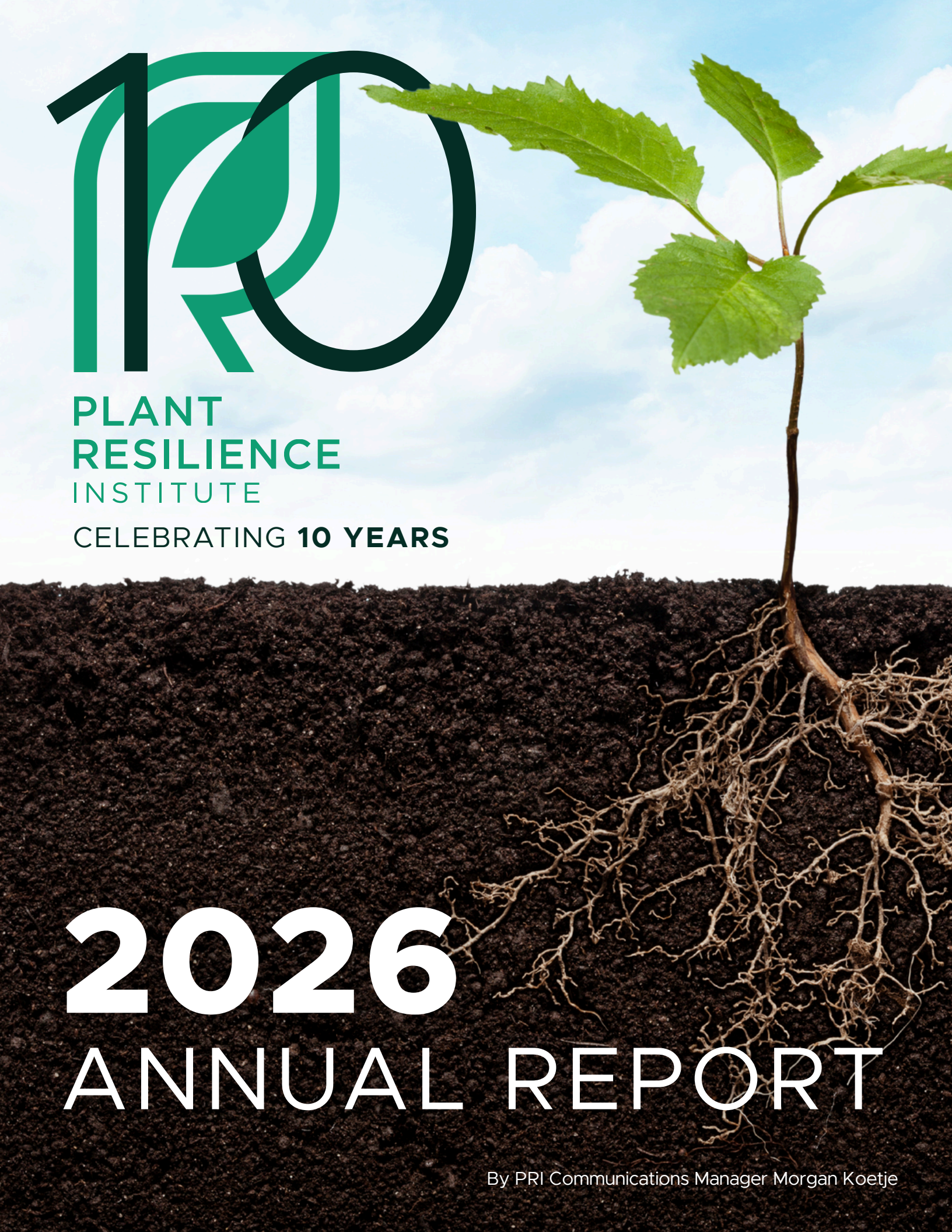


PLANT
RESILIENCE
INSTITUTE

CELEBRATING **10 YEARS**

2026 ANNUAL REPORT

By PRI Communications Manager Morgan Koetje

PLANT RESILIENCE INSTITUTE

The Plant Resilience Institute, or PRI, at Michigan State University is a globally renowned research center for plant resilience. Established in 2016 as part of MSU's Global Impact Initiative, PRI comprises 14 labs and brings together over 120 plant scientists from multiple departments and colleges across the university to address the global challenges of improving plant resilience and stabilizing crop production.



VISION

To be a leader in innovative plant resilience research, fostering a collaborative environment that attracts diverse talent and drives impactful discovery at MSU and across the globe.

MISSION

To strengthen our position as an internationally recognized "Center of Excellence" for groundbreaking laboratory and field research on plant resilience where adaptable future leaders of plant research are trained and the advancement of plant resiliency in our society and environment are advocated for and prioritized.

VALUES

PRI values professionalism, collegiality, and respect in a collaborative environment to facilitate resilience-related research with rigorous and high ethical standards.

plantresilience.msu.edu



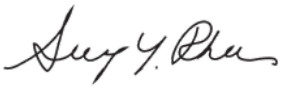
DIRECTOR'S MESSAGE

Ten years ago, the Plant Resilience Institute was founded with an ambitious vision: to bring together scientists across disciplines to better understand how plants respond and adapt to environmental stress. As we celebrate PRI's tenth anniversary, I am filled with gratitude for everyone who has helped turn that vision into the vibrant, collaborative research community we have today. What began as a strategic initiative at Michigan State University has grown into 14 laboratories and a community of more than 120 faculty, staff, postdoctoral scholars, and students working together to address some of the most consequential challenges facing plants, agriculture, and our environment.

This anniversary also gives us an opportunity to look forward. Over the past year, we continued laying the foundation for PRI's next decade of discovery. PRI researchers are leading and contributing to ambitious flagship initiatives and center-level efforts that span disciplines, institutions, and international borders. At the same time, we continue to build connections with the communities and stakeholders our science serves — including growers, students, fellow researchers, and the public.

Looking back on PRI's first decade reminds me that our greatest strength has always been our people. The scientific achievements described throughout this report are possible because of the creativity, dedication, and collaborative spirit of our community. From the beginning, PRI has been built on the idea that we can accomplish more by working together across disciplines and boundaries.

I feel an immense sense of gratitude and pride to serve as your director as we begin our second decade. We have accomplished much together in our first ten years, but the urgency of building a more resilient future has only grown. I am excited to see where our collective curiosity, collaboration, and scientific excellence take us next.



Seung Yon "Sue" Rhee, Ph.D.
Director, Plant Resilience Institute
Michigan State University

FY2026 RESEARCH EXCELLENCE

Through its innovative, bold, and transformative research, PRI has rapidly established itself as a globally renowned laboratory and field research center for plant resilience. PRI's research excellence extends from basic science to agricultural improvements, integrating interdisciplinary approaches to understand the complex mechanisms of how plants respond to, resist, and tolerate environmental stresses.

In 2026, PRI made substantial progress launching its three flagship initiatives, designed as a high-impact, interdisciplinary platform to advance understanding of plant resilience. Together, the flagship projects aim to make PRI a global hub for climate-resilient agriculture and systems-level plant science.

EWASPR

The Environmental Wide Association Study for Plant Resilience (EWASPR) project aims to identify environmental variables that causally shape plant growth, yield, and stress response by building on genotype-by-environment efforts but shifting the experimental emphasis to intensively study a small number of strategically chosen field sites using diverse, controlled environmental treatments.

GLACIERS

The Great Lakes Advanced Climate Impact & Experimental Research Station (GLACIERS) is designed to investigate how projected 2050-2100 climate scenarios will affect plant resilience, agroecosystem function, and the genetic and environmental bases of adaptation by bridging high-resolution climate manipulation with open-field conditions.

PRIME

The Plant Resilience-Inducing Metabolite Effectors (PRIME) initiative seeks to identify a new class of regulatory metabolites and their nuclear signaling mechanisms that govern plant resilience.

Over the past fiscal year, PRI scientists also advanced the overall understanding of plant resilience by publishing 82 peer-reviewed research papers in top journals including *Nature Plants*, *New Phytologist*, *The Plant Cell*, *Proceedings of the National Academy of Sciences*, and *eLife*.







FY2026 HIGH-IMPACT PUBLICATIONS

The following publications highlight the breadth and depth of PRI's excellence in research over the past fiscal year. Please see Appendix A for the full list of PRI publications from FY2026.

"Phosphorus availability controls flowering time through subcellular reprogramming of bGLU25 and GRP7 in *Arabidopsis*"

Cho et al., *Developmental Cell* (2026)

This study uncovers a previously unknown molecular mechanism that allows plants to adjust their flowering time in response to phosphorus availability, revealing how nutrient stress influences plant development and reproduction.

"Predicting complex phenotypes using multi-omics data in maize"

Creach et al., *The Plant Cell* (2026)

At the intersection of genomics, phenomics, artificial intelligence, and crop improvement, this study tested 129 maize phenotypes across nine environments using genomic, transcriptomic, and drone-derived phenomic data and found that multi-omics models generally improved prediction over individual data types.

"Early successional systems support nematode community resistance to drought stress"

Martin et al., *Soil Biology and Biochemistry* (2025)

This study demonstrates that soil nematode communities in early successional ecosystems are more resistant to drought than those in intensively managed no-till cropping systems, highlighting the important role of land use in shaping belowground resilience.

"Cryptic isoprene emission of soybeans"

Mostofa et al., *Proceedings of the National Academy of Sciences* (2025)

Challenging the long-held assumption that soybeans do not emit isoprene, this study reveals that soybean plants can release this volatile compound in response to leaf damage and heat stress. The discovery provides a new understanding of isoprene's functions in crop resilience and growth–defense tradeoffs.

"Photosynthetic acclimation is a key contributor to exponential growth of a desert plant in Death Valley summer"

Prado et al., *Current Biology* (2025)

By identifying physiological, cellular, and molecular mechanisms that allow photosynthesis to remain highly productive in the desert plant *Tidestromia oblongifolia* under extreme heat, this study provided promising targets for future efforts to engineer or breed crops capable of maintaining productivity as temperatures rise.

"Cyanoglobule lipid droplets are a stress-responsive metabolic compartment of cyanobacteria and the progenitor of plant plastoglobules"

Susanto et al., *The Plant Cell* (2025)

This study identifies cyanobacterial lipid droplets as metabolically active structures involved in stress responses and closely related to the plastoglobules found in chloroplasts. By revealing the evolutionary origins and potential functions of these structures, the research advances our understanding of how photosynthetic organisms evolved mechanisms to maintain cellular function and resilience under environmental stress.

"Local adaptation of both plant and pathogen: an arms-race compromise in switchgrass rust"

VanWallendael et al., *New Phytologist* (2025)

Using 10 replicated, multiyear common gardens and genome-wide association mapping, this research advanced understanding of plant-pathogen coevolution while providing insights that could inform breeding for durable disease resistance in switchgrass and other crops.

"Variability in drought gene expression datasets highlights the need for paired physiology and community standardization"

VanBuren et al., *Plant Physiology* (2026)

This study analyzed hundreds of publicly available plant gene expression datasets and revealed substantial variability in how plants respond to drought across experiments in order to provide a path toward more reliable, comparable data that can accelerate the discovery of mechanisms underlying drought resilience.

FY2026 NOTABLE AWARDS & HONORS

FACULTY MEMBERS

- **Emily Josephs** – MSU College of Natural Science Teacher-Scholar Award
- **David Lowry** – MSU College of Natural Science Postdoctoral Mentoring Award
- **Sue Rhee** – MSU College of Natural Science Research Leadership Award
- **Addie Thompson** – M. Rhoades Early Career Award in Maize Genetics
- **Robert VanBuren** – MSU College of Agriculture and Natural Resources Mid-Career Researcher Award

POSTDOCTORAL SCHOLARS

- **Derek Denney** – Ecological Society of America W.S. Cooper Award
- **Ian Gilman** – Danny Schnell Plant Biology Outstanding Postdoctoral Award
- **Febri Susanto** – MSU Molecular Plant Sciences Program Outstanding Paper Award
- **Jonathan Concepcion** – MSU-Bayer AgTech Hackathon First-Place Award

GRADUATE STUDENTS

- **Eleanor Carr** – MSU-Bayer AgTech Hackathon Second-Place Award
- **Ashton Datko** – Simons Foundation Graduate Fellowship in Ecology and Evolution
- **Rachel Drobnak** – MSU Graduate Student Award for Science Communication and Outreach
- **Andrew Fairclough** – NSF Graduate Research Fellowship Program Honorable Mention
- **Mataeus Funderburk** – NSF Graduate Research Fellowship Program Honorable Mention
- **Kristin Leutgeb** – NSF Graduate Research Fellowship Program Offer Recipient
- **Daniel Mok** – Botanical Society of America Best LI-COR Oral Presentation, Science Foundation "What If" Award, and JGI New Investigator Award
- **Madison Plunkert** – Donald R. Kaplan Dissertation Award in Comparative Morphology
- **Miles Roberts** – Society for the Study of Evolution Presidents' Award for Outstanding Dissertation Paper Honorable Mention
- **Kevin Santiago-Morales** – MSU Dissertation Completion Fellowship
- **Isabella Vergara** – NSF Graduate Research Fellowship Program Honorable Mention







FY2026 COMMUNITY HIGHLIGHTS



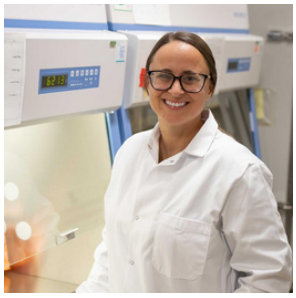
FEATURED: PRI members, alumni, and stakeholders celebrated the institute's ten-year anniversary at the PRI All-Hands Retreat.

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MSU opened the newly renovated $35-million Plant Science Research Greenhouse Complex.

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Sarah Lebeis was named the new Great Lakes Bioenergy Research Center Science Director.

LEARN MORE



David Lowry was appointed MSU Subcontract Lead of the Great Lakes Bioenergy Research Center.

LEARN MORE



PRI brought 18 unique plant science booths together in the "World of Plants" at the MSU Science Festival's STEAM Expo.

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FEATURED: Chris Topp launched SYNCORNET, an ARPA-E-funded project aimed at increasing corn's nitrogen efficiency.

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Addie Thompson organized the MSU-Bayer Hackathon at the North American Plant Phenotyping Network Annual Conference.

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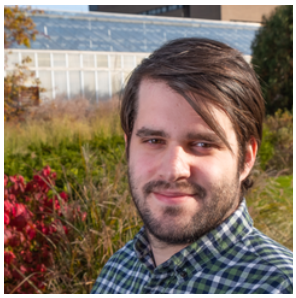
Joy Bergleson from the Simons Foundation and Nathan Springer from Bayer joined the PRI Scientific Advisory Board.

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FEATURED: Plant ecophysiologist William Hammond was recruited to the PRI faculty.

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The PRI faculty elected Robert VanBuren to serve as the new PRI associate director.

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CELEBRATING 10 YEARS OF RESILIENCE

The Plant Resilience Institute brought its community together at the 2026 PRI All-Hands Retreat to celebrate the institute's ten-year anniversary.

On May 6-7, 2026, the Plant Resilience Institute brought its community together at the MSU Multicultural Center for a special two-day All-Hands Retreat marking a major milestone: PRI's 10th anniversary. The gathering offered an opportunity to celebrate a decade of scientific innovation and collaboration while reflecting on PRI's growth and looking ahead to the next ten years.

The anniversary celebration opened with remarks from MSU Vice President for Research and Innovation Shashank Priya, followed by an overview of the "state of PRI" from Director Sue Rhee. Faculty members then shared brief research presentations representing all 14 PRI laboratories, highlighting the breadth of expertise within the institute and creating opportunities for discussion across research groups. Trainees were also at the center of the program, with students and postdoctoral researchers delivering flash talks and 38 research posters showcasing projects spanning plant resilience, environmental stress, plant-microbe interactions, phenomics, genomics, and more.



The retreat also highlighted PRI's growing scientific ambitions for the next decade. A keynote presentation from Purdue University agronomist Ignacio Ciampitti was followed by presentations on PRI's three flagship initiatives: Plant Resilience-Inducing Metabolite Effectors

(PRIME), the Environmental Wide Association Study for Plant Resilience (EWASPR), and the Great Lakes Advanced Climate Impact & Experimental Research Station (GLACIERS). Together, these initiatives reflect PRI's strategy of integrating expertise across laboratories to address complex challenges in climate-resilient agriculture and plant science.

Day two focused on PRI's commitment to developing the next generation of plant scientists. The program featured presentations from the fifth PRI Seed Grant Program cohort, demonstrations of new research technologies and equipment, and presentations from PRI Postdoctoral Fellows Derek Denney, Joanna Feehan, and Jinny Yang. Faculty, trainees, and members of PRI's Scientific Advisory Board also participated in dedicated discussions about the institute's research, training, and future direction.

More than a celebration of PRI's history, the retreat captured the collaborative spirit that has shaped the institute since its founding in 2016. By bringing together faculty, trainees, staff, alumni, and external scientific leaders, the anniversary gathering provided both a moment to appreciate how far PRI has come and a launch point for the next decade of discovery.











INTERNATIONALLY RECOGNIZED PLANT ECOPHYSIOLOGIST WILLIAM HAMMOND JOINS MSU

The Plant Resilience Institute welcomes William (Bill) Hammond to its faculty, advancing research on climate resilience, forest health, and the future of Earth's ecosystems.

As rising temperatures and increasingly frequent drought reshape forests and agricultural landscapes, understanding the how and why driving climate-induced plant mortality is critical.

The Michigan State University Plant Resilience Institute (PRI) will strengthen its leadership in this vital area by welcoming William (Bill) M. Hammond as a new assistant professor beginning in August 2027.

An internationally recognized plant ecophysiologist, Hammond's research incorporates fundamental plant biology, global change ecology, and imaging sensors to measure plant resilience in a changing climate.

"All plants eventually die," Hammond said. "But predicting the death of cells, organs, and organisms from climate-induced plant mortality remains a grand challenge."

Hammond helped pioneer the emerging field of spectral ecophysiology, which joins plant physiology, ecology, and the development of remote tools to detect plant dysfunction and mortality, even before visible symptoms appear.

"My lab studies both the external drivers and internal mechanisms that determine when plants stop living and start dying," Hammond said. "We use advanced sensor technologies to detect the various ways plants can dysfunction, de-structure, and die, which I call 'necrodiversity.' This framework for understanding plant mortality across scales is meant to improve our ability to predict which plants will be the most resilient to future climate extremes."

In particular, Hammond focuses on understanding the fate of Earth's historical forests—those dominated by large, old trees that have survived centuries to millennia of severe weather events.

"The largest and oldest trees often punch well above their weight, contributing significantly more to ecosystem services than their juniors," Hammond said. "Learning how these ancient trees have survived so many disturbances could prove vital in understanding what drives plant resilience for centuries to come."

PRI Director Seung Yon (Sue) Rhee said Hammond's addition to the institute will bring exciting new approaches to plant resilience research.

"Bill is an outstanding scientist who has quickly established himself as an international leader in plant ecophysiology," Rhee said. "His work combines cutting-edge physiology with large-scale ecological questions, and that integrative perspective makes him an outstanding addition to PRI. We're delighted to welcome him to our faculty."

Hammond will also hold joint appointments in the Department of Forestry and the Department of Plant Biology.

"Bill's innovative research and teaching on plant ecophysiology, especially tree responses to drought and heat stress, provide critical expertise to adapt to changes in precipitation and temperature," Department of Forestry Chairperson Richard Kobe said. "I am especially excited Bill is coming to MSU with affiliations in PRI and the Department of Plant Biology. Collaboration across disciplines can help ensure forests and other plant communities can be managed for resilience in the face of novel environmental stresses."

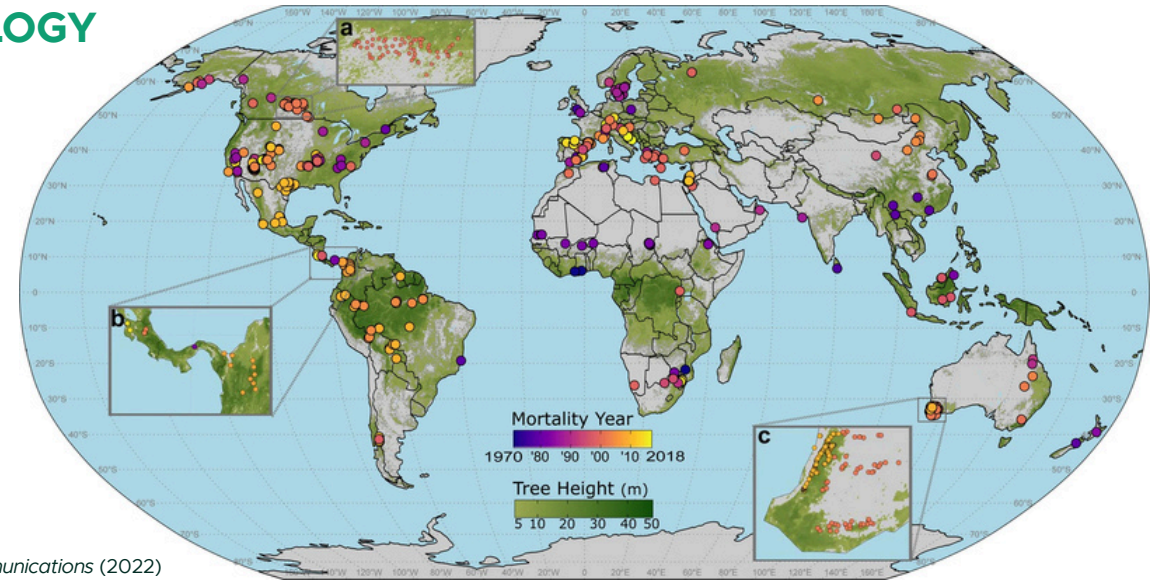
"Bill's research beautifully connects molecular and physiological mechanisms with whole-plant and ecosystem biology," Department of Plant Biology Chairperson Andrea Case said. "His commitment to mentorship and interdisciplinary science will enrich the MSU community and provide unique opportunities for students and collaborators alike."

At MSU, Hammond plans to collaborate with researchers across campus to better understand how plants respond to environmental stress and develop new strategies for improving the resilience of forests, agricultural crops, and natural ecosystems in an increasingly variable climate.

"MSU is uniquely positioned to tackle some of the most crucial biological questions of our time," Hammond said. "The opportunity to work across the Plant Resilience Institute, Forestry, and Plant Biology creates an environment where we can make discoveries from individual cells up to globally distributed ecosystems."

ECOPHYSIOLOGY OF CLIMATE-INDUCED PLANT MORTALITY

Global field observations of tree die-off reveal hotter-drought fingerprint for Earth's forests.



Hammond et al., *Nature Communications* (2022)



NEW MSU-LED PROJECT AIMS TO HELP CORN USE NITROGEN MORE EFFICIENTLY— AND MORE SUSTAINABLY

A new Michigan State University-led initiative aims to cut corn's nitrogen fertilizer use in half, potentially saving farmers billions of dollars and aiding the fight against climate change.

While nitrogen fertilizer has revolutionized modern agriculture by driving high yields in critical food crops, half of the nitrogen farmers apply to the soil never makes it into the plants. Instead, it leaches below the roots, runs off into waterways, or escapes into the atmosphere.

The stakes are high: corn is the largest consumer of nitrogen fertilizer in the U.S., using approximately 17 to 20 billion pounds annually. Even a 5% increase in nitrogen efficiency could save corn growers $530 million per year and significantly reduce nitrous oxide emissions and water pollution.

SYNCORNET: Engineering Synchronized Nitrogen Efficiency Traits in Corn Agriculture aims to solve this crisis by aligning nitrogen availability with when corn plants can most effectively absorb it.

SYNCORNET is spearheaded by Christopher N. Topp, a root biologist at MSU's Plant Resilience Institute and the departments of Plant, Soil and Microbial Sciences and Plant Biology.

For Topp, increasing corn's nitrogen efficiency means starting below ground.

Modern fertilizer practices often front-load nitrogen early in the growing season, but young seedlings have small root systems and limited capacity to absorb nutrients. The result is a mismatch between supply and demand.

"We want the plants to think ahead a little bit," Topp explained. "Native plants do this better, because nitrogen is in higher demand, so they have to hoard it."

SYNCORNET will develop corn varieties with

improved root system architecture and enhanced nitrogen metabolism to capture more of that early-season fertilizer and reduce losses to the environment.

"In an ideal future, farmers would only need to purchase and apply half the current amount of nitrogen fertilizer to their field, but the crop would take all of it," Topp said.

The project also focuses on reviving corn's natural symbiosis with arbuscular mycorrhizal fungi, also known as AMF. These ancient soil allies extend the reach of roots and help shuttle nutrients into plants.

This biological partnership may have weakened over decades of breeding corn in high-fertilizer environments. The team hypothesizes that enhancing interactions with AMF could be a more efficient way to grow crops than by using fertilizers.

"We want to provide modern corn plants with the tools and capabilities they may have lost after we've been breeding them under an ocean of synthetic nitrogen," Topp said. "Ultimately giving more reliable, cheaper solutions for farmers that can increase yields and have the benefit of being sustainable."

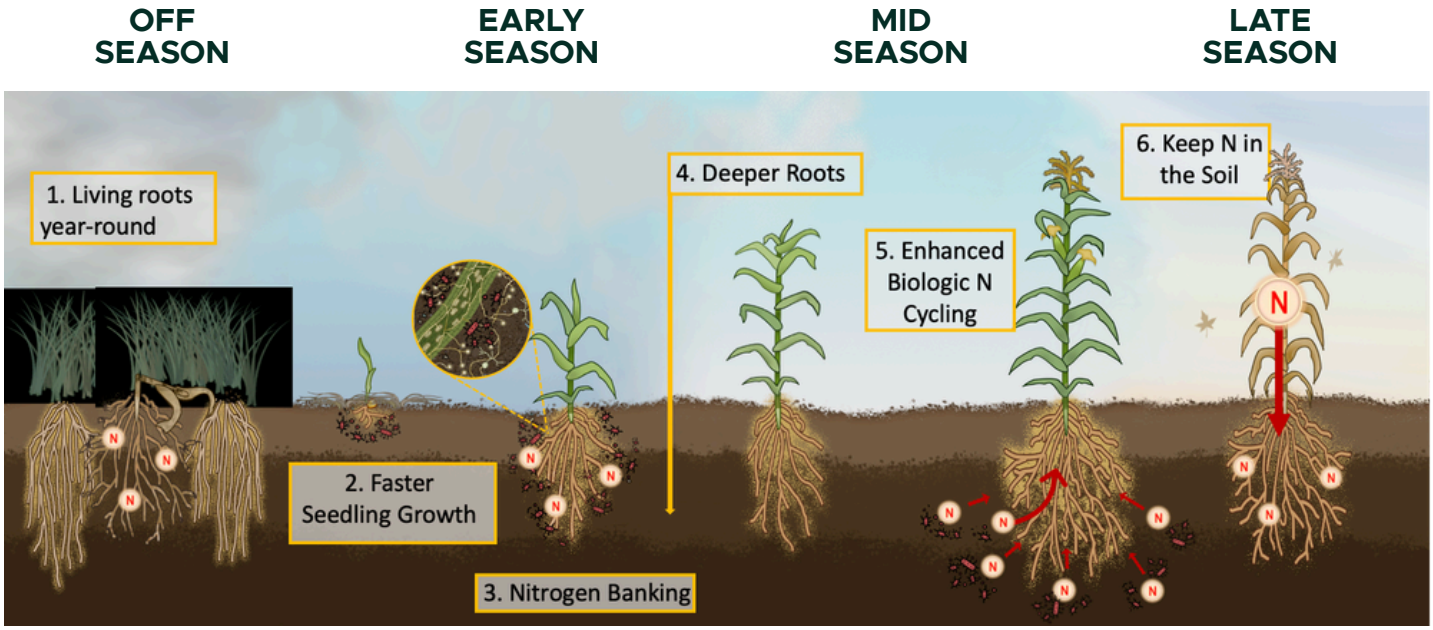
By identifying maize lines that interact more effectively with beneficial fungi and fine-tuning when nitrogen-related genes are activated in roots, the team hopes to engineer crops that are biologically synchronized with their soil environment.

Unlike past efforts that focused on single genes or management tweaks, SYNCORNET takes a systems-based approach. It integrates plant genetics, root biology, and plant-microbe interactions across the entire growing season.

Topp received funding for the project from the U.S. Department of Energy's Advanced Research Projects Agency-Energy through its TEOSYNTE program, which supports bold strategies to reduce harmful nitrous oxide emissions from crop production while maintaining yields.

"Our goal is to design crops that function like resilient natural systems," Topp said. "Capturing and recycling nutrients efficiently, season after season."

SYSTEMICALLY ADDRESSING NITROGEN (N) INEFFICIENCIES ACROSS THE GROWING SEASON



U.S. DEPARTMENT of ENERGY
ARPA-E

This project is funded in part by the Advanced Research Projects Agency - Energy (ARPA-E), U.S. Department of Energy, under Award Number DE-AR0002022, as part of the Technologies to Emend and Obviate Synthetic Nitrogen's Toll on Emissions (TEOSYNTE) program.


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