Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-137

Proposal Title: Minnesota Center for Agricultural Spray Drift Reduction

Project Manager Information

Name: Christopher Hogan

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: The University of Minnesota will establish a center devoted to developing and implementing protocols and technologies to mitigate the impacts of pesticide spray drift on water and land habitats.

Funds Requested: $1,090,000

Proposed Project Completion: June 30 2025

LCCMR Funding Category: Methods to Protect, Restore, and Enhance Land, Water, and Habitat (F)

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?

During the Project and In the Future

Narrative

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

Agricultural spray drift causes economic harm to growers, increased legal and regulatory costs, and hurts the natural environment. Drift occurs when pesticides are transported beyond their target field to the surrounding environment and has significant detrimental effects on land and water habitats. Ultimately, this contributes to the proliferation of invasive, pesticide resistant weeds, and loss of habitat for both plants, pollinators, and aquatic species. In particular, use of Auxin herbicides (i.e. Dicamba) has exacerbated these issues; in the past several years the MN department of Agriculture has handled more than 500 complaints linked to visible damage from spray drift, hence, pesticide drift is a major burden for both the environment and Minnesota citizens.

From a purely physical perspective, drift occurs when the droplets spayed are too small to gravitationally deposit before being entrained by prevailing winds. Our proposed Spray Drift Reduction Center will provide statewide, easy-to-understand online tools to reduce the negative impacts of pesticides on the environment.

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.

Our proposed solution to spray drift is multi-tiered and data-driven. Through a spray drift reduction center, we intend to (1) improve predictions of drift via more rigorous droplet size measurements, (2) bring state-of-the-art spray size distribution measurements to the field, allowing MN growers to see first-hand if their current practices lead to spray drift, (3) provide MN growers with more accurate local information on temperature inversions, which are a major contributor to drift, and (4) aid MN companies and non-profits in developing drift reduction technologies via rigorous quantitative measurements needed to demonstrate the efficacy of new spray drift reduction nozzles and agrochemical tank mix additives. Such public-private partnerships also ensure long-term financial sustainability of the center's core activities.

This multi-tiered approach will lead to a reduction in spray drift in both the near-term, with mechanisms to continue long-term. Our approach takes research from the lab, tests it in the field, and then deploys it as a part of a statewide pesticide risk sensing network to provide growers easy-to-understand red, yellow, green indicators on whether or not pesticides risk harming their neighbors and the environment.

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?

Multiple project outcomes will lead to a reduced dispersion of pesticides onto state lands and waters, including:
1. The development of field-deployable, droplet size distribution measurement techniques to assess in-situ the potential for spray drift to occur, directly assessing its impact on state lands.
2. The development of a state-wide, all-county temperature inversion monitoring network, providing MN growers with real-time information needed when spraying agrochemicals to ensure that spraying will not lead to drift.
3. Increased testing of nozzles and agrochemical adjuvants designed to reduced spray drift, enabling their implementation by MN growers

Activities and Milestones

Activity 1: Development of improved measurement methods to quantify agricultural spray droplet sizes.

Activity Budget: $318,880

Activity Description:
Current practices in approving pesticide tank mixtures require measurement of the size distributions of droplets using laser diffraction. Our previous work has demonstrated that such method has a large uncertainty to capture the number of small drift-responsible droplets under different tank mixtures. Our main objective here is hence to develop a single droplet, imaging-based technique, called digital-inline holography (DIH) to become the gold standard measurement approach to precisely quantify the drift-responsible droplets. DIH is a novel imaging-based technique that can capture individual droplets and enable realtime analysis of their size and shape and even chemical contents. Professor Jiarong Hong is one of the world's leading experts in DIH. First, we will improve our current machine-learning DIH measurement algorithms to enable robust realtime droplet measurements of the sprays generated by common nozzles and tank mixtures in the laboratory. Second, we will develop turn-key, portable, and low cost DIH systems that can be mounted on sprayers and on drones for direct droplet analysis in the field during actual spray applications. Third, we will apply DIH measurements in a series of field trials using approved tank mixes to assess the the true driftable content in field settings.

Activity Milestones:

Description	Completion Date
Machine Learning Algorithm Implementation for Droplet Size Distributions	January 31 2023
Development of portable DIH system for field deployment	December 31 2023
Field Deployment in Conjunction with Sensor Site	June 30 2024
Parameterization of Field Data into Risk Model	June 30 2025

Activity 2: State-wide Pesticide Drift Risk Network

Activity Budget: $467,585

Activity Description:
The potential for spray drift is strongly dependent on local weather conditions. This includes relative humidity, chance of rain, wind speed and importantly, temperature inversions (warmer temperatures higher up). MN growers must balance agrochemical treatment needs with daily, and in some cases hourly, variations of local weather, and presently do not have appropriate information on probability of a temperature inversion occurring.

We will build a statewide drift risk sensing network and public-private partnerships with growers cooperatives to support the network over the long-term. The monitoring network will deploying one MET station per county. We will build both traditional temperature inversion models, and improve on the state-of-the art by incorporating new machine learning techniques in a web-based tool to display the risk of pesticide drift to growers. The tool will display this information using a three tier system - red (high risk), yellow (medium risk), green (low risk) so that growers know if pesticides are at risk of leaving their fields to harm their neighbors and the surrounding environment. By partnering with local cooperatives, we will develop a sustainable partnership model whereby local coops provide the on-going management for each MET station, thus creating a sustainable, long-term pesticide risk sensing network.

Activity Milestones:

Description	Completion Date

Establish Cooperative Network	June 30 2023
Install 50% of Observation Network	December 31 2023
Install 100% of Observation Network	June 30 2024
Model of Spray Drift Risk	June 30 2024
Web Application with County Drift Risk	June 30 2025

Activity 3: Establishment of a testing center for technologies devoted to agricultural spray drift reduction in Minnesota

Activity Budget: $303,535

Activity Description:

An additional hindrance to spray drift reduction is that the approval process for new technologies aimed to reduce drift, including new nozzle types and new agrochemical tank mix additives designed to reduce spray drift is arduous. Only a finite number of laboratories (<5) in the United States have been traditionally set up to make the size distribution measurements needed for product registration, and none of these laboratories are in Minnesota. MN has a chance to be the leading state in the nation both in spray drift reduction practices and in spray drift reduction technologies. What is needed now for the latter is a streamlined measurement process from a reliable third party laboratory locally. We have rectified that issue by establishing a Good-Laboratory-Practice (GLP) protocol for measurements of spray size distributions, for the tank mix product registration process. Our third goal in establishing a center for spray drift reduction is now to establish UMN as a third party testing center, providing streamlined testing of spray drift reduction technologies. Using a combination of laser diffraction, and digital inline holography, we will collect a publicly available data set on the performance of various nozzles and tank mixes, including predictions of drift potential.

Activity Milestones:

Description	Completion Date
Incorporated of DIH measurements into Tank Mix Certification Protocols	June 30 2023
Comparison of Lab Approved Tank Mixes to Field Performance	June 30 2024
Incorporation of Tank Mix Information into Risk Model	June 30 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Professor Jiarong Hong	University of Minnesota	Center Co-Director	Yes
Dr. Bryan Runck	University of Minnesota GEMS Agroinformatics Initiative	Informatics Lead	Yes

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?

Drift reduction measures will be implemented by establishing temperature inversion measurement sensors in each MN county, allowing growing improved access to information needed to spray safely. Ongoing efforts beyond the project will be supported by providing testing services for companies developing adjuvants and nozzles towards spray drift reduction. Growers cooperative have an interest in improving information to better managing pesticides because they perform a lot of custom spraying for growers. Thus, if pesticides drift, the the cooperatives are liable for damages. As our letter of supports suggest, cooperatives are able and willing partners to sustain this public investment.

Project Manager and Organization Qualifications

Project Manager Name: Christopher Hogan

Job Title: Professor

Provide description of the project manager's qualifications to manage the proposed project.

Professor Chris Hogan has been a faculty member at the University of Minnesota since 2009. Since that time, he has been Principal Investigator or Co-Principal Investigator on external grants and contracts totally over $7.5M (this includes current funds, but only funds devoted to his laboratory group and not to co-investigators). Sponsors include the Department of Defense, the National Science Foundation, the Department of Energy, the Advanced Research Projects Agency for Energy, the Center for Disease Control, BASF, Winfield United, Boston Scientific, Honeywell, and numerous other local and international companies. 9 PhD students, 5 Master Students, and 7 post-doctoral associates have completed their studies performing research under his supervision, and currently his laboratory group consists of a full-time staff researcher, a laboratory manager, 7 PhD students, and 4 MS students. He has published more than 115 peer-reviewed scientific publications, his work has results in 3 patents (including one commercial measurement instrument), and he is the Editor-in-Chief of the Journal of Aerosol Science. With Professor Jiarong Hong and Dr. Bernard Olson (UMN staff scientist), he oversaw the donation, and installation of a unique low speed spray analysis wind tunnel, laser diffraction, and PDPA system (from Winfield United with a >$500K valuation), as well as the development of a digital inline holography system at the University of Minnesota. This facility is the only one of its type in a United States University Mechanical Engineering Department.

Organization: U of MN - College of Science and Engineering

Organization Description:

The University of Minnesota-Twin Cities campus, spanning the East Bank, West Bank, and Saint Paul Campuses, is the flagship campus of the University of Minnesota system, with nearly 48,000 students and ~3,800 academic staff. Its educational and research programs in science and engineering consistently rank in the top 25 in nearly all disciplines.

This project in particular will be housed within the department of Mechanical Engineering and the GEMS Agroinformatics Initiative, part of the College of Food, Agricultural and Natural Resource Sciences.

Founded in 1889, the Mechanical Engineering department has 44 active faculty, 50+ staff members, 300+ graduate students, 74 postdoctoral associates, research associates and visitors, and about 560 undergraduate students. Aerosol and Particle Technology measurement techniques, leveraged heavily in this project, were originally developed in the University of Minnesota Mechanical Engineering Department in the 1950s, and leadership in aerosol and fluid mechanics measurement continues in the department to this day.

College of Food, Agricultural and Natural Resource Sciences (CFANS) is a world-renowned center of learning and research in food, agricultural and natural resource sciences. CFANS has 250+ faculty training 2,000+ undergraduate and 700+ graduate students.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Professor Chris Hogan		Center co-Director and Project Manager			37%	0.12		$28,409
Professor Jiarong Hong		Center co-Director			37%	0.12		$25,081
Postdoctoral Associates		Research Engineers			25%	9		$581,398
Dr. Bryan Runck		Informatics Lead			37%	0.51		$73,786
							Sub Total	**$708,674**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	Laboratory Supplies	The spray wind tunnel facility at the University of Minnesota is installed and operation. $26,775.33 per year is needed for the purchase of laboratory supplies for tunnel operation, based on recent operating estimates					$80,326
	Equipment	Digital Inline Holography Equipment	Funds towards the development of digital inline holography equipment					$100,000
	Tools and Supplies	Temperature Inversion Sensor Network Equipment	Supplies for the installation of temperature inversion sensors. Each individual items is below $5000					$175,000
							Sub Total	**$355,326**
Capital Expenditures								
							Sub Total	**-**

Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Other	Travel costs to monitoring stations	These funds will be used to support project personnel travel to monitoring sites throughout the state					$25,000
							Sub Total	**$25,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Publication fees	$1000 are requested per year to be used towards color printing fees in peer-reviewed, technical publications					$1,000
							Sub Total	**$1,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$1,090,000**

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				
			Non State Sub Total	**-**
			Funds Total	**-**

Attachments

Required Attachments

Visual Component

File: d45af2c2-fb4.pdf

Alternate Text for Visual Component

Page 1:
Image (a): Palmer Pigweed spreading in Minnesota (https://agfaxweedsolutions.com/2019/04/03/minnesota-palmer-pigweed-continues-to-spread-what-you-should-know/)
Image (b): Wild rice in Minnesota (https://statesymbolsusa.org/symbol-official-item/minnesota/state-food-agriculture-symbol/wild-rice)
Image (c): Minnesota native plants (http://mnnps.org/)
Image (d): Pollinators endangered by pesticides (https://www.mda.state.mn.us/pesticide-fertilizer/best-management-practices-pollinators-the...

Optional Attachments

Support Letter or Other

Title	File
Winfield United Letter of Support	d27e7e5e-c8b.pdf
University of Minnesota Sponsored Projects Letter	673abd98-f19.pdf
Department of Agriculture, Letter of Support	46e1e444-fcf.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

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?

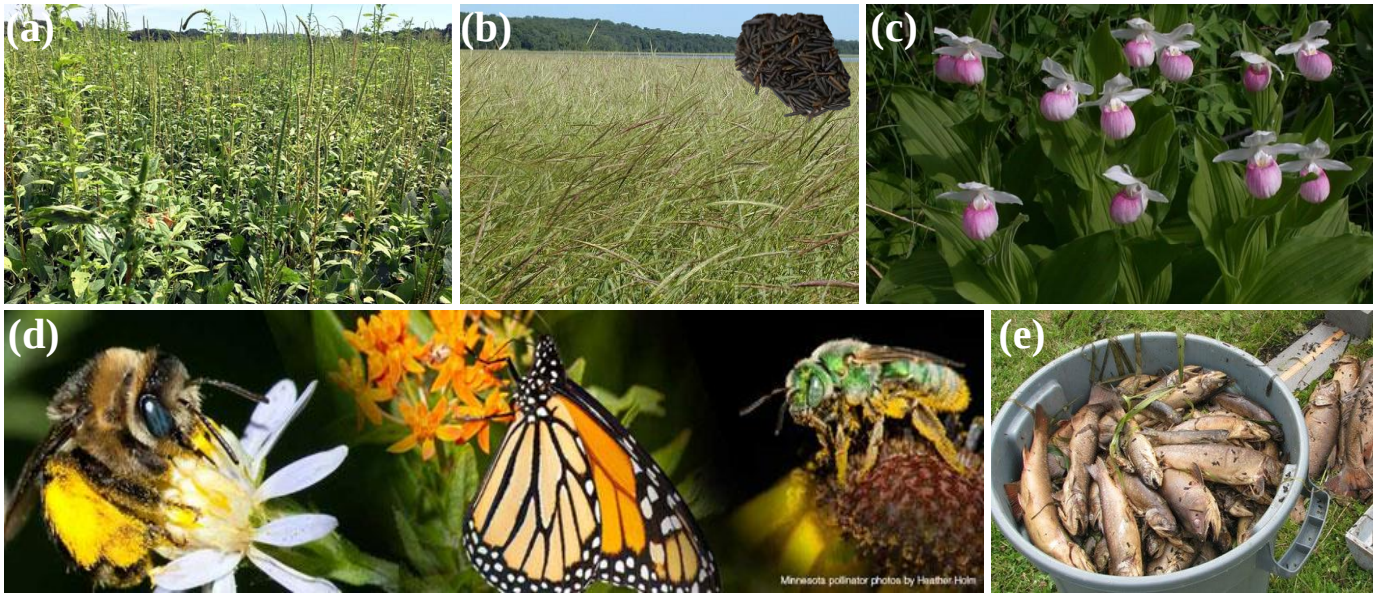
No

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration


(a)
(b)
(c)
(d)
(e)
Minnesota pollinator photos by Heather Holm

From lab to field