PROGRESS UPDATE 2024

Dairy Soil & Water Regeneration

"We are optimistic that the DSWR findings will have lasting impacts on how dairy farmers grow feed and shape their carbon footprints."

– Dr. Reza Afshar, Dairy Management Inc.

Checking in on the eight-year project assessing how farming practices affect soil health, agronomics, greenhouse gases and water quality in dairy feed production.

OVERVIEW & PROGRESS

Dairy farmers who are considering implementing sustainable field practices face the challenge of having limited quantifiable data to guide them. To address this gap, Dairy Management Inc. and the Soil Health Institute initiated DSWR in collaboration with research partners at eight institutions to advance progress toward the dairy industry's collective 2050 environmental stewardship goals, established through the Innovation Center for U.S. Dairy. By using comprehensive measurements for soil health, water quality, greenhouse gas and forage yield and quality, researchers are comparing soil health management systems to conventional field practices on working dairies and research farms in key dairy states. Now in its fourth year, the project is beginning to demonstrate the impact of these systems. 2024 marked the completion of a baseline of soil health and carbon storage on dozens of dairy farms across the U.S. and saw findings from extensive field trials come into clearer focus. DSWR will provide science-based strategies to better inform guidance, practice standards, incentives and markets.

BY THE NUMBERS

32,729 soil greenhouse gas measurements

1,046 soil health samples

577 yield measurements

6 water-focused trials

PROJECT FRAMEWORK

Most of the data collected thus far originates from the various DSWR research partners, who are extensively engaged in field trials.

TASK 1:	TASK 2:	TASK 3:
Baseline data collection on soil health in dairy regions 2022-2024	Field trials at research sites 2021-2029	Outreach and modeling work
100% Complete	50% Complete	Ongoing

University of Vermont team collecting samples to assess soil health (Image courtesy of Bruce Gibbs)

PARTNERS

DSWR is largely supported by the Foundation for Food & Agriculture Research, which awarded $10 million toward this work, and matching funds from companies like Dairy Management Inc., Newtrient, Nestlé and Starbucks.

FFAR® · DMI DAIRY MANAGEMENT INC.™ · INNOVATION CENTER FOR U.S. DAIRY HEALTHY PEOPLE • HEALTHY PRODUCTS • HEALTHY PLANET · SOIL HEALTH INSTITUTE Enriching Soil, Enhancing Life · NEWTRIENT INNOVATIVE SOLUTIONS IN RESOURCE RECOVERY · Nestlé · ™

FINDINGS TO DATE

Interested in previous findings? Check out last year's Progress Update!

GHG = greenhouse gas | **SHMS** = soil health management systems | **Novel manure products** = evaporative and flocculated manure solids
Evaporative manure solids = derived from liquid manure by removing moisture, often through heat, creating a drier and more solidified product
Flocculated manure solids = manure treated with a flocculating agent to aggregate fine particles into larger solids that separate from liquid

STATE	STUDIES DESCRIPTION	SNAPSHOT OF FINDINGS TO DATE
CALIFORNIA Dairy Farm UNIVERSITY OF CALIFORNIA Agriculture and Natural Resources	Comparing how differences in tillage and manure amendments affect GHG emissions, soil health and crop yields in a forage sorghum-triticale rotation.	**Productivity:** On average, sorghum and triticale yields were slightly smaller in SHMS. **GHG:** Applying compost or manure solids early in the season increased methane emissions in conventional plots. Depending on the size of the experiment, there were mixed results in terms of increased nitrous oxide emissions between SHMS and conventional field practices.
CALIFORNIA Almond Orchard UCDAVIS	Evaluating the combination of fertigation and composted dairy manure in almond production to enhance yields, improve soil health and reduce GHG emissions.	**Productivity:** No significant yield differences among treatments, with fertigation plus compost treatments being slightly higher. **Soil health:** Soils amended with compost consistently showed higher levels of dissolved organic carbon. **GHG:** Relative to fertigation only, fertigation plus compost significantly reduced nitrous oxide emissions. There were no significant differences in methane emissions, but all treatments were net methane sinks, removing atmospheric methane.
IDAHO Research Farm USDA ARS	Exploring effects of novel manure products in soils with and without prior manure application in a corn silage-triticale rotation. A two-year study evaluated the nitrogen fertilizer replacement value of manure.	**Soil health:** Novel manure products did not affect soil organic carbon or total nitrogen. Soil microbial activity was higher in plots with prior manure application and in those treated with evaporative solids, while flocculated solids plots were similar to the controls. **GHG:** In three out of four growing seasons, the greatest nitrous oxide emission fluxes occurred during the first few irrigation events, then dropped to near background levels. In 2023, emissions were low overall; however, plots treated with evaporative solids still showed slightly higher emissions. Across the other three years, cumulative nitrous oxide emissions were highest in plots treated with evaporative solids, followed by those treated with flocculated solids and the control plots. **Nitrogen replacement:** In the first year after applying manure, the novel manure products responded well to added nitrogen fertilizer, resulting in higher yields. However, all manure treatments boosted yields regardless of how much nitrogen fertilizer was added, suggesting that manure provides benefits beyond just nitrogen.
NEW YORK Dairy Farm & Custom Dairy Forage Producer CornellCALS College of Agriculture and Life Sciences	Investigating two field studies comparing SHMS and conventional practices in a corn silage-alfalfa rotation. Treatments vary by tillage, novel manure products and cover crops. A two-year study also assessed the nitrogen fertilizer replacement value of manure.	**Productivity:** At one experimental site, SHMS corn silage yields were lower, likely due to soil compaction associated with no-till practices. The second site observed a decrease in corn silage yield in the first year following the application of novel manure products; however, yields were similar across treatments in subsequent years, likely due to enhanced nutrient retention and the slow release of nutrients from the novel manure products. **Soil health:** Soil health indicators have been unresponsive to treatment at both sites. **GHG:** At one site, SHMS showed lower yield-scaled nitrous oxide emissions in the third year, but emissions were similar to the conventional system in earlier years. At the second site, novel manure products led to lower yield-scaled nitrous oxide emissions compared to conventional practices, also in the third year. **Nitrogen replacement:** In Years 1 and 2 (carry-over year), liquid dairy manure boosted yields beyond what was achieved with inorganic fertilizer alone. Novel manure products slightly reduced yields in Year 1 but led to yield increases in Year 2. No treatment replaced the need for nitrogen in Year 1, but the higher yields in Year 2 increased the need for sidedress nitrogen applications.
TEXAS Research Farm Texas A&M AgriLife Research	Studying agronomic water conservation strategies using five manure treatments in forage sorghum – evaporative solids, injected manure, broadcast manure, synthetic fertilizer and a control – within conventional field practices and SHMS.	**Productivity:** No significant yield differences among nutrient treatments. Conventional practices had higher yields than SHMS. **Soil health:** Soil total carbon was higher in conventional plots in 2023 and 2024. Bulk density increased slightly since 2023, though not significantly, likely reflecting higher carbon levels, especially in tilled soils. **GHG:** Manure and synthetic fertilizers increased carbon dioxide emissions compared to no fertilizer, particularly in plots treated with evaporative solids. SHMS showed higher carbon dioxide emission, which was not directly linked to the type of soil amendment applied. Methane emissions were negative (oxidative conditions), with non-significant increases occurring alongside farming activities. SHMS with strip tillage, synthetic fertilizer and manure showed short-term nitrous oxide peaks. **Soil moisture:** After the second cover crop season, there were no significant differences in soil moisture among nutrient and tillage treatments. However, at harvest, the SHMS plots showed significantly higher soil moisture throughout the soil profile.
VERMONT Dairy Farm The University of Vermont	Examining how SHMS interacts with the climate and water dynamics of the Champlain Basin's clay soils in corn and alfalfa.	**Soil health:** Following an unseasonably heavy rainfall in 2023, total carbon, total nitrogen and soil bulk density differed across low and high points in the study field. **GHG:** Methane emissions were greatest in SHMS and in low areas of the field across all the treatments. SHMS increased nitrous oxide emissions in the low areas of the field. Flocculated solids had the lowest GHGs. **Water quality:** An edge-of-field phosphorus filter removed 80% of total phosphorus and 95% of soluble phosphorus from tile drainage effluent over two years.
WISCONSIN (Madison) Research Dairy Farm WISCONSIN UNIVERSITY OF WISCONSIN-MADISON	Conducting two studies comparing SHMS and conventional systems in corn silage production. A two-year study also evaluated the nitrogen fertilizer replacement value of manure.	**Productivity:** At one site, yields were initially depressed in SHMS, but the yield gap nearly closed by the fourth growing season. **Soil health:** No differences seen in soil water infiltration rates between conventional and SHMS tillage practices. **GHG:** Novel manure products sustained yields relative to liquid dairy manure with no additional impact on nitrous oxide emissions. **Nitrogen replacement:** Though marginal differences in nitrous oxide exist among liquid manure and novel manure products, lower emission factors suggest more applied nitrogen is recovered by the corn silage crop in plots receiving novel manure products.
WISCONSIN (Platteville) Research Dairy Farm UNIVERSITY OF WISCONSIN PLATTEVILLE	Analyzing SHMS and conventional field practices in corn silage for GHG emissions, soil health, crop yield and water quality outcomes.	**Productivity:** No significant differences in corn silage yield between treatments. **Soil health:** SHMS enhanced soil aggregate stability and water holding capacity. **GHG:** SHMS plots showed elevated carbon dioxide emissions, likely due to increased soil biological activity. Annual cumulative nitrous oxide emissions were also significantly higher under SHMS compared to conventional practices. **Water quality:** Conventional field practices had significantly greater phosphorus and sediment loads to surface water. SHMS were associated with a larger volume of water moving through the rooting zone.

The content and information on this page have been reviewed and approved by the associated institutions.

For further information on site-specific projects, visit dairysoilwater.org.

Thank you to partners, funders and other DSWR supporters for contributing to U.S. dairy sustainability!