

PROGRESS UPDATE 2025

Dairy Soil & Water Regeneration



"The intensive data collection and sampling are providing a high-quality data set that is specific to dairy production and will ultimately be used to improve crop and environmental system models, which will assist farmers with making management decisions."

– Victor Green, Dairy Management Inc.

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

OVERVIEW & PROGRESS

The Dairy Soil & Water Regeneration (DSWR) project was initiated by Dairy Management Inc. and the Soil Health Institute in collaboration with research partners at eight institutions across the country to advance progress toward the dairy industry's collective 2050 environmental stewardship goals, established through the Innovation Center for U.S. Dairy. Taking a unique, whole-systems approach, DSWR is studying the effects of various management practices on soil health, greenhouse gas (GHG) emissions, water quality and forage yield and quality in dairy feed production. Quantifiable data collected through comprehensive on-farm measurements is being used to compare soil health management systems, such as implementing reduced tillage, cover crops and novel manure-based products, to conventional practices on commercial dairies and research farms in key dairy states. The results will assist farmers in decision-making and build a foundation for evidence-based strategies to inform guidance, practice standards, incentive programs and market opportunities for dairy farms. 2025 marked the completion of field work in multiple extensive trials and the beginning of comprehensive data analysis. Because site conditions, crops and treatment durations differ across locations, findings should be interpreted within each site context.

PROJECT FRAMEWORK

TASK 1:

Baseline data collection on soil health in dairy regions 2022-2024

100% Complete

TASK 2:

Field trials at research sites 2021-2027

83% Complete

TASK 3:

Outreach and modeling work

Ongoing

BY THE NUMBERS

	Soil GHG Measurements	Soil Health Samples	Yield Measurements	Publications
2021-2023	22,059	798	398	0
2024	32,729	1,046	577	3
2025	51,857	1,277	960	6



University of Wisconsin-Platteville and University of Wisconsin-Madison hosted project partners at field days during the annual team meeting

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.



PROGRESS ACROSS THE COUNTRY

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Update at dairysoilwater.org

KEY: GHG = greenhouse gas | SHMS = soil health management systems, including practices like cover crops, reduced tillage and novel manure products
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

NORTHEAST

NEW YORK

Cornell CALS
College of Agriculture and Life Sciences

Dairy Farm & Custom Dairy Forage Producer

STUDY DESCRIPTION:

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.

FINDINGS TO DATE:

Productivity: At one site, the SHMS and novel manure products continued to show corn silage yields similar to liquid dairy manure applications. An alternative site observed lower yields in SHMS than conventional practices in previous years, with smaller gaps in 2025.

Soil health: No significant difference in indicators among treatments at one site. At the second site, nitrate tests indicated adequate soil nitrogen levels in conventional plots but limited levels in SHMS where compost application likely caused compaction and contributed to additional weed pressure compared to the conventional plots.

GHG: Nitrous oxide emissions were elevated following liquid manure application and sidedress nitrogen application at both sites, but



Dr. Asmita Gautam, postdoctoral researcher, checks a datalogger at a corn silage field site.

higher in conventional practices with liquid dairy manure compared to SHMS. Data analyses are ongoing to determine if such elevated emissions are source-specific and/or influenced by the overall nitrogen application rate. Incubation studies showed limited nitrous oxide emissions when soil nitrate and/or moisture levels are low.

Nitrogen replacement: Evaporative and flocculated solids increased yields in the second year after application, showing the novel manure products' positive carry-over benefits. No differences were observed in year one because the original soil nitrogen supply levels were sufficient in providing crop needs. No carry-over benefits were documented in year three in any nutrient source.

VERMONT

Dairy Farm

University
of Vermont

STUDY DESCRIPTION:

Examining how SHMS and flocculated manure solids interact with field topography (low and high points of the field), climate and water dynamics of the Champlain Basin's clay soils in corn silage.

FINDINGS TO DATE:

Productivity: At one of the two field sites, conventional practices produced slightly higher crop yields than SHMS. 2025 yield analysis for the second site is underway.

Soil health: Continued differences were observed in soil health indicators across field topography. No significant differences between conventional and SHMS treatments.

GHG: Nitrous oxide emissions remained highest in wet, low areas of the field and lowest in areas with flocculated solids compared to liquid dairy manure. Following extreme drought, rewetting and late-season manure application, nitrous oxide emissions in conventional-low plots exceeded those in SHMS-low plots for the



Molly Ratliff, graduate research assistant, and Shealagh Brown, summer undergraduate intern, perform GHG sampling at a corn silage field site.

first time during the study. Methane emissions in all treatments were substantially lower than previous years due to drought but remained net methane sources.

Water quality: Preliminary results indicate conventional practices generated approximately 50% greater runoff loads and nutrient concentrations than SHMS. Filters on tile drainage removed over 80% of dissolved phosphorus loads from effluent at the conventional field site.

PROGRESS ACROSS THE COUNTRY

MIDWEST

WISCONSIN (Platteville)

Research Dairy Farm



STUDY DESCRIPTION:

Analyzing grazing pasture, SHMS and conventional field practices in corn silage for GHG emissions, soil health, crop yield and water quality outcomes.

FINDINGS TO DATE:

Productivity: No significant differences in corn silage yield between conventional practices and SHMS.

GHG: 2025 GHG analysis is underway.

Soil health: Grazing fields had significantly higher soil organic carbon than conventional practices but were only numerically higher than SHMS. Statistical differences existed among all treatments for aggregate stability, with grazing as the highest and conventional practices as the lowest. Carbon mineralization potential was also significantly the highest in grazing fields. No statistical differences were observed in bulk density across treatments. Over the project period, nitrate levels remained low in grazing fields, while elevated surface levels occurred intermittently in SHMS and more frequent in conventional field practices.



Tristan Martins, instrumental technologist, showcases water quality monitoring during annual team meeting.

Water quality: Runoff, erosion and nutrient loads were significantly greater in conventional practices than SHMS, except for plant-available phosphorus. Differences between the two systems were greater in 2025 than 2024, likely due to late cover crop termination in 2025, resulting in greater crop residue. Significantly greater volumes of water moved through the vadose zone in SHMS, as expected. Conventional practices had higher nutrient loads, though not significantly different.

WISCONSIN (Madison)

Research Dairy Farm



STUDY DESCRIPTION:

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.

FINDINGS TO DATE:

Productivity: In year five, SHMS yields averaged 5% lower than conventional practices, closing a 15% yield gap observed in the first full year of treatments. Typically, yields were smaller in low areas of the field and exacerbated in extreme wet or dry conditions.

Soil health: In most years, carbon mineralization was greater in the SHMS compared to conventional practices. The highest soil organic carbon levels were in SHMS, particularly under evaporative solids at one site. Aggregate stability at one site was greater in SHMS for half of the project years and greater only in 2025 at another site.



Research specialist Greta Hippensteel moves the weather station location at a corn silage field site.

GHG: On average, nitrous oxide fluxes were slightly greater in wet areas than dry areas and in SHMS compared to conventional practices.

Nitrogen replacement: Over two years, use of evaporative solids resulted in higher corn silage yields than flocculated solids or liquid dairy manure, suggesting strong potential to offset synthetic fertilizer.

PROGRESS ACROSS THE COUNTRY

SOUTHWEST

TEXAS

Research Farm



STUDY DESCRIPTION:

Studying soil health management strategies using five nutrient management treatments in forage sorghum – evaporative solids, injected liquid dairy manure, broadcast liquid dairy manure, synthetic fertilizer and a control – within conventional field practices and SHMS.

FINDINGS TO DATE:

Productivity: Fertilizer with conventional practices plots produced significantly lower yields than other treatment-tillage combinations.

Soil health: After two years of treatment, improvements in soil health indicators have not been observed in this water-limited, semi-arid environment.

GHG: Soils functioned as net methane sinks among treatments. Increases in carbon dioxide fluxes aligned with sorghum growth and enhanced biological activity. Nitrous oxide fluxes remained



Past research team member Zach Hilliard and his colleagues Kylie Deaton and Tamara Chapman collaborate to measure water infiltration rates in the soil.

near zero in unfertilized plots but exhibited short-lived peaks following nutrient applications, particularly with synthetic fertilizer.

Soil moisture: Contrary to 2024, total seasonal water use did not significantly differ between SHMS and conventional practices, likely due to timely precipitation.

WEST

IDAHO

Research Farm



STUDY DESCRIPTION:

Exploring effects of novel manure products in soils with and without prior manure application in a corn silage-triticale-alfalfa rotation. A two-year study evaluated the nitrogen fertilizer replacement value of manure.

FINDINGS TO DATE:

Productivity: Forage quality did not differ across treatments. Corn silage yields were similar in manure and novel manure product plots. Triticale yields were significantly higher in plots with prior manure applications, with statistically lower yields in flocculated versus evaporative solids. Alfalfa yields were comparable among treatments, except the control without a history of manure, which was significantly lower.

Soil health: Manure additions enhanced microbial activity and soil carbon in plots with a history of manure versus those without prior applications, but no significant differences existed among novel manure product types. Nitrogen uptake increased with manure applications compared to no manure.



Alaina Groom, graduate student and biological science technician, presents findings at a project field day.

GHG: Nitrous oxide emissions were highest, statistically, from evaporative solids, followed by flocculated solids then controls.

Nitrogen replacement: All of the manure and novel manure treatments had higher yields when combined with supplemental nitrogen as compared to the treatment using fertilizer alone.

PROGRESS ACROSS THE COUNTRY

WEST

CALIFORNIA

Almond Orchard

UC DAVIS

STUDY DESCRIPTION:

Evaluating standard fertigation and the combination of fertigation and composted dairy manure in almond production to enhance yields, improve soil health and reduce GHG emissions.

FINDINGS TO DATE:

Productivity: On average, dairy manure compost-amended soils had higher yields versus standard fertigation and control (no nutrients), with highest yields in compost with fertigation treatments and lowest being the control, although not significantly different. Overall yields were lower than previous years due to high temperatures and dry conditions.

Soil health: Similar to past years, dissolved organic carbon and nitrogen levels were higher in compost-amended soils.

GHG: All treatments were methane sinks, removing more methane from the atmosphere than emitted, with compost-amended soils being slightly stronger. As in prior years, nitrous oxide emissions decreased in the compost plus fertigation treatment, reflecting their interaction to process nitrogen differently, particularly after fertigation. Chemical markers were used to determine the outcomes of treatments.



Adolfo Coyotl, Ph.D. researcher at UC Davis, takes measurements in a commercial almond orchard.

Dairy Farm

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

STUDY DESCRIPTION:

Comparing how differences in tillage and manure amendments affect crop yields, GHG emissions and soil health in a forage sorghum-triticale rotation.

FINDINGS TO DATE:

Analysis of productivity, soil health and GHG data is in process.



Nicholas Clark of the University of California Agriculture and Natural Resources and Dr. Dan Liptzin of the Soil Health Institute discuss research conducted at a dairy forage site.



Members of the University of California Agriculture and Natural Resources team and Soil Health Institute sample triticale.



Deep core soil samples are partitioned as part of research by UC Davis.

PROGRESS ACROSS THE COUNTRY



USDA-ARS, Idaho



Texas A&M AgriLife Research, Texas



Cornell University, New York



UW-Platteville, Wisconsin



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KEY TAKEAWAYS

Agronomic Yield and Transition Dynamics

- **Long-Term Yield Trajectory:** Data from the longest-running trial site in Wisconsin (Madison) indicated that a 15% yield gap initially observed in SHMS relative to conventional practices closed to a 5% difference by year five.
- **Treatment Equivalence:** In New York, SHMS utilizing novel manure products produced corn silage yields comparable to conventional liquid dairy manure applications.
- **Regional Variability:** Lower average crop yields under SHMS persist in several shorter-term or water-limited treatments, including the California forage rotation and specific sites in Vermont.

Water Quality and GHG Metrics

- **Runoff and Nutrient Mitigation:** Surface runoff, erosion and nutrient loads were significantly lower under SHMS compared to conventional practices in Wisconsin (Platteville). In Vermont, tile drainage filtration systems removed over 80% of phosphorus loads from conventional field effluent.
- **Nitrous Oxide Fluxes:** Nitrous oxide emissions varied by amendment type and region; Idaho reported higher emissions from evaporative solids relative to flocculated solids, whereas Vermont observed lower emissions in plots utilizing flocculated solids compared to liquid manure.

Nutrient Efficiency and Carry-Over Effects

- **Fertilizer Replacement Value:** Idaho trials determined that all evaluated manure products demonstrated a significantly higher nitrogen fertilizer replacement value than standalone synthetic fertilizer treatments.
- **Residual Year-Two Benefits:** In New York, both evaporative and flocculated manure solids demonstrated positive carry-over benefits, increasing crop yields in the second year post-application. However, no carry-over benefits were documented by year three across any nutrient source at that site.

These multi-site datasets are currently being integrated into crop and environmental system models to refine nitrogen budgets, inform practice standards and provide evidence-based decision support for U.S. dairy farmers.

The content and information on these pages 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!