- **Project Boundary & SSRs** - the project boundary here is defined as all of the fields from a sourcing region within a reasonable distance from the first point of collection enrolled in the project. Emissions factors are estimated from cradle to farmgate. The sources and sinks used in the cradle to farmgate estimation of emissions and removals are as follows:
    - Sinks - soil carbon sequestration; soil methane sequestration
    - Sources (emissions)
        - Soil organic carbon
        - Soil direct N_2O
        - Soil indirect N_2O
        - Soil methane
        - Upstream fertilizer production
        - Upstream other non-fertilizer chemical production
        - On-farm energy consumption

- **Baseline** - the emissions for the baseline year of current commitments will be recalculated using the Habiterre methodology for the purposes of reporting. As much primary data for the original baseline year as possible will be used in the recalculation. Where primary data are not available, data will be gap filled from appropriate resources. Since this is an inventory approach, the absolute emissions for the baseline year are all that is needed - no counterfactual baseline is required in this approach.

- **Primary data** - as much primary data as possible from each field will ensure compliance with the intent of the GHG Protocol LSRS. Where data are missing, accepted databases and/or HabiTerre's proprietary remote-sensing algorithms can be used to gap fill.

- **Soil sampling** - for the purposes of SOC reporting, soil sampling or other primary soil data should be used for reducing modeling uncertainty. HabiTerre currently offers stratification services to optimize for cost and uncertainty tradeoffs across a given project area to meet this requirement. Given the dynamic nature of soil organic carbon, the LSRS requires a “true up” at five-year intervals to help ensure accuracy of the estimated removal and to provide insight into permanence. For modeling-based approaches as proposed in this methodology, the LSRS draft states that a “recalibration” is required at the 5 year interval to fulfill this requirement. HabiTerre will provide this recalibration to maintain compliance with the LSRS.

- **Uncertainty** - for the reporting of both emissions and removals in an emissions factor, uncertainty reporting is required. In the most recent update to the draft LSRS guidance, only uncertainty values and the associated statistical significance and the confidence intervals are required along with how the uncertainty is estimated. This is subject to change with the publication of the final guidance in Q4 2025. HabiTerre provides this calculation as part of the project quantification.

- **Permanence** - to be compliant with LSRS, a monitoring plan is required for any potential reversals of carbon removals. In the most practical implementation, remote sensing can be used on all project fields to ensure maintenance of practices and thus, removals. Since the traceability of removals is proposed to be required at the land management unit (LMU), meaning the farm, enrollment of fields on a year-to-year basis with the verification of practices can fulfill this requirement. This is particularly attractive when crop rotations occur within a farm. If one field on the farm is not in the project for a given year, but a new field on that same farm enrolls in the project year using the same crop and the same practices as the field that leaves, then in theory the removals should be consistent and traceable to the LMU. As an alternative, permanence may be accounted for at the project level, tracking the total acres, balancing and replacing lost growers and acres, and monitoring GHG emissions/reductions that occur across the project to maintain total GHG emissions balance across the entire project area. This approach is valid in the draft LSRS if the first point of collection is known, but direct traceability to the LMU is not established. In this case, the average removals value across all productive lands within the project area should be reported. Lastly, If a project owner ceases investment in a project area, remote sensing can be used to monitor practice permanence on previously enrolled fields.

- **Double counting/claiming** - The proposal for avoiding double counting or appropriate claiming within LSRS is
- to have a signed “right to report” from the farmer to the reporting entity. This is still to be determined in the final guidance (expected end of 2025).

- **Verification** - The approach does not require certification by third-party verification schemes outside the normal auditing process for current corporate inventory reporting requirements. Project owners may seek other third-party certification if they choose.

Conclusion

The Project Shed Inventory framework addresses the shortcomings of existing intervention-based methodologies by simplifying integration with corporate GHG inventories and reducing implementation costs. Companies can:

- Achieve cost-effective compliance with regulatory frameworks.
- Provide clear incentives to accelerate the adoption
- of sustainable practices.
- Mitigate financial, reputational, and logistical risks associated with Scope 3 GHG accounting.
- Build a more resilient supply chain.

This proposed framework offers a scalable, efficient, and scientifically rigorous methodology to drive the transformation of the agricultural and food system. By creating incentives for regenerative practices and simplifying GHG accounting, this approach paves the way for meaningful progress towards climate goals while ensuring the sustainability of growers and the food supply chain.

[13] https://ghgprotocol.org/land-sector-and-removals-guidance
[14] https://sciencebasedtargets.org/sectors/forest-land-and-agriculture
[15] Value Change Initiative. https://valuechangeinitiative.com/resource/accounting-and-reporting-scope-3-interventions-in-the-food-and-agriculture-sector/

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Frequently Asked Questions

- **Is the Project Shed Inventory Program approach compliant with the Greenhouse Gas Protocol Land Sector Removals Standard?** The approach, as a modified inventory framework, is expected to comply with the intent of the LSRS, if not its precise requirements where such requirements are infeasible at reasonable cost and scale. A final determination will follow the publication of guidance at the end of 2025.

- **Will the Project Shed Inventory Program meet Science-based Targets Initiative requirements?** The approach is designed for reporting against SBTI-FLAG targets and is expected to meet the intent of the GHG Land Sector Removals Standard.

- **Why does intervention accounting not apply to this framework?** Incentivizing regenerative practices within this framework creates commodities with lower emissions but does not produce tradeable GHG assets. These emissions data can still be utilized by various entities across the value chain, but is not designed to generate GHG assets as tons to be traded independently of the commodities sourced. By designating a supply shed through a project boundary, the accounting stays within the definition and intent of inventory reporting, simplifying the process and leveraging familiar corporate reporting practices.

- **How does the methodology address the modeling vs. measurement conundrum?** The model vs. measurement for soil organic carbon quantification lies at the crux of creating economically viable regenerative agriculture programs. The GHGP Land Sector Removals Standard draft allows for both approaches as well as a hybrid model-measure approach.[16] The proposed framework prioritizes modeling, calibrated and validated with primary, measured data. For some regions, registry validation reports,[17] may support modeling-only estimates, ensuring that model estimates are a valid approximation of soil carbon stocks and emissions in a given reporting year.

- **How is remeasurement and soil sampling handled?** To meet pending LSRS requirements for removals reporting, soil measurements are needed every five years to validate carbon removals - the "true up." Under the LSRS, any overestimated outcomes would need to be reported in the inventory of the true up year. Data from true up measurements can be used to improve model performance. However, due to the high cost of sampling across large areas, the proposed framework does not mandate such intervals, leaving the decision to project owners. Instead, the framework prioritizes soil sampling for localized calibration and model validation. This approach balances scalability and cost while aiming to align with LSRS principles.

- **How is the baseline inventory recalculated when transitioning to this program?** Re-baselining uses primary data from the original baseline year, supplemented by databases where gaps exist. This approach provides reasonable estimates for reporting against SBTI targets and corporate inventories while addressing the practical limitation in retroactively collecting soil samples.

- **How is permanence monitored?** The Land Sector Removals Standard requires a permanence monitoring plan for any reported carbon removals. In this methodology, permanence is tracked at the project level by monitoring acres and practices throughout the program. Fields leaving the program are counterbalanced by enrolling new ones with comparable practices. This is inline with the proposed LSRS that traceability of removals must be to the land management unit (LMU), i.e. the farm. Remote sensing can fulfill permanence requirements post-program. In cases without ongoing monitoring, the LSRS requires reporting a full reversal of removals.[18] A buffer pool to account for reversals is not a typical approach used for corporate inventory reporting but is used in the case of carbon credit markets to offset the potential for reversals of carbon removals. A buffer pool is not necessary here as any reversals of soil carbon removals would be reported as a net emission in the year in which the reversal occurs.

- **What is the project-level uncertainty of net GHG emissions?** We define the project-level uncertainty of net GHG emissions as the distribution of the total (or per-acre average) GHG emissions driven by cradle to farm-gate activities among the farms enrolled in the inventory project. The distribution of project-level net GHG emissions can then be used to determine the uncertainty of the modeled net emission factor, emission factor, and total tonnes of carbon removals over the project domain.

- **What is HabiTerre's procedure to get the distribution of project-level net GHG emissions and how do we use this to estimate model uncertainty?** We use Markov chain Monte Carlo (MCMC) error propagation estimates to determine the model uncertainty of net GHG emissions driven by field-specific cradle to farm-gate activities. First, for each field in the project, we assume that the net GHG emissions follow a normal distribution, with the mean being the net GHG emissions estimated by the HabiTerre model and the standard deviation set to the validated model errors (or the applicable parameter uncertainties). Next, we perform 10,000 random draws (simulations) from its net GHG emissions distribution to quantify the field-level model uncertainty. In each simulation, we sum the simulated net GHG emissions across all fields to calculate the project-level net GHG emissions distribution. This process results in 10,000 simulated model outcomes of the project-level net GHG emissions, allowing us to derive the model uncertainty for a given inventory project.

- **How are emissions outside the project boundary tracked and combined for reporting?** Emissions outside the boundary can be tracked using any way the sourcing company currently tracks those emissions, whether that be book value emission factors, remote sensing, or another program. Emissions factors within the project boundary are reported separately from external emissions factors.

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- **How is land use change estimated and reported?** For direct land use change, farmer attestation that no land use change has occurred in the previous 20 years should be part of the enrollment documentation. Remote sensing may be used to verify farmer attestation for added assurance at the discretion of the project owner. For indirect land use change (iLUC) estimates, the Land Sector Removals Standard should be consulted for the most up to date methods for estimating iLUC.

- **Is investing in primary farmer data worth the cost compared to remote-sensing alone?** Direct engagement with farmers offers critical benefits, including accelerated adoption of regenerative practices through financial and technical assistance incentives, in addition to providing primary nutrient management data, which can not be remotely observed. This creates lower-emission commodities and enhances supply chain resilience, which remote sensed observations alone cannot achieve.

- **Does the program require third-party verification?** No. Assurance is supported by normal auditing procedures for corporate inventory reporting. However, third-party verification (e.g., by SustainCERT or Verra) is optional and can be added at the project owner's discretion.

- **What deliverables does the downstream sponsor receive at the end of a project year?** Deliverables include: Technical documentation of the methodology
    - **Net emission factor:** (-ΔSOC + N2O + CH4 + other LCA emissions) / remote-sensed (or farmer provided) yield
    - **Emission factor:** (max(-ΔSOC,0) + N2O + CH4 + other LCA emissions) / remote-sensed (or farmer provided) yield
    - **Total tonnes of removals:** - min(-ΔSOC,0) * field acreage
    - Verification of management inputs
    - Uncertainty calculations
    - A summary of field management practices across enrolled fields

- **How can HabiTerre help facilitate services such as grower enrollment, primary data collection, soil sampling, or supply shed delineation for sourcing companies who do not have these capabilities currently?** HabiTerre has developed integrated service offerings with various channel partners who are able to provide a range of both upstream and downstream support services, with the goal of providing a seamless, easily auditable, but still customizable service for the customer. HabiTerre can assist with selecting the partners that best fit specific customer needs.

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[16]Ecosys Model 1.0 Validation Report https://www.climateactionreserve.org/wp-content/uploads/2024/05/ecosys-validation-report-v3.2-2024011 0.pdf
[17]Greenhouse Gas Protocol Land Sector Removals Guidance, part 2. Table 16.6 https://ghgprotocol.org/sites/default/files/2022-12/Land-Sector-and-Removals-Guidance-Pilot-Testing-and- Review-Draft-Part-2.pdf
[18]Greenhouse Gas Protocol Land Sector Removals Guidance, part 1. Section 6.2.1. https://ghgprotocol.org/sites/default/files/2022-12/Land-Sector-and-Removals-Guidance-Pilot-Testing-and- Review-Draft-Part-1.pdf