SMARTFARM—Systems for Monitoring and Analytics for Renewable Transportation Fuels from Agricultural Resources and Management

PROJECT DESCRIPTIONS

University of Illinois – Urbana, IL

The "System of Systems" Solutions for Commercial Field-Level Quantification of Soil Organic Carbon and Nitrous Oxide Emission for Scalable Applications (SYMFONI) - $4,500,000

Accurate and rapid field-level quantification of carbon intensity at a regional scale is critical to facilitate adoption of new technologies to increase the bioeconomy's feedstock productivity and reduce its carbon footprint. The University of Illinois will develop a commercial solution, SYMFONI, to estimate soil organic carbon and the dynamics of nitrous oxide emissions at an individual field level. The solution can be scaled up to perform per-field estimates for an entire region. SYMFONI is a "system of systems" solution that integrates airborne-satellite remote sensing, process-based modeling, deep learning, atmospheric inversion, field-level sensing, and high-performance computing.

University of Utah – Salt Lake City, UT

Soil Organic Carbon Networked Measurement System (SOCNET) - $1,899,317

The inability to measure on-the-spot underground carbon flux and storage within an economically sensible operation cost limits the accurate quantification of carbon sequestration, capture, loss, and storage necessary to achieve a carbon negative bioeconomy and biofuel supply chain. The University of Utah aims to develop and deploy a distributed carbon sensor system that is buried into the soil, capable of locally stimulating a surrounding volume of soils at multiple depths, and sensing carbon and carbon flux at ultra-low operational cost. The sensor will enable high-accuracy and real-time decision data for cost-effective carbon removal, storage, and management.

Soil Health Institute – Morrisville, NC

A Rapid In-Field System to Measure Deep Soil C Stock and Flux - $3,250,609

The Soil Health Institute aims to develop an integrated soil carbon measurement and monitoring system—the DeepC System—that meets current and future needs for carbon markets in agriculture. The system comprises three main components: in-field measurement hardware, an optimized spatial sampling algorithm to select measurement sites, and machine learning calibrations that leverage the current infrastructure of national soil spectroscopy libraries. As a system, these components synergistically allow a user to obtain rapid, non-destructive measurements of soil carbon stock.

Princeton University – Princeton, NJ

NitroNet: Smart System to Quantify Nitrous Oxide Emissions - $3,004,563

Nitrogen management for agricultural production of crops, the primary source of nitrous oxide (N_2O), contributes approximately 4% of all greenhouse gases from the U.S. annually. Quantifying these emissions, which are non-uniform in space and time, is a significant challenge at the field and farm scales. NitroNet is an

autonomous sensing system designed to monitor N_2O emissions over an entire growing season at high spatial and temporal resolutions. By casting a virtual "net" over an entire field, NitroNet will monitor the non-uniform N_2O emissions within the field using atmospheric laser imaging. The total nitrogen loss over a growing season through N_2O emissions will be quantified to inform practices that minimize the climate change impacts and environmental harms of agricultural crop production.

Michigan Aerospace Corporation – Ann Arbor, MI

DroN$_2$O: A Drone-Based System for Measuring Nitrous Oxide Emissions from Agricultural Fields - $1,967,446

Michigan Aerospace Corporation proposes to develop an inexpensive system to sense nitrous oxide (N_2O) emissions from agricultural fields using laser-based sensors mounted on drones. These sensors include an optical absorption cell, a short-range miniature wind LiDAR, and a camera for plant health and ground assessment. The measurements from these sensors will be combined and processed with artificial intelligence-enabled software to accurately measure N_2O emissions from a given farm field during the entire growing season. The resulting data will provide farmers of bioeconomy feedstock crops with tangible incentives to alter farming practices in ways that reduce greenhouse gas emissions.

Dagan, Inc. – Durham, NH

Integrating Sensors, Remote Sensing and DNDC Model for Quantifying GHG Emissions - $1,840,203

Spatial and temporal variability of soil carbon stocks and environmental drivers that cause the production and flux of nitrous oxide (N_2O) across agricultural systems create challenges for cost effective quantification of N_2O emissions and soil carbon stock changes at scale. Dagan proposes to build, validate, and demonstrate an integrated system for reliable and cost-effective measurement of field-level soil carbon and N_2O emissions. This system will consist of the following four components: a field sampling and measurement system; subfield scale process modeling to improve the quantification of soil carbon and greenhouse gas emissions; a detailed model validation system for quantification of model uncertainty; and an operational platform for implementing the system at scale.