Final Natural Resources Conservation Service (NRCS) Conservation Innovation Grant (CIG) Report

Project Title:
Scalable on Farm Greenhouse Gas Reductions and Water Quality Improvements: Development and Implementation of an Economical and Verifiable Insetting and Accounting Framework

Project Number: 69-3A75-17-15
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Background/Project Rationale

In the United States, agriculture is responsible for approximately 9% of total greenhouse gas (GHG) emissions or 581 Million Metric Tons of carbon dioxide equivalent (CO_2e) (EPA, 2017). However, unlike other industries, agriculture is also uniquely positioned to be able to pull carbon dioxide (CO_2) out of the air and sequester it in the soil. For this reason, improvements in agronomic practices can significantly reduce agricultural emissions. Although this potential has been recognized for quite some time, unfortunately, to date, initiatives to generate carbon offsets from farms have largely been unsuccessful. Progress in this area has been hindered by a lack of cost-effective methods for gathering farm data, collecting evidence to support practice changes, quantifying emission changes and verifying intervention activities.

The "Scalable on Farm Greenhouse Gas Reductions and Water Quality Improvements: Development and Implementation of an Economical and Verifiable Insetting and Accounting Framework" project began in December 2016. At this time, corporate interest in supply chain interventions that reduce GHG emissions was growing and many coffee, chocolate and cosmetics companies had already begun to implement on-farm emission reduction projects in their supply chains. These supply chain interventions were often called 'insetting' projects. However, at the time no guidance on what insetting was or how the impacts of interventions should be quantified was available. Therefore, there was concern about the credibility and consistency of these insetting claims. Given this and given the challenges associated with past agricultural offsetting initiatives this project aimed to:

1. Develop a verifiable framework for measuring and reporting the environmental benefits of carbon insetting from three Climate Smart Agriculture (CSA) practices; cover cropping, conservation tillage and improved fertilizer management.
2. Develop a low-cost, low-touch system for verifying the environmental benefits of implementing CSA practices.
3. Integrate precision business planning methods into the insetting framework to determine the economic impacts of CSA practices.
4. Create a method for quantifying water quality (reduced nitrogen and phosphorus losses) co-benefits associated with implementing CSA practices.
5. Pilot use of the framework and associated verification, profitability, and water quality tools on Soil Health Partnership (SHP) research strip trials.

The project built upon existing practices and standards for measurement, reporting and verification in the carbon offset space; however, it incorporated the use of emergent technologies such as high-resolution satellite imagery.

The project was co-funded by Bayer. Bayer planned to use the outcomes of this project for its carbon neutral strategy. Furthermore, Bayer wished to share the framework and other tools developed by this project more broadly to help enable broader adoption of CSA practices. Further details about the projects methods, results, challenges, impacts, and next steps are provided below.

Summary of Project Methods and Activities

The project was implemented in six phases over a 39-month (3.25 years) period. A summary of the methods and activities by phase is provided below.

Phase 1 – Project Initiation

Phase 1 commenced with a face-to-face project team meeting. During this meeting the project plan, project objectives and technical aspects of the insetting framework were discussed in the context of Bayer's climate goals. Prior to and after this first in person meeting, monthly calls were held to further discuss technical aspects of the project and initial activities that needed to take place. A roles and responsibilities document and modified workplan were created.

Phase 2 – Carbon Accounting and Insetting Framework Development

Phase 2 began with a review of existing insetting programs and available tools and models for quantifying on farm emission reductions. After this, the project team began to draft the insetting framework based on ISO 14064:2 and ISO 14064:4 guidance and the input of the advisory committee. This task was initially scheduled to be complete by the Spring of 2017. Although a draft of the framework was created early in the project, the document underwent several rounds of revisions as the project progressed and the global dialogue on insetting evolved. Further details about this process are provided in the section on results below.

Phase 3 – Water Quality Co-Benefits Measurement

Originally, the project team planned to model and calibrate water quality metrics; however, the Ag Solver runs ended up focusing on carbon instead of water. As a result, it was not possible to update the DNDC model as initially planned. Instead, an analysis of the impact of using no-till (vs. conventional till) and cover crops (vs. no cover crop) on rates of nitrate (NO_3) leaching was completed using the DNDC model. Data from county level summaries of DNDC simulated NO_3 leaching rates from more than 1.7 million field segments were used in this analysis. The purpose of the analysis was not to compare the difference in the absolute size of the effect of each practice on NO_3 leaching, but instead to establish a general classification of a positive or negative effect. The investigation found that when there was an effect, the effect was positive. This means that on average the higher the percent of conventional tillage in a county, the higher the county level rate of NO_3 leaching. Further, the higher the percent of no cover cropping in a county, the higher the rate of NO_3 leaching. Nevertheless, for most counties, the effect of no cover cropping was found to be non-significant. This may reflect the lack of variability in the percentage of no cover cropping in counties in the dataset. Overall, the analysis concluded that on average conventional tillage is associated with increased rates of NO_3 leaching, while there was insufficient contrast in no cover cropping percentages to make conclusions. Further details can be found in the full report, which is available and can be submitted if desired.

Phase 4 – Low-cost and Low-touch Verification System Development

In Phase 4 the Operational Tillage Information System (OpTIS) was used to observe and quantify tillage practices, cover cropping practices and crop residue on the selected Soil Health Partnership (SHP) farms. OpTIS is an automated system for mapping tillage, residue cover, winter cover and soil health practices on farms using remote sensing data. The OpTIS data was validated through ground-truthing. Specifically, field visits were completed to collect cover cropping data for the surrounding watersheds and the validation process demonstrated that OpTIS maps conservation practices with accuracy greater than 80% Furthermore, Sentinel-2 and Landsat imagery were incorporated into the OpTIS system. Once this was complete, OpTIS was used to map the conservation practices on the selected Soil Health Partnership pilot project sites.

Initially the project had planned to demonstrate/determine the accuracy of high-resolution satellites (<10-meter spatial resolution) in detecting tillage practices and cover crops; however, obtaining consistent, usable high-resolution satellite imagery was more difficult than expected. Satellogic, the project team's original partner was not able to provide imagery due to technical issues with the launch of its satellites. Nevertheless, the project team was able to obtain high resolution satellite imagery for multiple SHP sites for multiple years from the SPOT4 and Planet Labs satellites with spatial resolutions between 3 and 5 meters. Analysis on these farms indicated that higher resolution imagery was more sensitive and better able to detect tillage and cover crop practices than 10-meter imagery, but cost and availability hinder its usefulness. The possibility of using drone imagery was also explored. Drone imagery was very successful in mapping tillage and cover crops, including residue levels and percent biomass; however, cost, logistics and FAA restrictions on the use of drones once again hamper practicality. Overall, given the current limited availability of high-resolution satellite imagery, it was not possible to develop automated algorithms for providing conclusive and gapless verification of cover crop, tillage and residue management practices using high spatial resolution imagery as initially planned.

Phase 5 – Integration of Decision Service Tools, Verification Systems and Framework Demonstration

In Phase 5 the project team piloted use of the framework and tools developed in Phases 1 through 4. Specifically, the project team:

1. Engaged several SHP growers and collected data from their farms to complete an economic evaluation of the climate smart agriculture (CSA) practices implemented. The results were summarized in precision management business plans, which were shared with the farmers.
2. Piloted the use of the Carbon Accounting and Insetting Framework (CAIF), soil organic carbon quantification methodology and low-cost, low-touch monitoring, reporting and verification system on a subset of SHP farms.
3. Generated inset project plans outlining how the CAIF was applied for the pilot.
4. Refined the CAIF and verification approach as needed.
5. Identified outstanding challenges.
6. Gathered the farm data needed to calculate the carbon insets generated. Used this data along with the soil organic carbon coefficients to quantify the insets generated. Summarized the findings in an inset report for the mock verification.
7. Completed a mock-verification of the pilot.
8. Quantified the uncertainty of the meta-model based on the county coefficients used in the quantification.
9. Hired a third-party verifier to review the project (completed by Gold Standard and SustainCert)

Additional Work Completed

Part way through the project (2018), the Gold Standard released its draft Value Chain Interventions Guidance. This guidance was developed by the Gold Standard in collaboration with Danone, Livelihoods Funds, WWF, MARS, the Science Based Targets Initiative, CDP and UNEP. Gold Standard was identified as the entity who could facilitate, through Ag working groups, and their various Pilots, further development of the Value Chain Guidance. The guidance was meant to inform for Agri-Food corporates how they may embed emission reductions from interventions in their supply chains (or Scope 3 emissions) and report those against their GHG inventories (using the WRI GHG Protocol). Shortly after, the Gold Standard also released is draft Soil Carbon Guidance. This document provides guidance on how to quantify carbon sequestered in soil. Collectively, these two pieces of guidance influenced the global dialogue on carbon insetting. Given this, the project team reviewed both documents and identified an opportunity to align this project with the Gold Standard's work. Specifically, the project team saw an opportunity to broaden the Gold Standard 2018 guidance by adapting its 'supply shed' concept for agri-food companies (i.e.

companies sourcing products from farms such as MARS, Danone and others), into a 'sales shed' concept that could be used by agri-input companies (i.e. along with Bayer, Syngenta and Nutrien who are now participating) interested in influencing on-farm interventions. In this respect, we have broadened the opportunity for multiple entities to collaborate and invent on farm to bring about reductions and removals through interventions. The relationship between agri-supplier and agri-food corporations' scope 3 emissions is provided in Figure 1 below.

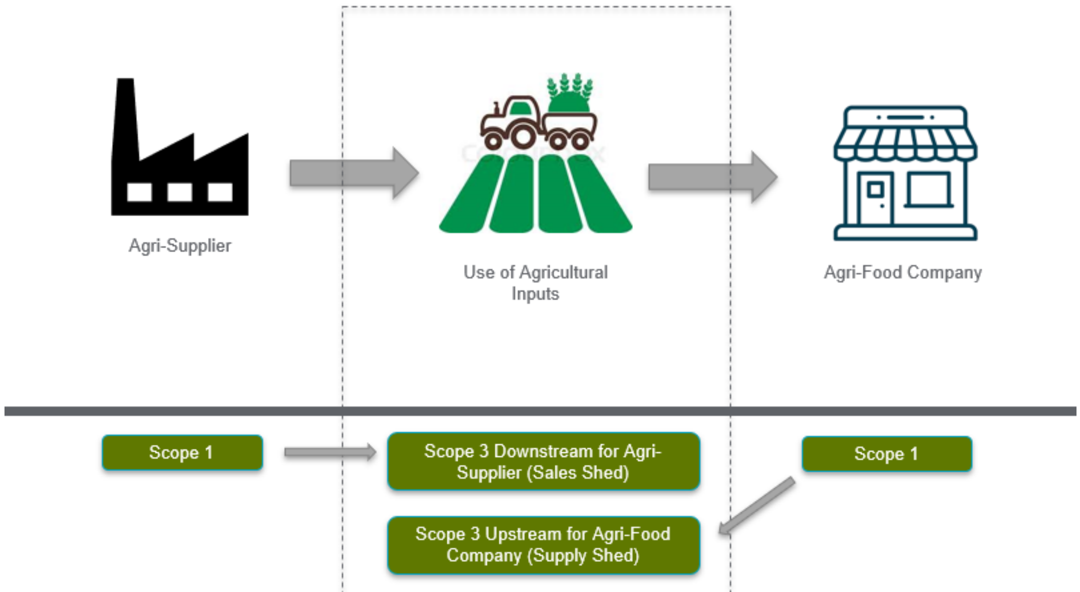

Figure 1: The Intersection of Scope 3 Emissions Between Agri-Suppliers and Agri-Food Corporations

Given the above, the project team reached out to the Gold Standard to discuss how the Carbon Accounting and Insetting Framework (CAIF), soil organic carbon methodology and SHP Pilot work could be assessed. After several discussions about this process, a service agreement was signed for SustainCERT to proceed with verification of the SHP Pilot, and for Gold Standard to review and recognize the Soil Organic Carbon methodology developed by the Team. To date, the project has undergone three and now the final round of review of the soil organic carbon methodology with the Gold Standard Technical Advisory Committee, despite the methodology being published in the Journal of Cleaner Production. This has delayed what the project team thought would be a straight-forward certification process. All of this back and forth effort on the SOC methodology has resulted in Gold Standard realizing that it will need to publish guidelines for Scope 3 SOC estimates on model evaluation, uncertainty and continuous improvement. What works for carbon markets should not be applied to insetting/scope 3 so once again, this project is blazing new trails and helping to shape those who come after us, such as ESMC or Nori. It is anticipated that the pilot will be certified soon; however, the methodology will likely require further revisions to be recognized. Furthermore, Gold Standard recognizes that the CAIF for agri-input suppliers is a gap in their initial design of Value Chain Interventions guidance and they want to work with our team to either adapt the CAIF as an addendum to their 2020 Value Chain Guidance update or pull elements out of it to incorporate into the updated guidance. Additional details are provided in the section on next steps below.

Results

The results of this project are summarized by objective and deliverable in Table 1 below.

Table 1: Summary of Project Results

Objective	Proposed Deliverable	Result/Outcome
Objective #1: Develop a verifiable framework for measuring and reporting the environmental benefits of carbon insetting from three CSA practices at a commercial field scale, to facilitate conservation finance.	Carbon Accounting and Insetting Framework (CAIF)	A Carbon Accounting and Insetting Framework (CAIF) that discusses and recommends approaches for addressing several key criteria, such as additionality, double counting and leakage, has been created. In addition, a set of inset design documents and inset reports were created for the pilot project. Unfortunately, due to lack of adoption of improved fertilizer management practices among the pilot farms, emission changes were only quantified for cover cropping and no-till interventions.
Objective #2: Build a method for quantifying water quality (reduced N and P losses) co-benefits associated with implementing CSA practices. Metrics include reductions in nitrate leaching and sediment and phosphorus loss.	Initially, a water quality co-benefits document outlining the metrics and models used to quantify water quality benefits was planned, but the AgSolver analysis focused on carbon only and not water. Therefore, Plan B was to use the SHP sites in Illinois that had some U of Illinois water quality measurements that could be used to identify linkages between soil carbon, emissions and water quality and calibrate DNDC to assess the impacts of the SHP strip trial practices.	Due to the Project Team being unable to obtain the water quality measurements conducted by a 3rd party on an SHP site during the timeframe for analysis, Plan C was completed which used DNDC to analyse the impact of no-till (vs. conventional till) and cover crops (vs. no cover crop) on rates of nitrate (NO_3) leaching for 1.7 million field segments w/ county level data. (see Phase 3 above). Overall, the analysis concluded that on average conventional tillage is associated with increased rates of NO_3 leaching, while there was insufficient contrast in no cover cropping percentages to make conclusions.
Objective #3: Develop a low-cost, low-touch system for	Demonstration of a process to prove in a gapless way that	OpTIS was used to map residue cover and cover crops in two

Objective	Proposed Deliverable	Result/Outcome
verifying the environmental benefits of implementing CSA practices. Compare two systems to evaluate performance, accuracy, reliability and cost: (1) Sentinel-2 imagery integrated with Landsat imagery in OpTIS over two MLRA's and six million acres; and (2) Microsatellite (e.g. Satellogic) constellations on 10 fields.	tillage disturbances can be tracked/verified (for permanence purposes); demonstration and validation of the OpTIS system for the project sites; linkage of the outcomes of the OpTIS system with the models being used to measure water quality benefits and a procedures document outlining how to use the data in a verification.	areas (NE Iowa and central Illinois) over four years (2015 – 2018). Certified crops advisors were also engaged in these regions to gather road-side information for validation purposes. Over 800 fields were analyzed. The results showed that OpTIS estimates of cover crops and residue cover matched the road-side observations well. Specifically, the kappa statistics for both practice types exceeded 0.60, suggesting that OpTIS is a useful tool for providing low-cost tracking of conservation practices at the field scale. Furthermore, OpTIS evaluation of SHP fields showed consistently higher rates of adoption of conservation practices on SHP fields in comparison to other fields not in the SHP program.
Objective #4: Integrate precision business planning methods into the insetting framework to determine the economic impacts of CSA practices by measuring profit ($/acre), return on investment (%), production efficiency (bushels/$1000), N efficiency (bushels/lb N), P efficiency (bushels/lb P) and K efficiency (bushels/lb K).	A document showing that all SHP participants are in the precision business planning framework along with associated outcomes (e.g. ROI, enhanced economic performance, etc.) for a total of approximately 200,000 acres.	All SHP growers received precision business planning reports. Unfortunately, documentation demonstrating this is unavailable due to the sale of AgSolver during the life of the project.
Objective #5: Pilot use of the framework and associated verification, profitability and water quality tools on Soil Health Partnership (SHP) research strip trials and then expand to approximately 200,000 acres to demonstrate scalability.	The production of credible, defensible insets that take a pragmatic approach to carbon offset policy criteria.	The framework, soil organic carbon quantification methodology and low-cost, low-touch verification system were piloted, and insets were generated. At the time of writing, the project team has been working through the SustainCert certification process for approximately six months. It

Objective	Proposed Deliverable	Result/Outcome
		is anticipated that in the near the future the pilot receive SustainCert certification.

List of Outputs, Outcomes, Deliverables and Products with Links

The following outputs from the project are currently posted publicly and available online:

- Key Issue Discussion Papers on Additionality, Aggregation, Permanence and Verification - https://climatesmartgroup.com/initiatives/
- A Tableau website showing the results of the Soil Organic Carbon Methodology - https://public.tableau.com/profile/gabe.mcnunn#!/vizhome/SoilGHGEmissionsEstimatesbyPracticeCountyScale/Dashboard1

In addition to the above, the project has created a Carbon Accounting and Insetting Framework (CAIF), mock verification reports, inset design documents, inset report and meta-model. Furthermore, a manuscript titled "Projected Climate Smart Agriculture Opportunities for Reducing GHG Emissions" has been submitted for publication to the Journal of Cleaner Production. The manuscript is currently undergoing a second round of revisions and the project team is hopeful that is will be accepted for publication.

All final documents will be shared with USDA through a Dropbox folder. In addition, Bayer is organizing a launch for this program in Washington, D.C. in June once the SustainCert verification process is complete. Several other companies have expressed interest in participating in the broader program across the U.S. Mid-West.

At present multiple aspects of the project are still being reviewed by SustainCert, including:

- The Carbon Accounting and Insetting Framework (CAIF)
- The soil organic carbon methodology
- The Soil Health Partnership pilot program

The CAIF will be modified later this year after the completion of the Gold Standard's use of products sold labs. It is hoped that aspects of the CAIF, including the sales she concept will be incorporated into the Value Chain Interventions Guidance. If this occurs, it will enable the opportunity for agri-suppliers to participate in the Value Change Program (aka insetting).

More broadly, through this CIG, the project team has influenced the Gold Standard and SustainCert's thinking on the following aspects of their Value Change Program:

- The use of agricultural technology and inputs in North American agriculture.
- The scope of companies that contribute to on-farm GHG reduction interventions. Specifically, the CIG project has advocated for the inclusion of corporations selling agricultural inputs to farms through a sales shed concept. This would enable companies such as Bayer to participate and capture on-farm emission reductions in their down stream scope 3 use of products sold emissions.
- Model quality and uncertainty in scope 3 interventions (aka insetting). Specifically, in seeking recognition of the project team's quantification methodology, the Gold Standard identified a need for a discussion paper on model quality and uncertainty for the insetting community. The project team will work with the Gold Standard to draft this document.

It is hoped that this work will pave the way for those who follow, such as Ecosystem Services Market Consortium (ESMC) and Nori.

Challenges

The three main challenges that this project faced over its three-year lifespan were:

1. Changes in project partners and staff resources;
2. Shifts in the global insetting landscape; and
3. Data limitations

Throughout the project's life there were several changes in the core project team. Although this is to be expected in a three-year project, it can pose a challenge as some knowledge is lost with the loss of each team member. Nevertheless, one of the benefits of team turnover is it allows for a broader range of individuals to influence the project's direction over time.

Since early 2016, when the project team first summited its application, global civil societies have brought an increasing amount of standardization to the insetting space. This is in part embodied in the value change program of the Gold Standard. Over the course of 2020, a significant amount of effort will be spent on further developing the value chain guidance. Specifically, working group labs are currently being held on double counting, emission factor tracking, use of products sold and how to handle soil removals in the context of Science Based Targets Initiative (SBTi), carbon neutral and net zero. Given the current global landscape on insetting, the project team has had to continuously adapt its approach and determine how it can best compliment and contribute to these developments.

The last challenge this project faced was data limitations. The on-farm data used in this project was not collected with this purpose in mind. As such it posed somewhat problematic when it came to apply the input data to the emissions quantification model.

Impact on Conservation

This objective of this project was to develop and pilot a framework for encouraging adoption of climate smart agriculture practices on U.S. Mid-West farms. Specifically, this project was focused on three practices:

- Cover cropping;
- Conservation tillage methods (no-till or strip tillage); and/or,
- Advanced nutrient management techniques (such as 4R or similar beneficial management techniques).

These practices are known to have a positive environmental impact on soil health, agricultural GHG emissions and crop productivity. More specifically, the use of cover crops helps manage soil erosion, improves soil fertility, increases soil carbon sequestration and minimizes weeds and pests. Conservation tillage also enhances soil carbon sequestration by reducing carbon loses to the atmosphere when soil is disturbed. Finally, advanced nutrient management techniques which call for the judicious application of fertilizers, reduce nitrogen loss from fields, enhance crop productivity, reduce nitrate leaching, reduce phosphate leaching and reduce nitrous oxide emissions.

Unfortunately, due to low adoption rates of advanced nutrient management techniques on SHP farms, the project team was unable to pilot this practice using the CAIF and low-cost, low-touch verification approach. Nevertheless, the CAIF was designed to enable adoption of a wide variety of climate smart agriculture practices and therefore it is hoped that advanced nutrient management will be part of the larger roll out.

In total, 1,044 tCO_2e of emission reductions and removals were generated and validated as part of this pilot project. Although this value is small, the intention of this project was to test and revise the approach as opposed to generate large volumes of emission reduction and removals at this stage. In the larger roll out of the program, the emissions reductions and removals will increase.

Next Steps

Moving forward the project team plans to:

1. Continue to work with the Gold Standard to integrate aspects of the CAIF into the Gold Standard's Value Chain Interventions Guidance. Currently, this guidance is designed to only be used by corporations that are sourcing agricultural commodities from farms that would like to influence upstream Scope 3 interventions on these farms to lower their emissions. In contrast, the CAIF enables agri-suppliers, such as Bayer, that are selling inputs to farms to account for on-farm interventions in their downstream end use of sold products Scope 3 emissions. The Gold Standard has created a working group to discuss this issue, which will be holding its first call in April 2020. The project team for this project intends to be active participants in this group and to play a key role in influencing this discussion. In addition, the project team will continue to participate in two other working groups being held by the Gold Standard on their Value Chain Interventions Guidance. These working groups are focused on double counting and emissions factor tracking.
2. Continue to work with the Gold Standard to explore options for refining the project team's soil organic carbon quantification methodology to meet the requirements of their review process.
3. Expand the pilot into a program that involves multiple corporations and their supply chains in the U.S. Mid-West. This will occur once SustainCert has completed its certification process.