Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)

Project Title: **ENRTF ID: 195-F**

Replacing Plastic Cover in Vegetable Production with BioMulch

Category: F. Methods to Protect or Restore Land, Water, and Habitat

Total Project Budget: $ 310,000

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

A biodegradable product will be developed to replace non-degradable petroleum based plastic used in vegetable and fruit production. This project, if funded, will revolutionize horticulture in Minnesota, and potentially worldwide.

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Sponsoring Organization: U of MN

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Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

The visual maps shows how the new biodegrabale product is applied on to the soil prior to planting, then at the end of the season it is incorporated into the soil. During the degradation process (in the following year) nutrients are relized making this product also a source of nutrients for the following crop.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

PROJECT TITLE: Replacing Plastic Cover in Vegetable Production with BioMulch

I. PROJECT STATEMENT

This LCCMR proposal is an interdisciplinary, interinstitutional (Agricultural Utilization Research Institute – AURI – and the University of Minnesota) partnership focused on developing a material that would replace petroleum derived polyethylene plastic films in vegetable and fruit production in MN. Plastic films are indispensable in vegetable production as they help to increase yield, conserve water while suppressing weeds and pests, and serve as pathogen protection for the plants. Unfortunately, the plastic is largely non-recyclable, often chemically contaminated (herbicide and pesticide), labor intensive to remove, and overall a source of environmental pollution. Therefore, a biodegradable replacement is needed for cleaner vegetable and fruit production in MN, and potentially nationwide. Such new material must be engineered to achieve three critical functions:

- be a soil cover that provides all the benefits the currently used non-degradable plastic provides
- be biodegradable so that at the end of the season the material can be incorporated into the soil providing carbon as food source for microorganisms
- be a nutrient source for plants during the years following incorporation as it slowly decomposes

In this project we will develop a product (BioMulch) which will meet all of the requirements stated above. The product will be in a liquid form that is spread on top of the soil just prior to transplanting the vegetables, and within a couple of hours the product will harden to seal the beds and start working in a similar manner as the plastic does. This project will also be used to generate all of the information related to applicability of the product, ease of management, longevity, decomposition rate, nutrient release rate, and its effects on microbial communities in the soil receiving the BioMulch. The results will be publically disseminated through applicable peer reviewed journal articles, the University of Minnesota Research and Outreach Centers (ROCs), AURI online and print publications including AG Innovation News and as a component of public field days at AURI and/or the ROCs.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Development and testing of the BioMulch to establish application protocols and primary attribute characterization in order to make selection of final composition for field tests. **Budget: $186,000**

A series of greenhouse and incubation studies will be conducted to assess the best formulation needed to create a BioMulch that meets the needed specification in terms of plasticity and elasticity, decomposition rate after mixed with the soil, optimum nutrient concentration for required release rates for various vegetable crops, and effects on microbial communities under controlled conditions.

Outcome	Completion Date
1. Fabrication of BioMulch and best composition for vegetable production	December 2018
2. Development of information for complete understanding of BioMulch behavior in soils	December 2019

Activity 2: Agronomic evaluation of BioMulch to determine its true potential to replace non-degradable plastic for vegateble and fruit production **Budget: $124,000**

Performance of BioMulch requires testing and verification through replicated trials in both high tunnel and open field sites. A guide to BioMulch application and monitoring will be used based on results from Activity 1 as the standard to coordinate multisite testing under a set of standard operating procedures (SOPs). Plant health/vigor, fancy and total yields, soil moisture retention, soil temperature and nutrient availability within the soil profile, and covering integrity will be monitored compared to traditional plastic and non-covered controls. In addition, the decomposition rate of the BioMulch will be assessed during the summer months.

Outcome	Completion Date
1. A detailed analysis of performance of BioMulch	May 2021
2. Recommendations on how to best use BioMulch for industry	May 2021

III. PROJECT STRATEGY

A. Project Team/Partners

Project Partners being paid by the project

Project leaders: Paulo Pagliari, Assistant Professor in the Department of Soil Water and Climate, University of Minnesota, will oversee the whole project.

Emily Evans, Assistant Scientist at the Southwest research and outreach center. Mrs. Evans will be responsible for overseeing implementation of field trials and data acquisition.

Dr. Jimmy Gosse, Microbiologist, Agricultural Utilization Research Institute (AURI) will oversee all AURI efforts in addition to industry contacts, intellectual property and public dissemination.

Dr. Michael Stutelberg will be responsible for formulation, controlled soil decomposition and analytical analysis.

Research Engineer: To be determined. Responsible for application equipment including application control and quality.

No Paid Personnel: Dr. Forrest Izuno; Dr. Vincent Fritz.

B. Project Impact and Long-Term Strategy

Removing a distributed source of microplastics and a large volume input for landfills using an economically favorable alternative for growers is a strong incentive for change that will result in reduced natural resource impacts from agriculture. To this end, a multidisciplinary project team has been assembled to represent the critical technical areas needed to gather the essential data industry stakeholders require. Industry partners will serve as touch points to ensure project objectives are focused on their needs as an addition to continual feedback from coordinated communication and outreach at both organizations. Adoption on the local scale has a high likelihood of success through locally demonstrated benefits attained by strategic joint development with industry.

C. Timeline Requirements

Three years are needed for this project to be completed.

2018 Detailed Project Budget

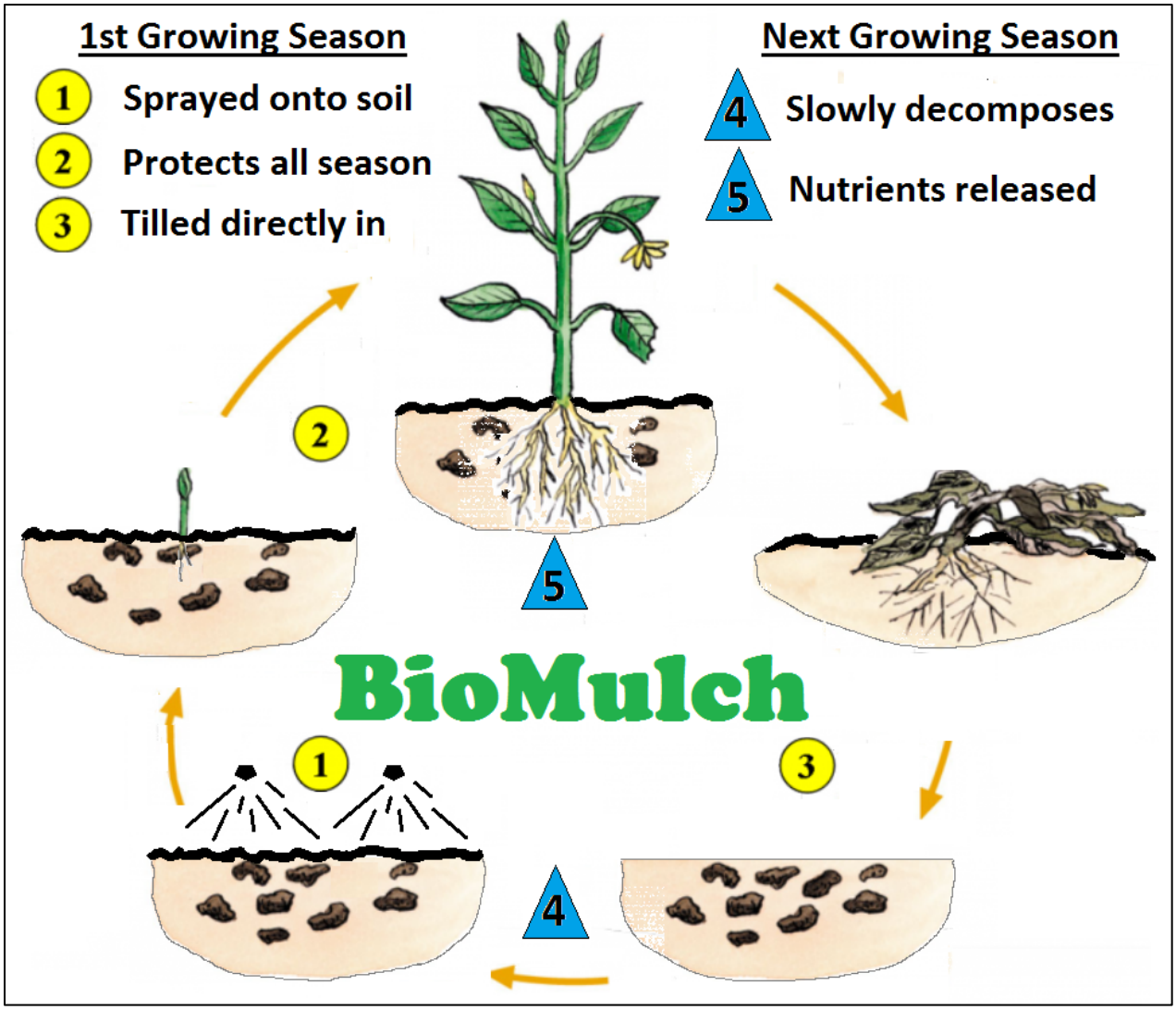
Project Title: Replacing plastic cover in vegetable production with BioMulch

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Personnel:	
U of M Project Manager responsible for ROC coordination and overall project management 10% FTE for salary $11,202 and fringe $2,812 (33.5%) each year, total for three years $33,606.	$ 33,606
U of M Research Technicians reponsible for sample collection and preparation at 0.75 FTE for salary request at $40,620.80 and $11,048.86 fringe (27.2%) for three years, total $119,185	$ 119,185
AURI Project Coordinator responsible for project coordination with AURI 10% FTE for salary at $40/hr and fringe at $15/hr (27%), total for three years $33,330.	$ 33,330
AURI Research Engineer responsible for application technology at 10% FTE at $40/hr and fringe at $15/hr (27%), total for two years $22,220.	$ 22,220
AURI Research Chemist responsible for formulation technology 10% FTE at $40/hr and fringe at $15/hr (27%), total for two years $22,220.	$ 22,220
Equipment/Tools/Supplies:	
Ingredients for three demonstration sites (100 ft x 3 ft each) total $10,409. Ingredients for formulation refinement and long term decomposition studies $5,359.	$ 15,469
Nutrients for production of biomulch at $1,000 per year.	$ 3,000
Sample Analysis at $40 per samples to determine the rate of biotarp degradation and nutrient availability (40 samples at each of 3 sites for 3 years, total 360 samples)	$ 14,400
Moisture and temperature probes, 20 per location at $250 per probe; total $15,000 for all three ROC locations. 4 dataloggers at $1,000 each per location; total of $12,000 for all three ROC	$ 27,000
1 Helium (at $400.00 each) and 1 Oxygen (at $300.00 each) gas cylinders required for carbon nitrogen and sulfur analysis. Total of $700.00 per year.	$ 2,100
Travel:	
In state travel to maintain plots and collect soil samples at the different locations being managed. Estimated 4,000 miles per year, for 20 (weekly travel during May-Spring) x 200 miles round trip from Lamberton to Waseca. Travel estimated at $0.535 per mile to a total of $2,140 per year.	$ 6,420
In state travel to plots for applications, sample aquisition and for project meetings estimated average 459 mile round trip and 15 trips per year at $0.535 per mile, total $11,050.	$ 11,050
Additional Budget Items:	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 310,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	N/A	N/A
Other State $ To Be Applied To Project During Project Period:	N/A	N/A
In-kind Services To Be Applied To Project During Project Period: *AURI* overhead expensis in support of project team and laboratory effort calculated as $20/hr per hour expended.	$ 29,120	N/A
Funding History: Application to be submitted June 2017 to Minnesota Soybean Research and Promotion Council (Contract Sept 2017-Aug 2018) BioMulch soy oil forumlation testing.	Pending	Pending
Remaining $ From Current ENRTF Appropriation:	N/A	N/A


1st Growing Season
1 Sprayed onto soil
2 Protects all season
3 Tilled directly in
Next Growing Season
4 Slowly decomposes
5 Nutrients released
BioMulch

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Dr. Paulo Pagliari has a PhD. in soil science with emphasis on phosphorus management and soil fertility from the University of Wisconsin-Madison (UW-Madison), and M.S. degree in soil science at the University of Minnesota, and a BS degree in agronomy from the Maringa State University in Brazil. During his PhD. research, Dr. Pagliari became very familiar with newly developed techniques used to determine and quantify the amounts of bioavailable phosphorus (P) in animal manure and how they affected the different P pools in soils.

After graduating from the UW-Madison Dr. Pagliari had a one-year post-doc appointment at the southwest research and outreach center (SWROC) at the University of Minnesota and in 2012 he was hired as a tenure-track faculty. In his current appointment Dr. Pagliari is responsible for the development of innovative research to improve the knowledge on nutrient management in organic and conventional agricultural cropping systems. His focus has been primarily around soil P behavior, movement, transport, and cycling. In his research, Dr. Pagliari has been using newly developed methods and also developing new methods to better understand the role of organic P cycling on the availability of P from soils.

Selected peer reviewed publications include:

Schmitt, D., P.H. Pagliari, and C.A.C do Nascimento. 2017. Chemical distribution of phosphorus in soils used during the development of sorption isotherms. Soil Sci. Soc. Am. J. 81:84-93.

Zhongqi, H.E., P.H. Pagliari, and H.M Waldrip. 2016. Aplied and environmental chemistry of animal manure: a review. Pedosphere. 26:779-816.

Sakurada, L., M.A. Batista, T.T. Inoue, A.S. Muniz, and P.H. Pagliari. 2016. Organomineral Phosphate Fertilizers: Agronomic Efficiency and Residual Effect on Initial Corn Development. Agro J. 108:2050-2059.

do Nascimento, C.A.C., P.H. Pagliari, D. Schmitt, Z. He, and H. Waldrip. 2015. Phosphorus concentrations in sequentially fractionated soil samples as affected by digestion methods. Scientific Reports 5: 17967.

Waldrip, H.M., P.H. Pagliari, Z. He, R.D. Harmel, N.A. Cole, and M. Zhang. 2015. Legacy phosphorus in calcareous soils: Effects of long-term poultry litter application. Soil Sci. Soc. Am. J. 79: 1601-1614.

Pagliari, P.H. and C.A.M. Laboski. 2014. Effects of manure inorganic and enzymatically hydrolysable P on soil test phosphorus. Soil Sci. Soc. Am. J. 78:1301-1309.

The SWROC is one of 10 research centers at the University of Minnesota and provides local growers with current research based knowledge regarding best management practices for various cropping systems. Dr. Pagliari has a fully equipped laboratory where he conducts all of the chemical analysis needed for the success of his research program.