



UW College of Agriculture and Natural Resources
Global Perspectives Grant Program
Project Report Instructions

1. COVER PAGE

Trip Date: 05/25-05/27/2022 and 05/25-05/27/2023

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Project Title from Application: Soil management effects on soil organic matter properties and carbon sequestration

Non-technical summary

In 2022, the European Joint Program SOIL (EJP SOIL) funded project titled “The Soil Management Effects on Soil Organic Matter Properties and Carbon Sequestration (SOMPACS)”. This project seeks to identify management practices that enrich soils with stable soil organic matter resistant to loss. This stable SOM represents important potential to expand the role of soil management in sequestering atmospheric carbon (C) to offset emissions that drive global climate change. Soil C capture represents a potential income stream (besides improving soil productivity) for Wyoming producers as organizations seek to pay offsets and achieve C neutrality. My role was to engage in this collaborative research as an external partner along collaborations from 12 research institutions from Poland, Germany, Ireland, Lithuania, UK, and Italy. The project is still ongoing and is slated to end in fall 2025. It utilizes eight long-term field experiments in Europe, long-term paired sites in Wyoming, and shorter-term treatments with different soil management, cultivation, and amendments. The long-term sites range in age from a 22-year tillage experiment in Lithuania, to the iconic 178-year Broadbalk experiment in the UK. Other sites are in Poland (30-, 46-, and 100-year experiments), a 54-year experiment in Lithuania, and a 26-year experiment in Italy. Wyoming entries include 20 year-minimum till, and organic winter wheat fallow production with and without cover cropping and compost additions.

2. REPORT:

1. Main results of activities planned in the proposal

Two meetings were conveyed thus far, to start off the project and assigned roles (Wroclaw, Poland, May 2022) and to convene for the first-year progress overview (Rostock, Germany, May 2023). Results so far suggest that, based for example on the 100-year experiment established at the Experimental Station of the Warsaw University of Life Sciences in Skierniewice (central Poland). The results confirmed the beneficial effect of long-term organic amendments on soil organic matter sequestration. Not only do they alter soil organic matter contents and qualities, but also, they result in chemical and physical properties. The following findings are reported in the long-term treatments of interest which were:

- (1) Control (Ca, N, P, K).
- (2) Cattle manure applied every five years at a rate of 30 t ha⁻¹.
- (3) Winter-killed legume cover crops.
- (4) Cattle manure and winter-killed legume cover crops.

Soils are sandy loams annually amended with mineral fertilizers (Ca, N, P, K), based on soil test recommendations. Soil samples (0-20 cm depth) were collected during the 2022 mid-growing season. Manure application results in the greatest positive impact on soil organic matter and resulted in an increase in total organic carbon (TOC) by 48% when manure alone is applied and by 68% when manure application is followed by planting of the winter-killed legume cover crops. Planting winter-killed legume cover crops alone also increases TOC, but by 32% only.

Manure application also results in significant increases in humic acids in the soil, which are soil organic matter compounds that are large sized molecules, more stable, and capable of improving crop growing environment. Soils amended with cattle manure demonstrates a predominance of organic matter in form of lipids which are products of partially decomposed and undecomposed plants and animals that will undergo further decomposition in time and will serve as a pool of plant available nutrients. Conversely, adding winter-killed legume cover crops decreased the humic acids content and changed humic acids chemical composition, such as soil organic matter predominantly contains lignin fraction which is the fraction that contributes to the humus formation (the most resilient soil organic matter fraction). Most striking observation was the soil enrichment in simple carbohydrates in soils amended with manure followed by planting of the winter-killed legume cover crops. Carbohydrates are the simplest forms of soil organic matter which help in microbial and then, plant nutrition, soil structure and soil water relationships. Ultimately, soil carbohydrates are easily decomposable, enhance plant root growth, microbial proliferation, and the protection of soil enzymes.

Adding organic amendments to the soil also influences water holding capacity. Manure addition increases plant available water by 20% and by 10% in soils amended with manure followed by planting of the winter-killed legume cover crops. But winter-killed legume cover crops alone decrease plant available water by 11%.

My role as a collaborator is to conduct analyses on soils from experiments under long-term cropping management scenarios in different countries by using two methodologies used in my lab: permanganate oxidizable carbon (POXC) and autoclaved citrate-extractable (ACE) protein assay. POXC is a tool sensitive to detect fraction of carbon involved in nutrient cycling. POXC content changes with changes in soil management. It is often used as a tool for assessing soil improvement over time. ACE protein assay is an indicator of the soil protein-like content in the soil organic matter. It reflects the amount of microbially available nitrogen (N) and is considered one of the more robust soil health indicators supporting biological activity and hence,

quality of the soil. Interacting with other collaborators who analyze the same soil samples for different soil properties that equate with their understanding of soil health is a very meaningful experience that helps in my professional growth.

2. Describe any future plans

I plan to return to Poland in Fall 2024 to start my AY 2024-2025 sabbatical to conduct ACE and POXC analyses on all soils from the SOMPACS project. Soil samples from WY are already shipped and stored at the Warsaw University of Life Sciences in Warsaw, Poland.

Results from these two assays will then be compared to series of other analyses performed in collaborators' labs with the purpose of identifying best management practices defined by a combination of the most robust series of analytical indicators. I plan to help establish lab methodology capable of performing the abovementioned analyses and perform all the analyses on samples from collaborating countries at Warsaw University of Life Sciences. I also plan to participate in the 3rd annual project update slated to take place in fall 2024 in Lithuania.

3. Outline potential impacts to

The outcome of this project will be a better understanding of results obtained by using different analytical tools to best define soil function and soil health in context of resilient management practices.

(The College of Agriculture, Life Sciences and Natural Resources) This project will increase global perspectives content within teaching, research, and extension programs at CALSNR. The class I offer every spring (PLNT 4020/5020) Agroecology and Global Agroecosystems with a "G" USP designation will draw on forthcoming research results I plan to produce in Poland. A new module for the existing class will cover the topic on the lessons learned from field experimental farm trials in Europe.

(The University of Wyoming) Finally, one of the important outcomes of this sabbatical leave is to increase the capacity of UW employees and students to appreciate cultural differences of the perception and the importance of research and research application to practice on sustainable agriculture and organic farming that are highly prioritized in European Union.

(The State of Wyoming) The knowledge gained from this project will benefit Wyoming farmers by validating and proposing implementation of novel practices under successful implementation in different parts of the world. Anticipated scholarly products of this opportunity will be producing peer-reviewed research papers, extension bulletins, present at local and international conferences.

(Other) Possible joint opportunity to submit a collaborative research grant to a funding agency that supports international research exchange. The outcome of this study will be a set of deliverables that can serve as preliminary data for potential collaborative research proposal(s).

3. Photos



Photo 1: 100-year long rotation in one of the rotational research projects in Poland



Photographs 2 a and b: Close ups of the field plots highlighting the treatment of winter-killed legume cover crops.



Photograph 3: Winter rye planted after cattle manure application.