**PROJECT TITLE: New organic fertilizer to protect Minnesota’s water quality**

**I. PROJECT STATEMENT**

**The objectives of this study are to protect the quality of Minnesota’s precious surface and groundwater resources by developing a marketable, slow-nutrient-release fertilizer based on composting biochar together with manure, which will also help Minnesota’s livestock farmers realize more value from their manure.** According to the Minnesota Department of Health, farm-related nitrate pollution represents a growing threat to Minnesota's drinking water. Nitrate comes from many sources, including manure, septic systems, and natural decomposition of organic matter. Fertilizers applied to land used for crop production have the biggest influence on Minnesota's ground and surface water nitrate levels. Recently, our research has provided evidence that *co-composting of farm manure and biochar* has positive effects on plant growth, carbon mineralization, nutrient capture, and retention. Converting abundant agricultural residues, such as green waste and manure, to valuable products, such as biochar and organic fertilizer, can create a new profitable market and revenue for Minnesota livestock farmers. **This proposed project will provide Minnesota’s livestock farmers and the Minnesota Pollution Control Agency with information on a new innovative treatment process for manure management which will help the State to protect its surface water quality.**

Biochars are an abundant end product of the biomass energy industry. Converting woody biomass and agricultural byproducts into renewable biofuels leaves behind a carbon-rich material similar to charcoal (called biochar). Our research has recently shown that addition of these chars to waste treatment processes such as composting, reduces the losses of nitrogen and phosphorous from the compost mixture creating a well-stabilized product that can be beneficial to agriculture. For example, biochars co-composted with mixed manures have been shown to be effective in adsorbing and retaining manure nutrients (such as nitrate and phosphate) preventing nutrient leaching and runoff when applied to the field. **We propose that biochars can be used to capture nutrients from manure to create a sustainable, slow-release organic fertilizer that has an increased market value, can be transported, and effectively applied to the field. The new organic fertilizer will protect Minnesota’s water quality and help Minnesota livestock farmer to better manage manure nutrient application and to realize more value from their manure for crop production.** Besides nutrient management, the application of biochar as an additive to manure storage structures and composting facilities also offers other benefits, such as increased carbon storage in soils and reduced odor emissions during manure handling. The composting process (degradation of organic matter at temperatures up to 70°C) can help to reduce the load of pathogenic bacteria and antibiotic resistant genes in the manure prior to field application. **The process of co-composting manure with biochar has the potential to significantly save costs for nitrogen and phosphorous fertilizer application and reduce the environmental consequences of excess nutrient leaching and runoff into Minnesota’s waterways.**

**II. PROJECT ACTIVITIES AND OUTCOMES**

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| **Activity 1 Title: Production and characterization of biochar-amended manure compost (BMC) to protect MN water quality**  **Description:** There are a range of practical things we need to understand when adding biochar during the manure composting process (amounts needed, best types of biochar/manure to use, does the compost or biochar need to be shredded first, etc.). This will help optimize the process and provide the highest-quality product. In this activity we will produce different biochar-blended composts and study their nutrient retention properties in order to lower nutrient run-off from fields after manure application. **ENRTF BUDGET: $ 173,735** |

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| **Outcome** | **Completion Date** |
| *1. Production of four different biochar blended composts (2 chars + 2 manure types)* | *March 31, 2021* |
| *2. Determine the optimal* doses, biochar feedstock and particle size | *August 31, 2021* |
| *3. Quantification of nutrient retention and water quality impacts of biochar-manure compost fertilizer* | *June 30, 2022* |
| **Activity 2 Title: Nutrient cycling and storage in biochar-amended manure compost. Monitoring of antibiotic resistance gene and microbial pathogen loads for water quality protection.**  **Description:** Microorganisms play a key role in the composting process, nutrient capture and release. We will study the interaction of biochar with the soil microbiome and key nutrient cycling processes taking place during composting and after compost field application (biodegradation, gas emissions, nutrient transformation, etc). We will quantify antibiotic resistant genes and microbial pathogens in the manure before and after composting to better control their environmental impact on Minnesota’s water quality after manure field application.  **ENRTF BUDGET: $ 208,801** | |

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| **Outcome** | **Completion Date** |
| *1. Genomic analysis of microbial nutrient cycling processes in biochar blended composts* | *July 31, 2022* |
| *2. Quantification of antibiotic resistance in manure and compost (before & after composting) for water quality protection* | *December 31, 2022* |
| *3. Quantification of loads of microbial pathogens in manure and compost (before & after composting) for water quality protection* | *December 31, 2022* |

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| **Activity 3 Title: Field trials and cost-benefit analysis**  **Description:** The production, distribution, and application ofbiochar-amendedmanure compost requires a comprehensive understanding of the challenges associated with using manure as a fertilizer. To understand whether integration of biochar into commercial manure composting operations is viable, we will conduct full-scale field experiments and a life-cycle cost-benefit analysis. In this activity we will also explore the monetary value of co-composting manure with biochars for farmers in Minnesota and disseminate our results at local conferences and through scientific publications. **ENRTF BUDGET: $ 116,464** |

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| **Outcome** | **Completion Date** |
| *1. Measure long-term performance and nutrient slow-release in field experiments* | *July 31, 2023* |
| *2. Perform cost-benefit analysis on the livestock-energy-nutrient-management* *life-cycle and benefits for Minnesota’s water quality* | *July 31, 2023* |
| *3. Publication in scientific journals and presentation of results at State conferences* | *July 31, 2023* |

**III. PROJECT PARTNERS AND COLLABORATORS:**

The project team will be led by Drs. Sebastian Behrens (Dept. of Civil, Environmental, and Geo-Engineering, University of Minnesota) and Dr. Melissa Wilson (Dept. of Soil, Water, and Climate). Behrens is an expert on soil-biochar nutrient cycling and Wilson is an expert on manure handling techniques and farming practices that reduce impacts on water quality. The proposed research will be conducted in collaboration with Dr. Timothy LaPara (Dept. of CEGE), an expert on the environmental fate of antibiotic resistance markers. The team also will include one post-doctoral research associate, a graduate student, and a field technician.

**IV. LONG-TERM IMPLEMENTATION AND FUNDING:**

Results of the proposed research will be shared with the Minnesota Pollution Control Agency (MPCA) to inform the development of new rules that govern the collection, transportation, storage, processing, and land application of animal manure for water quality protection. This project will **develop economic incentives for Minnesota’s livestock farmers while protecting Minnesota’s water resources and pristine aquatic ecosystems from excess nutrient pollution.**

**V. SEE ADDITIONAL PROPOSAL COMPONENTS:** A. Proposal Budget Spreadsheet