Environment and Natural Resources Trust Fund

M.L. 2020 Approved Work Plan

General Information

ID Number: 2020-077

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: August 13, 2021

Project Title: Lignin-Coated Fertilizers for Phosphate Control

Project Budget: $250,000

Project Manager Information

Name: Eric Singsaas

Organization: U of MN - Duluth - NRRI

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Project Reporting

Date Work Plan Approved by LCCMR: August 13, 2021

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: June 30, 2023

Final Report Due Date: August 14, 2023

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 08c

Appropriation Language: $250,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute in Duluth to test a new, natural, slow-release fertilizer coating made from processed wood to decrease phosphorus runoff from farmland while also storing carbon in soils. This appropriation is subject to Minnesota Statutes, section 116P.10.

Appropriation End Date: June 30, 2023

Narrative

Project Summary: We will develop and test a novel, bio-based, fertilizer coating that slows nutrient release to reduce nutrient runoff from agricultural fields based on modified cellulose and lignin extracted from wood.

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

This proposed project will provide a real-world test of a novel, bio-based, fertilizer coating that slows nutrient release to reduce nutrient runoff from agricultural fields. Anthropogenic phosphorus pollution is reaching dangerously high levels in freshwater basins around the world, with mineral phosphate fertilizers from cereal grain farming being among the largest contributing sources1. Phosphorus is a common component of both mineral and manure fertilizers because it is necessary to achieve high crop yields necessary to support conventional family farms in Minnesota. However, a large portion of phosphorus applied as fertilizer is not taken up by plants, and either builds up in the soil or washes into rivers, lakes, and coastal seas. Minnesota has implemented policies aimed at reducing agricultural runoff through wetlands preservation and increased buffer strips around fields. Another way to reduce fertilizer runoff is to coat fertilizer particles in a material that controls water diffusion so that the nutrients are released slowly over time, giving the crop roots a chance to absorb the fertilizer before percolation and runoff can remove the product. There has been work on developing slow-release fertilizers, but there remains a need to address issues of cost, performance, and effective implementation by farmers.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

We are developing a technological solution to address this need. We have created a slow-release fertilizer coating made from lignin, a byproduct of cellulosic ethanol production. This form of lignin has properties that allow it to be processed like a plastic, yet it is a 100% natural and biodegradable material made from wood. We have developed formulations with this material that can be coated onto granulated fertilizers to control the rate of dissolution and thereby maintain a constant nutrient supply in fields without the need to over apply. When the fertilizer is used up from a coated particle, the lignin coating becomes part of the slow-turnover carbon pool in the soil. Therefore, implementation of this technology throughout the agricultural sector has the potential both to decrease eutrophication and increase carbon sequestration.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

We will demonstrate the scale-up of the coating process and have acquired necessary real-world data on the efficacy of this coating material to bring it to market. NRRI is working with the University of Minnesota Technology Commercialization office to patent the technology and identify commercialization partners. Likely partners would include Minnesota-based fertilizer distributer Mosaic for agricultural markets and Ohio-based Scotts for lawn and golf course markets. The results from this research program are essential to attracting high-profile commercialization partners such as these. We understand the need to comply with Minn. Stats. section

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

In the Future

Activities and Milestones

Activity 1: Scale-up of lignin-material coated fertilizer and performance testing

Activity Budget: $116,557

Activity Description:
We will purchase 500 kg of granulated fertilizer and apply our best-performing lignin-based coating, developed in collaboration with colleagues from the Technical University of Cologne, Germany. This work will be done at NRRI's prototype laboratory using a pilot spheronizer. Plain Sight Innovations will supply organosolv lignin from their pilot plant for this activity. We will produce lignin for all greenhouse testing in Activity 2 in year 1. We will make formulation adjustments based on findings from greenhouse studies during scale-up for the field production to be conducted in Activity 3. Greenhouse and field trials will be supervised by Dr. Jane Johnson USDA-ARS scientist in Morris, MN and tasks will be preformed by student workers at UM-Morris. NRRI will support this work with chemical and statistical analyses and reporting.

Activity Milestones:

Description	Completion Date
Produce sample coated fertilizer for greenhouse testing	January 31, 2022
Measure phosphate dissolution rate compared to uncoated fertilizer	February 28, 2022
Scale-up production of fertilizer for greenhouse trials	May 31, 2022

Activity 2: Assess high lignin coating impact on soils in greenhouse

Activity Budget: $54,015

Activity Description:
A replicated (4x) and repeated (2x) greenhouse experiment will assess the ability of lignin-coated fertilizer to provide Phosphorus (P) to agronomic crop(s) as indicated by plant biomass accumulation at 30 days after planting. At the end of the study the amount of extractable P in the soil will be determined.

Activity Milestones:

Description	Completion Date
Greenhouse testing of lignin coated fertilizer	August 31, 2022
Chemical analysis of extractable phosphorus from greenhouse study	September 30, 2022
Plant growth and biomass accumulation measurements	September 30, 2022

Activity 3: Replicated field trials of lignin-coated fertilizer

Activity Budget: $79,428

Activity Description:
Replicated plot-scale field testing will assess agronomic crop (s), wheat or corn, response to incorporated lignin coated P fertilizer. The study will be repeated in at least 3-locations. We will plant the crop in May 2022 with fertilizers delivered from Activity 1. Crop will be managed through the summer of 2022 with harvest by October. Crop biomass and yield will serve as plant response indicators. Soil samples will be collected at two depth increments (0-15; 15-30 cm) at the end of the and assessed for extractable P. Samples will be collected during the growing season in the summer of 2022 and archived for analysis in the fall and early winter. Final data analysis will be complete in Q1 2023.

Activity Milestones:

Description	Completion Date
Plot-scale field testing to assess agronomic crop response	October 31, 2022
Crop biomass and yield analyzed	December 31, 2022
Soil sampling and processing	December 31, 2022
Extractable P measurements	January 31, 2023

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Jane Johnson	USDA Agricultural Research Services	Dr. Johnson works at the USDA-ARS office in Morris, MN. She will supervise greenhouse and field trials of the coated fertilizer products for this program with UM-Morris students. Dr. Johnson has led international projects in high lignin soil additives and their impact on soil nutrient retention and sequestration	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
All potential intellectual property resulting from this program will be submitted to the University of Minnesota's Technology Commercialization office for review before public disclosure. All results classified as confidential for IP protection will be presented under nondisclosure agreements to interested parties including, but not limited to, state agencies, federal agencies, non-governmental organizations, and companies interested in technology licensing for commercialization. All protected and non-confidential results will be presented at a national or international agriculture or biomass conference. Publishable results will be written up for publication in a peer-reviewed scientific journal. All progress and results that are of interest to the public will be disseminated through social media, press releases, and other public means.

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?
A key program deliverable is a product that will be sold into the agricultural fertilizer market. We will consult with Plain Sight Innovations to develop a business plan to bring this into widespread use.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Eric Singsaas		Project leader and will supervise product scale-up, participate in field trials, data analysis, and reporting.			25.1%	0.12		$21,583
Matthew Young		Bio-Process Engineer; Young will perform the production scale-up of the coatings technology in the process development laboratory.			22.3%	0.14		$11,912
Oksana Kolomitsyna		Organics Chemist; Kolomitsyna will perform synthesis of new coatings prototype materials and assist with coatings application to phosphate fertilizers.			25.1%	0.3		$21,427
Timothy Hagen		Coatings and Agglomerations Specialist; Hagen is NRRI's specialist in coatings and agglomerations. He will supervise process development and evaluation of lignin-based coatings on fertilizer products.			25.1%	0.1		$12,889
Brian Barry		Supervise chemistry laboratory activities, including synthesis of coatings materials, analysis of prototype coating performance, and develop phosphate analysis work instructions.			25.1%	0.14		$16,607
Sergiy Yemets		Analytical chemist; perform phosphate analysis on prototype coatings and runoff from greenhouse experiments.			25.1%	0.4		$15,144
Cally Hunt		Chemical engineer; will assist with development of coatings application process for new coatings developed by chemistry laboratory.			22.3%	0.4		$30,402
							Sub Total	**$129,964**
Contracts and Services								
USDA Agricultural Research Services	Sub award	The USDA-ARS office in Morris, MN will perform greenhouse and field trials of the coated fertilizer products for this program. The project will be led by Dr. Jane Johnson, lead soil scientist. Dr. Johnson has led international projects in high lignin soil additives and their impact on soil nutrient retention and carbon sequestration.				2.5		$108,319

							Sub Total	**$108,319**
Equipment, Tools, and Supplies								
	Tools and Supplies	Analytical lab reagents	Reagents will be used to perform analyses on phosphates in water to determine product dissolution in the laboratory and later on water collected from soil samples in the greenhouse and field studies.					$2,289
	Tools and Supplies	Solvents and supplies for coatings scale-up	Supplies are needed for production of coated fertilizer products in NRRI's process development laboratory. Production scale-up will produce sufficient experimental material for laboratory, greenhouse, and field tests.					$5,500
							Sub Total	**$7,789**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	NRRI personnel will perform site visit at ARS in Morris. One visit per year 3 people for 3 nights with meal per diem. I car w/ mileage est. @ $500. GSA rates will be applied.	Site visit at USDA ARS facility in Morris					$3,428
							Sub Total	**$3,428**
Travel Outside Minnesota								

							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		Shipping	We will ship completed fertilizers from Duluth to Morris for greenhouse and field trials.					$500
							Sub Total	**$500**
							Grand Total	**$250,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs.	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs)	Secured	$91,674
			Non State Sub Total	**$91,674**
			Funds Total	**$91,674**

Attachments

Required Attachments

Visual Component

File: 78dad525-0cc.pdf

Alternate Text for Visual Component

Problem - Innovation - Impact visual overview.
Problem is eutrophication of MN lakes by fertilizer runoff
Innovation is a biodegradable coating for fertilizers
Impact is improved water quality through reduced fertilizer runoff...

Optional Attachments

Support Letter or Other

Title	File
Signed background check form	4130fba7-768.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Milestone completion dates have been updated to reflect new project timeline from 2021-23. Lignin supplier is updated from Attis Innovations to Plain Sight Innovations.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I agree to the Commissioner's Plan.

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

Yes

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

Yes

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

No

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

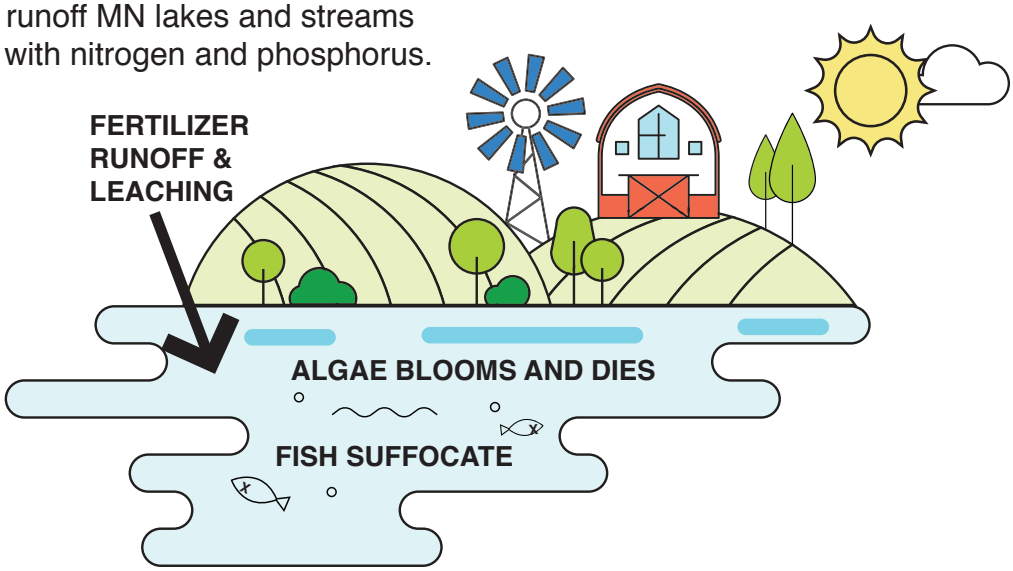
Natural Resources Research Institute
University of Minnesota Duluth
Driven to Discover

PROJECT DESCRIPTION:

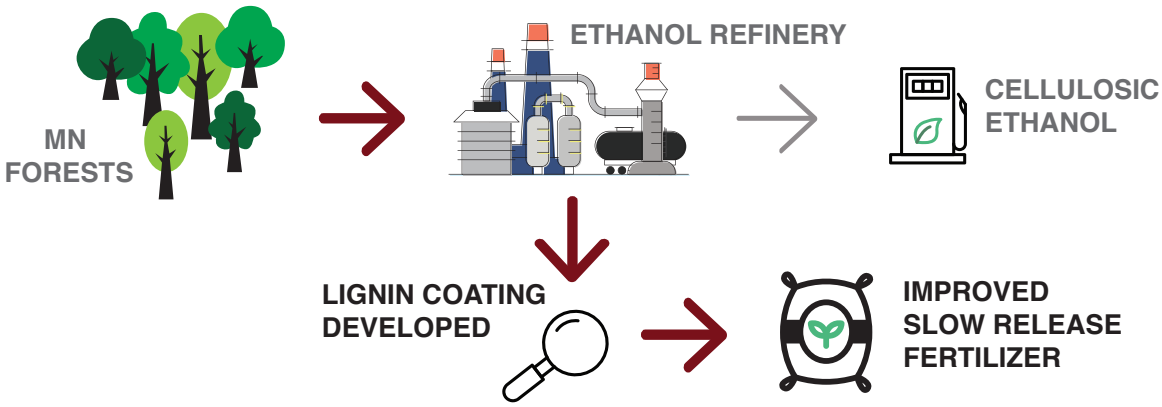
Biodegradable fertilizer coating designed to slow runoff, improve water quality and capture carbon in soil

Problem: Eutrophication

Due to fertilizer runoff MN lakes and streams are overloaded with nitrogen and phosphorus.



Innovation: Biodegradable Coating for Fertilizer Slows Runoff



Impact: Reduces Fertilizer Runoff, Directly Impacts MN Water Quality

- Utilizes a natural byproduct made by Minnesota biorefineries
- Empowers fertilizer applicators to use less overall fertilizer
- Stabilizes soil phosphate levels
- Addresses Minnesota's environmental need to reduce fertilizer runoff
- Sequesters carbon in agricultural soil
- Agricultural application process remains the same

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