Report to the President year ended June 30, 2025, Abdul Latif Jameel Water and Food Systems Lab

Submitted by Professor Rohit Karnik, Director

FY2025 Overview

FY25 marked the tenth anniversary of J-WAFS—an exciting milestone in the history of the program. Throughout the spring, we commemorated the anniversary by highlighting examples of the important work J-WAFS has supported since our launch. We championed faculty, students, and other community members whose research and innovations have made meaningful advancements in water and food across the globe. The semester-long celebration culminated in an anniversary event attended by MIT leadership, researchers, students, staff, donors to J-WAFS, and others in the J-WAFS community.

A major part of this anniversary year has been the transition of the J-WAFS leadership team; in the fall, founding director Professor John H. Lienhard V and founding executive director Renee J. Robins both announced their upcoming retirements. Lienhard and Robins have done a remarkable job establishing J-WAFS as the Institute's preeminent program for water and food research and significantly expanding MIT's presence in the water and food research space. J-WAFS excels in advancing MIT research that addresses pressing questions in water and food; in fostering student innovation; and in creating an engaged community through seminars, workshops, and other events. In total, J-WAFS has distributed over $25M in grants, fellowships, and awards to the MIT community, supporting roughly 10% of MIT's faculty and 300 students, postdocs, and research staff from 40 MIT departments, labs, and centers. Our grants have also helped researchers receive over $25M in follow-on funding.

This past year was exciting not only because J-WAFS turned ten years old, but because of the growing impact of the work of J-WAFS researchers. J-WAFS-supported researchers have published papers in peer-reviewed journals, garnered media attention, started spinout companies, and made significant progress in their objectives that feed into the greater J-WAFS mission of securing the world's supplies of water and food.

Highlights from this past year include:

- A J-WAFS seed grant project made strides to commercialize technology for monitoring nitrogen waste products in the environment. The research is led by Rajeev Ram, a professor in the Department of Electrical Engineering and Computer Science, who is using Raman spectroscopy to detect nitrogen-containing pollutants. One of Ram's students created Dottir Labs, a startup that aims to bring the technology to market. This

marks the twelfth spinout company that J-WAFS funding has helped launch.

- J-WAFS PI Sara Beery used cutting-edge computer vision methods on sonar data to automate monitoring of migrating salmon in the Pacific Northwest, including in the newly restored Klamath River. Four dams on the river were recently demolished, allowing 240 miles of the river to flow freely, with nearly 800 square miles of habitat now accessible to salmon. In a collaboration with California Trout, Beery and her team processed new data to adapt and create a customized model that can be deployed to help count the newly migrating salmon, an important part of fisheries management.

- J-WAFS spinout Nona Technologies successfully raised a $3.5 million seed round to advance its portable desalination device, invented by Junghyo Yoon, a former postdoc in Professor Jongyoon Han's lab. Yoon, Han, and Nona CEO Bruce Crawford MBA '23 were funded by a J-WAFS Solutions grant. Nona entered into a collaboration with the U.S. Army Natick Soldier Systems Center, where it co-developed early prototypes and began generating revenue while validating the technology. The company was also awarded two Small Business Innovation Research (SBIR) Phase I grants totaling $575,000, one from the National Science Foundation and another from the National Institute of Environmental Health Sciences.

Additional J-WAFS project updates, outcomes, awards, communications highlights, and events are reported in detail below.

J-WAFS Grant Offerings

J-WAFS Seed Grants

J-WAFS seed grants are the core of J-WAFS' various grant opportunities, offering up to $150,000 over a two-year period for early-stage research that holds promise for advancing sustainable water and food supplies for human need.

Nine different projects were awarded this year, which will be led by ten principal investigators from five departments, spanning three schools at MIT—School of Engineering, School of Science, and Sloan School of Management. Awarded projects and researchers are listed below.

Optimal subsidy design: Application to food assistance programs

PI: Assistant Professor Ali Aouad, Sloan School of Management

Food insecurity remains a major global challenge, especially in low- and middle-income countries where underserved communities often lack access to healthy, affordable food. Governments and organizations provide food-based safety net programs, such as subsidies for essential goods or cash transfers. However, these programs do not always accommodate recipients' actual needs or preferences, which can reduce their effectiveness and uptake.

Aouad aims to enhance the value of food subsidies by developing an approach to better align food assistance programs with the population's preferences and with policy objectives. He is working with outside collaborators, including Zhicong Hu of INSEAD, Professor Kamalini Ramdas of the London Business School, and Alp Sungu, PhD, of the Wharton School. The researchers will base their work on experimental evidence from Mumbai, India. Ultimately, they plan to test their 'precision food subsidy' methodology in a pilot field experiment to evaluate new subsidy designs.

Toward sustainable food protein manufacturing

PI: Professor Peter Dedon, Department of Biological Engineering

Manufacturing food proteins and cultivated meats by precision cellular agriculture holds promise as an environmentally sustainable replacement for livestock farming by reducing greenhouse gas production and land use impacts associated with animal agriculture. This approach can also help provide essential food proteins for farm-inaccessible regions. A significant challenge to cellular agriculture, however, is the high cost of growth factors—proteins that play a crucial role in the production of cultured products.

Dedon plans to reduce manufacturing costs by increasing protein yields in bioreactors using advanced genomics methods to enhance protein translation. In the standard genetic code, 61 three-nucleotide sequences—called codons—specify each of 20 different amino acids during protein synthesis. Dedon's team discovered that the "spare" or synonymous codons for each amino acid are concentrated in genes that respond to stresses, such as producing large amounts of a protein, which requires a large amount of energy. Using a machine learning model, Dedon will create a predictive biogeographical map of codon usage patterns across the 5000 genes in a commonly used protein manufacturing organism, *Komagataella phaffii*. The map will be piloted to reengineer the gene for the FGF2 growth factor for cultured meat production, with the long-term goal of optimizing food protein yields and reducing protein manufacturing costs.

Fluorine-free materials to trap and destroy PFAS

PI: Professor Jeremiah Johnson, Department of Chemistry

Per- and poly-fluorinated alkyl substances (PFAS), commonly known as forever chemicals, are widely used in consumer products—such as non-stick cookware, water-resistant clothing, and grease-resistant food packaging—and in various other contexts. Yet many PFAS molecules are known to be toxic, making their accumulation in drinking water and elsewhere in the environment a global concern.

To remove and destroy PFAS from contaminated water, Johnson proposes a novel class of materials. These materials uniquely combine different chemical interactions to concentrate PFAS synergistically, yielding purified water. Alongside the PFAS-absorbing substances, a

catalyst will be integrated into the team's absorbents to allow the destruction of the bound PFAS into benign products. With this novel class of materials capable of removing and destroying PFAS, the researchers hope to pave the way for a PFAS-free future.

Food-safe, wireless RFID sensor on smart packaging for pH monitoring in the cold chain

PI: Professor Sanjay Sarma, Department of Mechanical Engineering

Sarma is attempting to prevent spoilage along supply chains, which accounts for millions of tons of food waste each year. Existing methods to assess freshness and product quality rely on chemical changes related to microbial growth. These approaches can be expensive and slow, and sometimes require opening the packaging, thereby risking contamination or waste of still-fresh items. Sarma's lab plans to create low-cost, food-safe radio frequency identification (RFID) sensors that can detect changes in food freshness without opening the package.

The sensors will work by monitoring pH levels, an indicator of spoilage, as many foods release substances that change the pH as they go bad. Instead of using complex electronics or harmful materials, the sensors will be made from natural, food-safe polymers and designed to be part of RFID labels already used on food packages. By deploying RFID technology, the sensors can communicate that information over short distances to facilitate data retrieval. The goal is to reduce unnecessary food waste by giving clear, early signs of spoilage.

Stable, low cost engineered proteins as biofungicides

PI: Professor Hadley Sikes, Department of Chemical Engineering

Fungal diseases impact many forms of life. Unlike bacteria and viruses, which dominate as human disease pathogens, fungi have historically received little attention. Yet these understudied microbes are the major agents of disease in food crops. Fungal attacks on staple crops—such as rice, corn, and wheat—threaten global food security, which is already under increasing pressure from climate change and a growing population. Current fungal management strategies in agriculture rely heavily on the use of chemical fungicides, which contribute substantially to the cost of producing crops. In addition, they can be highly toxic to a broad range of organisms, including humans.

Sikes aims to engineer a novel and safe class of biological fungicides as an affordable and eco-friendly alternative to combat fungal plant pathogens. Her team will first identify pathogen-specific proteins that play a crucial role in fungal development and pathogenicity to plants. The goal is to develop and validate a protein-based biofungicide that protects food crops from fungal infections using engineered binding proteins.

Toward nitrogen-fixing crops: Improving nitrogenase activity in non-diazotrophic hosts

PI: Associate Professor Daniel Suess, Department of Chemistry

An essential element for life, nitrogen is abundant in Earth's atmosphere in the form of

dinitrogen (N_2). However, eukaryotes are incapable of incorporating N_2 into biomass because of the chemical inertness of the nitrogen triple bond (N≡N). Only microbes that express nitrogenases—enzymes that convert N_2 to bioavailable ammonia (NH_3)—can assimilate nitrogen from air. Although this process provides substantial quantities of fixed nitrogen for the biosphere, it is not sufficient to produce crops on a scale that sustains our growing human population. As a result, farmers in many parts of the world use nitrogen fertilizers derived from a highly energy-intensive and greenhouse gas-emitting method called the Haber–Bosch process.

As an alternative to nitrogen fertilizers, Suess' research will advance efforts to engineer nitrogen-fixing crops that express nitrogenase. He will study the chemical processes by which nitrogenase is assembled, potentially leading to improved nitrogenase activity in non-native organisms, and ultimately to the development of crops that can supply their own nitrogen.

Benchtop NMR with dynamic nuclear polarization for ultra-sensitive PFAS detection

PIs: Professors Tim Swager and Robert Guy Griffin, Department of Chemistry

Per- and poly-fluoroalkane substances (PFAS) are not biodegradable and do not burn, which has led to an accumulation of PFAS in the environment and in our bodies. Exposure to PFAS has been associated with adverse health effects, including altered immune function, liver disease, kidney disease, and cancer. Due to their harmful effects, the EPA has issued new impending regulations on the acceptable concentrations of PFAS in drinking water. But current detection methods require expensive equipment and highly skilled operators, and they struggle in the presence of highly complex mixtures containing PFAS species beyond the six PFAS targeted for regulation.

Fluorine-19 Nuclear Magnetic Resonance (NMR) is a spectroscopic method that provides a more accurate, easy-to-use alternative. Swager and Griffin will work together to develop NMR methods that meet the EPA parts per trillion PFAS detection limits. The researchers will use dynamic nuclear polarization, wherein the magnetically abundant Fluorine-19 nuclei are aligned with an applied magnetic field to enhance the NMR signal and enable accurate, high-sensitivity detection of a range of PFAS molecules in a simpler format.

AI enabled spectral fingerprinting of pathogens for rapid food and water screening

PI: Assistant Professor Loza Tadesse, Department of Mechanical Engineering

Despite public health measures, food and waterborne illnesses still cause over 420,000 deaths and $110 billion in losses worldwide each year. Current testing methods for detecting pathogens are slow, costly, and labor-intensive. Can we diagnose bacteria contaminating food and water sources in minutes rather than days? This is the research question that Tadesse seeks to answer.

Tadesse's team is using signal-enhancing microbeads and Raman spectroscopy—a biosensing

technique that measures a sample's unique molecular "fingerprint" through inelastic light scattering. These pathogen-specific beads capture microbes like Salmonella, E. coli, and cholera-causing bacteria directly from liquid samples and amplify their Raman signals for detection. The resulting Raman spectra are analyzed by on-device machine learning algorithms to accurately identify the pathogens and assess their resistance to antibiotics—information critical for deciding treatment and containment strategies.

Global access to safe drinking water in resource-constrained and water scarce areas

PI: Professor Xuanhe Zhao, Department of Mechanical Engineering

Currently, 2.2 billion people lack access to safe drinking water, and this number is projected to surge to 5 billion globally by 2050 due to the combined effects of climate change, population growth, and increasing urban, industrial, and domestic water demand. Zhao and his team aim to provide global access to safe drinking water at scale and speed by scaling up and deploying efficient, low-cost, low-maintenance, decentralized water harvesting systems.

Recognizing the challenges facing landlocked, off-grid regions with limited energy infrastructure and maintenance access, the team's project focuses on a solar-driven atmospheric water harvesting (SAWH) system, a fully passive system that utilizes only solar energy to extract water from ambient air. The team aims to develop the technology for family-scale implementation, targeting regions with constrained resources.

Seed grant projects that concluded in FY2025:

Projects originally funded in fall of 2021 (see the FY2021 Report to the President for abstracts):

Improving Smallholder Farmers' Welfare with AI-driven Technologies

PI: Associate Professor Yanchong (Karen) Zheng, Sloan School of Management

Yanchong (Karen) Zheng concluded a J-WAFS seed grant project that sought to help fill the gap between the information farmers receive and their ability to use it. She and her team focused on price prediction and market optimization models to support smallholder fresh produce farmers in Bihar, India. The researchers developed a market intelligence tool that includes two different steps. This first is a machine learning-based model to predict one-day-ahead prices for different produce in different markets. In the second step, the team used the predicted prices as inputs to an optimization model to help farmers decide which markets they should sell their produce at the next day. The optimization model accounts for various operational and behavioral constraints to ensure it can be efficiently implemented in the field. Armed with this market intelligence, the farmers can make decisions that will increase their profitability in agricultural wholesale markets.

To bring the developed approach into actual implementation, the team worked with Digital Green, a global development nonprofit active in India, Ethiopia, Ghana, and Afghanistan. Zheng

incorporated the models and algorithms into the Digital Green platform to create a dataset that involved 675 villages, 212 markets, and 151 crops. The data shows that the predict-then-optimize approach can generate 12%-20% revenue improvement for the farmers, with an even greater improvement when more historical data are available.

Precise Fish Vaccine Injection Using Silk-based Biomaterials

PI: Associate Professor Benedetto Marelli, Department of Civil and Environmental Engineering

This research project aimed to enhance the efficacy of vaccines in aquaculture to overcome barriers such as poor performance and cost. Marelli and his lab engineered food-grade materials made out of silk to create waterproof microneedles suitable for vaccinating juvenile fish in aquatic environments. The team built on knowledge gained from talking to experts in aquaculture and fish disease. They also conducted a pilot study at the National Center for Cool and Cold Water Aquaculture in West Virginia to assess microneedle immunization and elicitation of protective immunity. The researchers found that microneedle vaccination provided some protection, though its efficacy did not match that of the gold standard—intramuscular injection. However, the seed grant project offered foundational insights, and future work will aim to enhance immunity protection in fish by studying bio-nano interfaces—biomaterial/vaccine interface and biomaterial/tissue interface—to achieve higher immunity protection in fish. If successful, this technology could help fish hatchery farmers vaccinate juvenile fish without sedating the fish to inject them individually, as current practice requires. Their approach would alleviate the stress fish experience from sedation, while improving sustainable farming practices by reducing chemical (anesthesia) and metal needle use, and lowering farmers' costs.

A new approach to enhance genetic diversity to improve crop breeding

PI: Professor Mary Gehring, Department of Biology

Mary Gehring's primary objective was to design a universally applicable method that can increase genetic diversity to help crop species better adapt to climate-related threats, like increased heat or salinity. Gehring and her team accomplished this goal by developing a simple, inexpensive, accessible method to induce structural variation in any plant species of interest. They then piloted the method in a model plant species (*Arabidopsis thaliana*) and identified structural variants underlying mutant phenotypes of interest. They also developed approaches for applying the mutagenesis approach in the orphan crop pigeon pea (*Cajanus cajan)*. In addition, the group created an etoposide-mutagenized population of *C. cajan* and sequenced the genomes of two *C. cajan* strains. Because Gehring's approach requires inexpensive resources, it has the potential to be particularly beneficial in regions with less research infrastructure.

Projects originally funded in fall of 2022 (see the FY2022 Report to the President for abstracts):

High resolution plant water stress monitoring

PI: Assistant Professor César Terrer, Department of Civil and Environmental Engineering

This project leveraged a new generation of remote sensing observations to build high-resolution systems to monitor drought. César Terrer used data from Landsat and Sentinel (satellite products) to obtain daily images from space with such high resolution that individual trees can be discerned. Along with the images and datasets from satellites, the researcher and his team used ground-based observations from meteorological data. The group then calculated a crop water stress index to optimize irrigation and water management strategies. They implemented a semi-automatic processing chain for monitoring crop water stress and mapped crop water stress in 2020 across the conterminous United States with high spatial (30 m) and temporal resolution (two to three days). This work supports targeted irrigation, precision agriculture, drought monitoring and mitigation, and data-driven resource allocation and planning.

Solar Photomolecular Desalination

PI: Professor Gang Chen, Department of Mechanical Engineering

Gang Chen and his lab discovered a photomolecular effect that could dramatically lower the energy required for desalination. Their discovery shows that a photon with energy larger than the bonding energy between a water cluster and the remaining water liquids can cleave off the water cluster at the water-air interface, colliding with air molecules and disintegrating into 60 or even more individual water molecules. They went on to develop heat and mass transfer models to understand the thermodynamics of evaporation in a porous 3D evaporating device. Results show the amount of ambient heat that can be absorbed can reach quite high values relative to solar input if the 3D structure is sized appropriately, allowing for the benefit of continuous evaporation rates at nighttime. Chen's group also conceived of an "inverted" solar still concept with potential for higher efficiencies of up to 30% improvement compared with literature. They also built a prototype that could be deployed in freshwater-scarce communities with brackish water supply. They conducted experiments that showed there is reduced latent heat in polymeric hydrogels, but it doesn't play a major role in the natural convection evaporation rate and may not be the reason for the super-thermal evaporation rates measured under solar illumination. This lends more credence to the researchers' hypothesis of the photomolecular effect being the reason for the super-thermal evaporation under solar illumination.

Liquid-Infused Membranes to Separate Emulsified Oils from Water

PI: Professor Gregory C. Rutledge, Department of Chemical Engineering

This project sought to use liquid infused membranes (LIMs) to better separate oils from water without fouling. Gregory Rutledge and his lab first imaged the transport of oil from oil-in-water

emulsions through a form of liquid-infused membranes (LIMs), using confocal laser scanning microscopy (CLSM). The team proposed mechanisms for the observed capture and transport of emulsified oil through a LIM and developed approximate analytical models for each mechanism. They then validated analytical models for liquid entry pressure and channel formation as functions of infused liquid viscosity, pore diameter, contact angle and interfacial tension. Lastly, they developed analytical and numerical models for dynamics of penetration of pores by oil or water for a deeper understanding of the mechanism of the pore opening, helping developers of LIMs to identify and eliminate bottlenecks in transport through such membranes, and accelerate development of commercially viable, foulant-resistant membranes for oil-water separation.

Enzymatic biomaterials for PFAS degradation

PI: Assistant Professor Ariel Furst, Department of Chemical Engineering

Furst aimed to develop a technology that utilizes low-energy, scaffolded whole cell enzyme materials to degrade per- and polyfluoroalkyl substances (PFAS)—man-made chemicals that are hazardous pollutants. The team successfully expressed radical-generating enzymes on the surface of E. coli, though they were not as active as anticipated. They pivoted to using capture-based materials called cyclodextrins. Reversible capture of small-molecule PFAS is made possible with cyclodextrin because it is a sugar-derived molecule that is shaped like a cone, allowing for capture in the center of the molecule. This molecule is readily electropolymerized, which has enabled the team to modify inexpensive carbon felt materials with cyclodextrin and deploy it as a filter. Additionally, they found inexpensive photocatalytic materials for small-molecule PFAS degradation by coating titanium dioxide onto glass treated with visible light. Furst is preparing publications on this work and has secured industry-sponsored follow-on funding to continue the research, demonstrating interest in the results of the project.

J-WAFS Solutions Grants

Since 2015, the J-WAFS Solutions grant program has existed to help MIT technologies and innovations move from the lab to the market for real-world impact. Grants offer up to $150,000 (including full MIT research overhead) for projects up to one year in duration. Funded projects may be eligible to apply for one renewal grant pending the availability of funding and progress from the first grant year. The funding allows teams to advance technology readiness, investigate markets and conduct customer discovery, initiate product design and development, and carry out other research and commercialization activities.

In total, twenty-eight grants, including renewals, have been awarded to twenty-two faculty members across the Institute. The projects have led to a dozen spinout companies and two products. The Solutions program was originally funded by Community Jameel.

Solutions grant projects that concluded in FY2025:

Project originally funded in fall of 2022 (see the FY2022 Report to the President for abstract):

Sustainable hydrogel microparticles for the removal of micropollutants from water
PI: Professor Patrick Doyle, Department of Chemical Engineering

The Doyle team developed a platform that employs novel hydrogel microparticles, consisting of chemically bound micelles, chelating agents, and zwitterionic monomers, to rapidly absorb both organic and inorganic micropollutants from water in a single step. The hydrogels are tunable, reusable over long cycles, and process and industry agnostic, allowing them to be easily incorporated into existing processes. The researchers tested and refined bench-scale prototypes of the hydrogel platform both in the lab and with samples from different potential customers in the water treatment and biomanufacturing spaces.

The hydrogel system can effectively clean highly contaminated water to below regulatory limits on contaminants in drinking water, and it has a significantly lower carbon footprint than existing solutions. Doyle's system can also treat complex mixtures of chemically diverse micropollutants at least 10 times more rapidly than a commercial AC/ion exchange resin mixture, and up to 100 times faster than other multifunctional adsorbents reported in literature. This technology is currently protected by two pending patents and detailed in three peer-reviewed publications.

The team participated in a number of commercialization programs in the greater Boston area and at MIT, including the NSF-funded Spark and Fusion programs. They received a $50K award to conduct customer discovery in the NSF I-Corps National Program. The researchers investigated the various markets for the technology by holding discussions with individuals, companies, regulators, and potential industry collaborators. This market research revealed higher-value, more innovation-friendly markets with urgent purification challenges: namely, biomanufacturing.

Doyle and his lab have received several follow-on funding awards, including $75K from the Massachusetts Clean Energy Center, $250K from the Pillar VC Moonshot Competition, and a total of $70K from Cleantech Open as both the regional winner for the Northeast and the grand prize national winner. The researchers created Drosera Biotechnologies, Inc. to commercialize their technology and are currently operating out of The Engine Accelerator Space.

Project originally funded in summer of 2023 (see the FY2023 Report to the President for abstract):

Solid-state scrap processing: A pathway to drastically reduce water consumption in steelmaking
PI: Associate Professor Cem Tasan, Department of Materials Science and Engineering

This project sought a way to manufacture formable sheet metal by consolidating scrap steel, using less freshwater than traditional steel processing. Tasan's group began by identifying the bonding performance and mechanical response of stainless steel, aluminum, copper, nickel,

titanium, and galvanized steel. They then led lab-scale and formability trials with stainless steel and manufactured a prototype product. They conducted customer discovery through over 20 interviews with professionals in the scrap management ecosystem, completed a draft techno-economic model, and finalized an initial product offering. The team has filed two patents on their consolidation and bonding system and methods and received $500K in follow-on funding from the Massachusetts Clean Energy Center.

J-WAFS Water and Food Grand Challenge Grant

The J-WAFS Grand Challenge grant aims to support projects that address significant challenges in the areas of water and food for human need. To date, two requests for proposals have been announced, with the second one specifically in the context of climate change. The opportunity supports actionable, solutions-oriented research that leverages multiple existing areas of expertise, programs, and Institute resources.

On the last day of this reporting period, the team working on the first J-WAFS Grand Challenge project (originally funded in FY23) published a paper in the *Proceedings of the National Academy of Sciences (PNAS)*. The research focuses on the enzyme Rubisco, which is believed to be the most abundant enzyme on Earth. Rubisco is essential to the process of photosynthesis in plants because it catalyzes the reaction that converts carbon dioxide into organic compounds. Rubisco, however, is inefficient compared to other enzymes because it is slow acting. The lead researchers, Professor Matthew Shoulders, research scientist Robbie Wilson, both of the MIT Department of Chemistry, and postdoc Julie McDonald, of the Department of Biology, are studying how to improve the functionality of the slow-moving enzyme through directed evolution, in the hopes of enhancing forms of Rubisco utilized in plants to boost rates of photosynthesis, thus improving crop yields.

An external scientific advisory board was convened for the Shoulders Grand Challenge Project to assess progress and advise J-WAFS and the research team on future directions. The members are: Don Ort, Robert Emerson Professor of Plant Biology and Crop Sciences at the University of Illinois Urbana-Champaign; Laura Gunn, Assistant Professor, Plant Biology Section, School of Integrative Plant Science, Cornell University; Qiang Cui, Professor, Department of Chemistry, Boston University; and Tristan Bepler, Group Leader, Simons Machine Learning Center at New York Structural Biology Center.

The board met in person with the research team and J-WAFS leadership in a day-long meeting on November 1, 2024. The team presented research progress and initial results. The board found the project to address a real and important need, to be aspirational in its objectives, and to be well worth the team's time. It applauded the interdisciplinary collaboration and J-WAFS' vision in supporting such a unique project. Issues of computing and financial resources were discussed along with research challenges and possible technical approaches, and strategies to support and advance the more successful components of the project.

In January 2024, following a highly competitive multi-stage proposal process that shepherded initial ideas through to the full proposal stage, with thorough review and feedback from external experts, J-WAFS awarded its second $1.5 million Grand Challenge grant. The interdisciplinary team is led by Professor Christopher Voigt of MIT's Department of Biological Engineering. The project and team are described below.

Food security in Africa through microbiome engineering

PIs: Professor Christopher Voigt, Department of Biological Engineering; Associate Professor Tami Lieberman, Department of Civil and Environmental Engineering; Assistant Professor Darcy McRose, Department of Civil and Environmental Engineering; Professor Tavneet Suri, Sloan School of Management; Assistant Professor Sixian You, Department of Electrical Engineering & Computer Science; and Associate Professor, David Des Marais, Department of Civil and Environmental Engineering

This project aims to advance the use of microbes for sustainable agriculture in Kenya—and ultimately other locations across Africa where crop productivity is limited by lack of access to fertilizer.

All living things rely on microbes to conduct chemical reactions that convert key building blocks of life into biologically accessible forms. One example of this is bacteria that play a role converting atmospheric nitrogen into a form that crops can use. Voigt and the team are engineering bacteria that can enhance crop growth across a range of crop species and environmental variations. The multidisciplinary MIT team is working with researchers from Kenyatta University to conduct this groundbreaking research over the next three years.

Synthetic nitrogen fertilizer has adverse effects on the environment, wildlife, and human health, and is highly energy intensive to produce, causing extensive greenhouse gas emissions. However, it is used broadly across much of the world to increase crop productivity. Yet manufactured fertilizer use in Africa remains very low due to affordability and supply chain constraints. Finding sustainable alternatives to help African farmers increase yield is a central objective of the Grand Challenge project.

Researchers will collect and analyze soil microbial communities in order to build a library of species with nitrogen fixation capability. The strains will be tested for how well they colonize plant roots. Stable combinations of microbe and plant will be tested for enhanced maize yield. A core component of the project is to develop a plan for commercialization in Kenya and throughout Africa. Through a collaboration with economics faculty at Sloan, who are part of the Abdul Latif Jameel Poverty Action Lab, the group will work with farmers in Africa to test the microbial products and understand their benefits and challenges in the field. They will develop best practices and networks to educate and train farmers and assess distribution requirements to transport active bacteria. If this project is successful, crop yields could increase without sacrificing water use, energy requirements, and environmental impact.

J-WAFS Grant for Transforming Animal Agriculture Systems

The J-WAFS Grant for Transforming Animal Agriculture Systems funds MIT research that addresses how to feed a growing population in a sustainable manner—protecting the environment our food production systems depend on, providing a fair livelihood for those employed in food production, and maintaining the ethical treatment of animals that constitute a significant part of those systems. The grant offering is typically in the range of $15-25,000 and is open to all current members of the MIT community, including students.

Animal Ag grant project that concluded in FY2025:

Project originally funded in 2024 (see the FY2024 Report to the President for abstract):

The role of livestock in climate change: Holistic greenhouse gas assessments and implications for human diets

PI: Assistant Professor César Terrer, Department of Civil and Environmental Engineering

The main goal of the research was to develop a global database that includes detailed information on GHG emissions from livestock grazing. This goal was achieved as researchers were able to create the first open-access, global, spatially explicit livestock-climate database with 6,800+ field GHG measurements merged with satellites and socioeconomic layers. The dataset gives an unprecedented view of where ruminant emissions really come from. Terrer also built a new machine-learning life-cycle platform that converts the data into full supply-chain carbon ledgers, capturing hidden land-use emissions. His team quantified the climate-and-health pay-off of diet shifts from today's Western diet to a fully vegan diet, showing exactly how much warming, premature mortality, and GDP change each step of meat reduction would deliver. They discovered a "sweet-spot" combination of diet change and smart grazing can cut ruminant GHGs by about 90 % while raising global GDP 6%, allowing 7 in 10 countries hit net-zero livestock emissions.

The researchers aim to publish a paper and convert their analysis into a web-based tool that lets governments and producers see, in real time, how specific interventions change their carbon and health balance sheets.

J-WAFS Grant for Water and Food Projects in India

J-WAFS India grants support projects that benefit low-income populations by involving on-the-ground work with local communities in India. The funding opportunity is open to members of the MIT community in all departments and programs.

New India Grant projects funded this year aim to explore strategies to enable and support sustainable agricultural practices on farms across India. Read more about the two awarded

projects and the researchers below as well as a formerly awarded project that concluded this year.

Incentive design to promote long-term adoption of sustainable practices by smallholder farmers in India

PI: Yanchong (Karen) Zheng, MIT Sloan School of Management

This project will examine the effectiveness of two different incentives: a fixed reward prevalent in payments for ecosystem service programs and carbon offsetting projects; and a supply-dependent mechanism where sustainable farmers receive a premium per unit supply plus a fixed bonus. The project team will examine the efficacy of these incentives in randomized controlled field trials with smallholder farmers in India.

The research team is collaborating with the 2030 Water Resources Group (administered by World Bank) to design effective incentive structures for scaling the adoption of sustainable agricultural practices in Uttar Pradesh (UP), India through the UP Accelerator Program for Agriculture Transformation and Increased Incomes. Given the prominence of rice-wheat systems in the state, the team will initially focus on developing and operationalizing innovative incentive mechanisms to motivate permanent adoption of Direct Seeded Rice (DSR) practices, which have been proven to have significant productivity and environmental advantages over traditional planting methods. In the one-year scoping study, the team will engage with various stakeholders, including officials, private-sector players, and local communities to select the target region for initial intervention. A pilot experiment will be designed and conducted with representative farmer samples in the target region to obtain proof of concept regarding the efficacy of different incentives. Results from the pilot will also inform how the incentives may be adapted to suit local conditions to further enhance efficacy. Eventually, the researchers aim to have a refined design of the incentive structure for scaled implementation in the next phase of the project.

Affordable, accurate, detailed climate projections for climate-resilient agriculture in India

PI: Principal research scientist Sai Ravela, Department of Earth, Atmospheric, and Planetary Sciences; Postdoc associate Anamitra Saha, Department of Earth, Atmospheric, and Planetary Sciences; Professor Subimal Ghosh, Indian Institute of Technology

This project aims to develop climate projections for climate-resilient agriculture in India. Ravela and his team plan to develop a climate-aware decision support system that agricultural policy planners can use for decision-making in water management, irrigation planning, supply chain stabilization, and crop variety selection in India.

For context, India's economic productivity relies heavily on agriculture, which is threatened by climate change and the water crisis. To meet the growing demands, the country has implemented several agricultural policies with short-term benefits at the cost of long-term environmental sustainability. Rising temperatures, erratic monsoons, and increasing droughts

are now putting the food and water security of the country, as well as farmer livelihoods, at risk. As a result, the researchers hope to determine whether incorporating long-range climate projections could improve sustainable agricultural decision-making in the country. The project has two major components. First, the team plans to develop a computational method that transforms coarse resolution climate simulations into detailed predictions for local decision-making. Second, the team will build an AI-based optimization framework that handles multiple competing objectives, such as increasing resilience against climate-related risks, minimizing water and energy usage, and maximizing crop yield, to enable sound practices and policies.

India grant project that concluded in FY2025:

Project originally funded in 2024 (see the FY24 Report to the President for abstract)

Smart buckets: Measuring water access in rural India

Project leads: PhD students Gokul Sampath, Department of Urban Studies and Planning, and Jonathan Bessette, Department of Mechanical Engineering

Bessette and Sampath developed low-cost, small sensors that were placed inside water-fetching vessels to make “smart buckets.” The devices helped to obtain a clearer picture of water fetching practices in arsenic-affected villages in rural India. Bessette led the design and testing of the sensor prototype and Sampath validated the sensor functionality by conducting surveys, interviews, and water diary studies with hundreds of families in rural India. By utilizing the sensors, the researchers were able to obtain high fidelity, unbiased data that not only identified fetching locations but also the routes individuals took, the times of day people fetched water, and even water usage from the dispensers and buckets, all while being at a lower cost than employing surveyors. Sampath and Bessette discovered that fetching behavior is often influenced by social factors which create unintuitive behavior, like walking longer distances to fetch water or switching to lower quality water sources. By demonstrating the efficacy of a sensor-based approach to understanding water-fetching practices, this research addressed a major data gap in international development. In the future, the team plans to make the sensor designs open-source.

Collaboration with GEAR Center

The K. Lisa Yang Global Engineering and Research (GEAR) Center in Mechanical Engineering, led by Prof. Amos Winter, aims to catalyze MIT research by implementing a systematic methodology to identify research problems with stakeholder engagement to develop real-world solutions with pathways to commercialization, especially for impoverished communities. The GEAR Center and J-WAFS established a collaboration to jointly hire a postdoctoral associate to scope and identify problems in the water and food space that align with the missions of both the GEAR Center and J-WAFS. The postdoc, Chotiwat Jantarakasem, PhD, is funded by the GEAR Center and is working with both the GEAR Center and J-WAFS teams to help the MIT water and food research community initiate and advance research for greater real-world impact.

Jantarakasem has completed a preliminary analysis of critical water challenges that can be addressed by MIT researchers. He is also working closely with Greg Sixt, PhD, J-WAFS research manager for climate and food systems, on research to address water quality challenges in Southeast Asia.

External Engagement

The Food and Climate Systems Transformation (FACT) Alliance

Founded by J-WAFS in 2021, the Food and Climate Systems Transformation (FACT) Alliance is a global food systems convergence research network aimed at achieving healthy, sustainable, equitable, and resilient food systems in a rapidly changing climate. The network is made up of over 20 global institutions that are home to some of the world's leading experts in food and climate systems. FACT is directed by Greg Six, PhD, J-WAFS research manager for climate and food systems.

In the fall and winter of 2024, the FACT Alliance hosted a webinar series on how climate change is impacting land, water, and food. The series included three separate webinars, billed as dialogues, that featured different panels of experts. The webinars were co-hosted with the University of Natural Resources and Life Sciences, Vienna (BOKU), a FACT Alliance member, and were moderated by J-WAFS' Greg Sixt and Michael Hauser of BOKU. The first dialogue featured a discussion on climate change and food system shocks and how to build resilience for the near-term. The three speakers were:

- Molly Jahn, PhD, a professor at the University of Wisconsin-Madison
- Violet Kisakye, PhD, an associate professor in the faculty of Agriculture and Environmental Sciences at Mountains of the Moon University, Uganda
- Peter Läderach, PhD, a principal scientist at the Alliance of Bioversity International and CIAT

The second dialogue explored land degradation, extreme weather events, political instabilities, and economic fragilities, which are all putting pressure on food systems. The two speakers on the panel were:

- Hassan Yasin, the executive director of the Somali Greenpeace Association (SOGPA) and chair of communication, membership and partnership for the African Civil Society Biodiversity Alliance Centre
- Erin Coughlan de Perez, PhD, a professor at Tufts University

The final webinar examined the complex relationships between climate change, water resources and potential implications for human security. The speakers were:

- Annette Huber-Lee, PhD, a senior scientist at the Stockholm Environmental Institute

- Linus Mofor, PhD, a regional advisor on sustainability and climate change for East and Southern Africa at UNICEF

Also, during this reporting period, the FACT Alliance officially launched the Jameel Index for Food Trade and Vulnerability (Jameel Index), supported by Community Jameel. The FACT Alliance's foundational research project, the index, is a new framework for assessing countries' exposure to shocks in global food trade. Greg Sixt and J-WAFS-affiliated researcher Professor Kenneth Strzepek '75, SM '77, PhD '80 co-lead the cross-institutional Jameel Index team, which includes multiple FACT Alliance members. The Jameel Index is being developed as a vital tool to guide policy and investment for over 180 countries and has already been utilized by the World Bank to inform food security policy in West Africa.

Sixt and Strzepek first presented the Jameel Index in September of 2024 at a side event during the UN General Assembly (UNGA 79) in New York City. There, Sixt spoke on a panel about how the Jameel Index will help policymakers plan for future food system shocks from climate change. In October, the researchers described how the index will predict food trade vulnerability during a breakout session at the Norman E. Borlaug International Dialogue, a prestigious conference hosted by the World Food Prize Foundation.

In other developments this year, Sixt and Strzepek published a paper with United Arab Emirates University Professor Eihab Fathelrahman. The paper explores how India's ban on the export of non-Basmati rice impacted trade values, tariff revenues, producers, and consumers. The Jameel Index team used this case study to develop and test many aspects of the index. J-WAFS published the methodology working paper for the Jameel Index, which is currently in final preparation for submission to a peer reviewed journal.

The Index received a noteworthy media placement in a *Science* article by Joel Bourne, an award-winning environmental journalist and member of the Index advisory committee. Bourne wrote, "the index is intended to help policymakers understand potential threats and take steps to make their countries more resilient."

Other presentations on the Jameel Index took place at Mbarara University of Science and Technology in Uganda, The Southern Africa Office of the International Water Management Institute, and the College of Agricultural Sciences at the University of Pretoria, a FACT Alliance member. While in South Africa, the index team worked with Professor Rob Davies from Zimbabwe for capacity development training for researchers from Ethiopia and Malawi on macroeconomic modeling and food security. From June 25-27, the Jameel Index project supported the team from Ethiopia and Malawi in ongoing capacity development trainings at the Global Trade Analysis Project (GTAP) conference in Kigali, Rwanda.

Finally, on June 17, Sixt and Strzepek presented the Index at a special event at the Oxford Martin School at the University of Oxford, a FACT Alliance member. The event featured keynote presentations and a compelling address on the Index's relevance to the expanding BRICS trade

bloc, now comprised of 11 major agri-food economies. A panel discussion then took place with a group of global leaders in food systems, trade, and sustainability. Speakers included:

- Sir Prof. Charles Godfray – Director, Oxford Martin School (Intro remarks)
- Nader Iskandar Diab – Head of Programs, Community Jameel (Welcome remarks)
- Prof. Kenneth Strzepek – MIT J-WAFS / FACT Alliance (Researcher keynote)
- Prof. Mihaela Papa – MIT Center for International Studies (Thematic Address & Panelist)
- Linus Mofor, PhD – UNICEF (Panelist)
- Paola de Almeida – Pegasus Capital Advisors (Panelist)
- Prof. Rehab Osman – Oxford Brookes University (Panelist)
- Greg Sixt, PhD – MIT J-WAFS / FACT Alliance (Jameel Index Lead and moderator of the panel)

By mid-2025, the Jameel Index will integrate climate and geopolitical aspects to support food trade and security planning.

J-WAFS Visiting Scholar Program

J-WAFS welcomes visiting scholars to MIT to engage with the J-WAFS research community. Visiting scholars include professors on sabbatical for a full semester or longer, or others who might visit for just a few weeks to explore potential collaborations.

This year J-WAFS hosted three visiting scholars:

- Chandra Madramootoo, the Distinguished James McGill Professor in the Department of Bioresource Engineering at McGill University. His research focuses on irrigation and water management engineering, climate change and greenhouse gas emissions in agriculture, and agricultural research for development.

- Joanne Tingey-Holyoak, an associate professor of accounting and professorial lead at the University of South Australia. She uses accounting, financial, and biophysical data to improve agricultural decision-making, including through developing industry-based irrigator decision-making tools.

- Neda Trifkovic, an assistant professor in the Department of Economics at the University of Copenhagen. Her research interests include development and agricultural economics, contract farming, extreme weather events, and other related areas.

In the fall of 2024, J-WAFS organized a three-part, in-person seminar series with the visiting scholars on the topic of climate adaptation and mitigation for agriculture and water systems. All three seminars were very well attended by faculty, researchers, staff, and students from MIT and the surrounding area.

During the first seminar, Madramootoo and Tingey-Holyoak looked at the interplay between climate change and irrigated agriculture. Madramootoo focused on the implications of irrigation on greenhouse gas emissions, and Tingey-Holyoak discussed how an accounting-based decision-making support tool for irrigation can help adapt agriculture to more variable weather patterns.

The second seminar was given by Madramootoo and Trifkovic and explored localized approaches to climate resilience and adaptation for water and food security. Madramootoo focused on managing impacts of climate change on coastal regions, and Trifkovic spoke about impacts to agroforests.

Trifkovic gave the last seminar on the subject of economic and environmental sustainability for smallholder farmers. Specifically, she discussed how smallholder farmers in Mozambique are adapting to climate change in order to protect their economic livelihoods, and how their strategies fit with broader approaches to agricultural development.

J-WAFS Research Affiliate Program

The J-WAFS Research Affiliate Program connects corporate, government, and non-profit collaborators with leading researchers and laboratories across MIT to pursue research that addresses pressing issues in water and food. J-WAFS has one current research affiliate company, Xylem Inc., a leading company in the water industry.

J-WAFS director of external relations Longzhen (Longy) Han manages J-WAFS' outward-facing events and meetings. This year, Han continued engagement with donors and potential research affiliate companies through organized discussions, tours of labs at MIT, research webinars, and other events.

In November, J-WAFS co-hosted a webinar with the National Alliance for Water Innovation (NAWI). The event was titled "Sensor Technologies: Monitoring & Detection of Harmful Chemicals." Three J-WAFS researchers presented their work on the topic: Professors Rajeev Ram, Alexander Radosevich, and Timothy Swager.

Also in November, J-WAFS worked with MIT's Industrial Liaison Program to be part of their 2024 Research and Development Conference titled "Fostering Bold Ideas to Breakthrough Innovation." J-WAFS executive director Renee J. Robins '83 spoke at the conference about the mission of J-WAFS and various research projects of note. J-WAFS also hosted tours in the labs of some of our funded faculty that included research demonstrations for industry members. Additionally, Han conducted various executive briefings with industry members.

In May, as part of the MIT Alumni Association's Tech Reunion, J-WAFS hosted a special presentation titled "Tackling PFAS for Safer Water: Advances in Research and Solutions." The event began with an engaging overview of J-WAFS from Han. This included two videos: one showcasing the strides J-WAFS spinout NONA Technologies has taken to convert seawater to

safe, drinkable freshwater, and another highlighting J-WAFS spinout Takachar, which transforms waste biomass into marketable bio-products.

Shortly after, the audience heard from three J-WAFS PIs about their research:

- Jeremiah Johnson, the A. Thomas Guertin Professor Chemistry, presented his research, which employs metal-organic cages (MOCs) to absorb PFAS from drinking water.
- Professor Ariel Furst presented her research, which utilizes *Shewanella* (a microbe) to address problems surrounding PFAS-contaminated water sources, environmental remediation, and sustainability.
- John D. MacArthur Professor of Chemistry Timothy Swager presented his research, which uses polymers in excited states as hot-spots for harmful PFAS to migrate to, in hopes of removing them from the water source.

Student Engagement & Support

Graduate Student Fellowships

J-WAFS offers one-semester graduate student fellowships to outstanding doctoral students. The Rasikbhai L. Meswani Fellowship for Water Solutions is for MIT PhD students pursuing research related to water and water supply at MIT. The fellowship is made possible by Elina and Nikhil Meswani and family. The J-WAFS Graduate Student Fellowship (not awarded this year) is supported by the J-WAFS Research Affiliate Program and is awarded to MIT PhD students pursuing water or food-related research.

For the 2025-2026 academic year, J-WAFS offered the Rasikbhai L. Meswani Fellowship for Water Solutions. Read about the two awarded students and one honorable mention below.

Victoria Chen, Department of Biological Engineering

Victoria's research in Professor Christopher Voigt's lab centers on how bacteria can be genetically engineered to help clean polluted water, with an emphasis on figuring out the real-world impacts of releasing engineered bacteria into natural environments. Looking through both a biological and historical lens, her work investigates a unique case study of engineered bacteria being used to clean up toxic phenols in Soviet-era Estonia to explore the potential risks and benefits of such technologies.

Adela Chenyang Li, Department of Mechanical Engineering

Adela is working in the Device Research Lab (part of the Rohsenow Kendall Heat Transfer Lab) at MIT, with co-advisors Professor Evelyn Wang and Professor Gang Chen. Her research is focused on advancing a sorption-based atmospheric water harvesting (SAWH) technology that captures water from the air for water-scarce communities, even in extremely arid climates. She

is interested in combining both fundamental studies to better understand microscopic processes governing the limits of the technology, as well as practical device fabrication to demonstrate scalable SAWH in the real world.

Honorable Mention: Mrinalini (Mrin) Penumaka, Department of Urban Studies and Planning

Mrin works in the City Infrastructure Equity Lab with Professor Gabriella Carolini. Her research examines urban and infrastructure transitions in the context of cascading climate impacts. She takes a political economy approach to understand the governance and financing of climate and development challenges in the Global South. Her current projects study climate-focused infrastructure and labor transitions in South Africa, comparing transitions in water and energy systems and the landscape of multilateral and bilateral urban climate finance, addressing the Amazon's rapidly urbanizing biosphere.

MIT Water, Food & Agriculture (W.F.A.) Innovation Prize competition

The MIT Water, Food & Agricultural (W.F.A.) Innovation Prize is organized by the MIT Water Club and the MIT Food & Agriculture Club and co-sponsored by J-WAFS. The prize awards up to $50K to student teams from any U.S. college or university.

This year’s prize final pitch night was held at the MIT Media Lab, where attendees heard from seven student teams working to commercialize innovative research. The event kicked off with an informative message from keynote speaker Ashley E. Randle, Commissioner at the Massachusetts Department of Agricultural Resources (MDAR). Randle spoke about the agriculture industry in Massachusetts. She noted that 40% of farmers in Massachusetts are female, and while cranberries are a main crop, aquaculture is currently the fastest growing sector.

Following the keynote talk, the finalists began their pitches and Q+A sessions. This year’s finalist teams were Anomaly Bio, Cocoa Potash, High Degree, Kira, Pacific Carbon, SmArT Aerosol Technologies, and SmartHarvest.

Anomaly Bio won both the Audience Choice and First Place prizes, taking home a total of $55,000. Anomaly Bio harnesses advanced fermentation technology and filamentous fungi to produce high-value protein ingredients that have the potential to strengthen supply chain resilience and improve the climate adaptability of food systems.

Cocoa Potash was awarded Runner Up, taking home $20,000. Cocoa Potash takes agricultural waste from cocoa, palm nut, and coconut plants and transforms it into 95% purity organic potash and potash fertilizer using eco-friendly technology.

J-WAFS Travel Grants

J-WAFS provides travel grants to MIT graduate students to support their attendance at select water conferences, aiming to deepen their understanding of global water systems and challenges. The grants provide learning and networking opportunities for MIT students pursuing careers in the water sector, whether in academia, nonprofit organizations, government, or industry. This year, J-WAFS selected three outstanding students to receive funding to attend the Stockholm World Water Week conference in August 2025.

The J-WAFS Travel Grant for Water Conferences is supported by gifts to J-WAFS from Xylem Inc. and GoAigua through the J-WAFS Research Affiliate program. In addition to a wide variety of programmed events at World Water Week, the three MIT students will have the opportunity to meet with Xylem leaders and attend Xylem-sponsored side events, including a tour of their research facility in Stockholm.

Learn more about each of the students below.

Tyler Barron, Department of Urban Studies and Planning

Tyler is a Master in City Planning candidate, advised by Professor Larry Susskind. Prior to MIT, Tyler has a long history of involvement in water-related work such as ecological wastewater treatment and oceanographic fieldwork. By participating in Stockholm's World Water Week, Tyler hopes to hone an approach to planning that is grounded in water-based and water-informed solutions. He is fascinated by this year's theme, "Water For Climate Action," as it centers the role of water within the conversation of climate change, and focuses on environmental degradation and biodiversity loss.

Grace Smith, Department of Mechanical Engineering

Grace is a master's student working in Svetlana Boriskina's Multifunctional Metamaterials Lab. Grace's research involves addressing the challenge of water scarcity in arid regions by developing high-efficiency atmospheric water harvesting (AWH) techniques. Her work focuses on sorption-based technology, which uses hydrogels, salts, and metal-organic frameworks (MOFs) to capture atmospheric moisture, followed by water extraction via evaporation-condensation. She is interested in using vibrational mechanical actuation as a novel water release method to improve the efficiency of AWH systems.

Patrick Song, Department of Biological Engineering

Patrick is a PhD student advised by Professor Angela Belcher. His research is at the intersection of biomaterials, synthetic biology, and environmental sustainability. He is developing an engineered living material (ELM) utilizing genetically engineered yeast for low-cost bioremediation and biomining. His system enables efficient toxic metal removal from water

while minimizing environmental impact and costs. Attending Stockholm World Water Week provides a rare opportunity for Patrick to further deepen his understanding of these challenges, exchange insights on his biomaterial filter, and learn from experts beyond the scope of his lab at MIT.

Communications and Events Highlights

World Food Day

For World Food Day on October 16, J-WAFS put together a campaign around a special community spotlight video, where we interviewed Susy Jones, senior sustainability project manager in the MIT Office of Sustainability, who aims to advance food and climate solutions both on and off campus.

Collaboration with other DLCs

Also in October, MIT News published a J-WAFS news story on the many ways we operate within MIT's greater innovation and entrepreneurship system. The extensive piece highlighted J-WAFS' support of numerous J-WAFS PIs and collaboration with other programs on campus like MIT's Venture Mentoring Service and the New England Regional Innovation Corps Node (NE I-Corps) at MIT.

J-WAFS 10th anniversary

The J-WAFS 10th anniversary was celebrated throughout the spring semester with targeted messaging, articles, website updates, and other content that highlighted J-WAFS' impact over its first decade. To begin, a 10th anniversary edition of the J-WAFS logo was put into place on the J-WAFS website, monthly newsletter, and used in all anniversary assets and other collateral.

In February, we had two MIT News placements that focused on faculty impact: One on J-WAFS' long history of strengthening MIT faculty efforts in water and food research and innovation. And second, a faculty spotlight on J-WAFS PI Sara Beery and her work to use automation to improve monitoring of migrating salmon in the Pacific Northwest.

In March, research impact was highlighted. J-WAFS visiting scholar Chandra Madramootoo penned a piece for the J-WAFS website, describing how J-WAFS research aims to ensure access to clean water and safe food across the globe. In addition, research scientist Robbie Wilson wrote a piece for the website that presented his research to improve the enzyme responsible for photosynthesis in plants, which is supported by a J-WAFS Grand Challenge grant.

April was the month we highlighted student impact. One story, in MIT News, discussed the ways J-WAFS supports students through fellowships, grants, opportunities, and events. In collaboration with the MIT Alumni Association, a second piece focused on a past J-WAFS Fellow,

Sarah Fletcher SM ’12, PhD ’18, who is now a professor at Standford working on water security.

In May, we published an MIT News story on J-WAFS commercialization successes. We also held a large anniversary event, attended by over 100 J-WAFS community members. Event programming included speeches and presentations followed by a reception with a poster session featuring work by students, postdocs, and researchers supported by J-WAFS projects. To kick things off, MIT Vice President for Research Ian Waitz provided opening remarks, followed by talks from the J-WAFS leadership team—John Lienhard, Renee Robins, and Rohit Karnik. In addition, a congratulatory letter to J-WAFS from MIT President Emeritus L. Rafael Reif was read by J-WAFS director of external relations Longzhen Han, who also acted as the emcee. The formal part of the program concluded with select J-WAFS community members, who spoke about their projects and interactions with J-WAFS. These individuals were:

- Sherrie Wang, Brit (1961) & Alex (1949) d'Arbeloff Career Development Assistant Professor, Mechanical Engineering and Institute for Data, Systems, and Society
- Matt Shoulders, Class of 1942 Professor of Chemistry
- Jon Bessette, Doctoral Student, Mechanical Engineering
- Tim Swager, John D. MacArthur Professor of Chemistry

Short documentary film

J-WAFS helped to coordinate a documentary produced by Massachusetts College of Art and Design, supported by Community Jameel, which highlighted a J-WAFS Solutions grant project with Professor Patrick Doyle. The research resulted in a hydrogel system to remove microcontaminants from water as well as a spinout company. The film was screened at the J-WAFS anniversary event in May, but it is anticipated to have its formal, public debut at film festivals in the Fall of 2025.

World Water Day

For World Water Day on March 22, J-WAFS built a campaign around the 2025 theme of “Save our Glaciers.” A story was written for the J-WAFS website that highlighted the work of a J-WAFS seed grant with Professor John Fernández, researcher Scott Odell, and PhD student Caroline White-Nockleby. Their research examines how converging impacts of climate change and mining are affecting Andean glaciers and the agricultural communities dependent upon them.

Publications, presentations, and articles

In FY25, J-WAFS funding helped MIT researchers publish seven peer-reviewed papers in academic journals. Also, this year, 10 J-WAFS researchers presented their water and food-related work at 16 different conferences. There have been 26 MIT News stories that have featured the work of J-WAFS researchers and 16 other news articles that highlighted J-WAFS community members, spinouts, and projects. See a full list of all publications and articles below.

J-WAFS Researcher	Publication, Presentation, or Article Title	Category	Publications/News: Link
Aristide Gumyusenge	Copper-Based Two-Dimensional Conductive Metal?Organic Framework Thin Films for Ultrasensitive Detection of Perfluoroalkyls in Drinking Water	Academic journal article	https://pubs.acs.org/doi/10.1021/acsnano.4c16212
Heather Kulik	Metal?Organic Framework Stability in Water and Harsh Environments from Data-Driven Models Trained on the Diverse WS24 Data Se	Academic journal article	https://doi.org/10.1021/jacs.4c05879
Heather Kulik	MOFs with the Stability for Practical Gas Adsorption Applications Require New Design Rules	Academic journal article	https://www.doi.org/10.1021/acsami.4c13250
Scott Odell	From obstacles to heritage: The shifting status of glaciers across 150 years of mining research	Academic journal article	https://www.sciencedirect.com/science/article/pii/S2214629625000349
Sara Beery	Counting Fish with Temporal Representations of Sonar Video	Academic journal article	https://arxiv.org/abs/2502.05129
Matthew Shoulders, Robbie Wilson,	In vivo directed evolution of an ultrafast Rubisco	Academic journal article	https://www.pnas.org/doi/10.1073/pnas.2505083122

Julie McDonald	from a semianaerobic environment imparts oxygen resistance		
Ahmed H. Badran	Efficient genetic code expansion without host genome modifications	Academic journal article	https://www.nature.com/articles/s41587-024-02385-y
John H. Lienhard V	Chief editor of Nature Water visits MIT and meets with J-WAFS director	J-WAFS website article	https://jwafs.mit.edu/news/2024/chief-editor-nature-water-visits-mit-and-meets-j-wafs-director
Mary Gehring, Robbie Wilson	Colleagues from Community Jameel tour an MIT lab and learn about J-WAFS projects	J-WAFS website article	https://jwafs.mit.edu/news/2024/colleagues-community-jameel-tour-mit-lab-and-learn-about-j-wafs-projects
Michael Triantafyllou	Interagency working group on ocean and coastal mapping visits MIT Sea Grant	J-WAFS website article	https://jwafs.mit.edu/news/2024/interagency-working-group-ocean-and-coastal-mapping-visits-mit-sea-grant
Daniela Morales, Shubhi Goyal	MIT students gain valuable insights from Stockholm World Water Week	J-WAFS website article	https://jwafs.mit.edu/news/2024/mit-students-gain-valuable-insights-stockholm-world-water-week
Mrinalini Penumaka	MIT DUSP student attends UNC Water and Health Conference	J-WAFS website article	https://jwafs.mit.edu/news/2024/mit-dusp-student-attends-unc-water-and-health-conference
Mrinalini Penumaka	J-WAFS announces 2024 Travel Grantee to attend UNC Water and Health Conference	J-WAFS website article	https://jwafs.mit.edu/news/2024/j-wafs-announces-2024-travel-grantee-attend-unc-water-and-health-conference
Susan Murcott, Alexander Klibanov, Patrick	Translating MIT research into real-world results	MIT News story	https://news.mit.edu/2024/translating-mit-research-real-world-results-1002

Doyle, Devashish Gokhale, Arjav Shah, Jongyoon Han, Select Item 7 Gregory Stephanopoulos, Anthony Sinskey, Cem Tasan, Eric Verploegen, Daniel Frey, Leon Glicksman, Andrew Whittle, Tim Swager, Jeffrey Grossman, Jeffrey Ravel			
John H. Lienhard V	New filter captures and recycles aluminum from manufacturing waste	MIT News story	https://news.mit.edu/2025/new-filter-captures-and-recycles-manufacturing-waste-aluminum-0107
Ariel Furst	MIT faculty, alumni named 2025 Sloan Research Fellows	MIT News story	https://news.mit.edu/2025/mit-faculty-alumni-named-sloan-research-fellows-0220
Ariel Furst	Making agriculture more resilient to climate change	MIT News story	https://news.mit.edu/2024/making-agriculture-more-resilient-climate-change-1101
Peter Godart	A recipe for zero-emissions fuel: Soda cans, seawater, and caffeine	MIT News story	https://news.mit.edu/2024/recipe-for-zero-emissions-fuel-with-cans-seawater-caffeine-0725
Brendan Smith	Pioneering the future of materials extraction	MIT News story	https://news.mit.edu/2024/sitration-pioneering-future-materials-extraction-0702
Angela Belcher	MIT affiliates awarded 2024 National Medals of Science, Technology	MIT News story	https://news.mit.edu/2025/mit-affiliates-awarded-national-medals-science-technology-0103

Chris Voigt	Pivot Bio is using microbial nitrogen to make agriculture more sustainable	MIT News story	https://news.mit.edu/2025/pivot-bio-uses-microbial-nitrogen-sustainable-agriculture-0213
Benedetto Marelli	A new method to detect dehydration in plants	MIT News story	https://news.mit.edu/2024/new-method-detect-dehydration-plants-1216
Benedetto Marelli	Liftoff: The Climate Project at MIT takes flight	MIT News story	https://news.mit.edu/2024/liftoff-mit-climate-project-takes-flight-0918
Benedetto Marelli	New filtration material could remove long-lasting chemicals from water	MIT News story	https://news.mit.edu/2024/new-filtration-material-could-remove-long-lasting-water-chemicals-0906
Benedetto Marelli	Mission directors announced for the Climate Project at MIT	MIT News story	https://news.mit.edu/2024/mit-climate-project-mission-leaders-announced-0724
Susan Solomon	Q&A: What past environmental success can teach us about solving the climate crisis	MIT News story	https://news.mit.edu/2024/qa-susan-solomon-what-past-environmental-success-can-teach-us-about-solving-climate-crisis-0712
Evelyn Wang	MIT community members elected to the National Academy of Engineering for 2025	MIT News story	https://news.mit.edu/2025/mit-community-members-elected-national-academy-engineering-0219
Noelle Selin	MIT School of Science launches Center for Sustainability Science and Strategy	MIT News story	https://news.mit.edu/2024/mit-school-science-launches-center-sustainability-science-strategy-0805
Eric Verploegen	D-Lab off-grid brooder saves chicks and money using locally manufactured	MIT News story	https://news.mit.edu/2024/d-lab-grid-brooder-saves-chicks-money-using-locally-manufactured-thermal-batteries-0812

	thermal batteries		
Rohit Karnik	Rohit Karnik named director of J-WAFS	MIT News story	https://news.mit.edu/2025/rohit-karnik-named-director-j-wafs-0228
Kripa Varanasi	Technology developed by MIT engineers makes pesticides stick to plant leaves	MIT News story	https://news.mit.edu/2025/mit-engineers-develop-pesticides-stick-on-plant-leaves-0325
Linzixuan (Rhoda) Zhang	A new biodegradable material to replace certain microplastics	MIT News story	https://news.mit.edu/2024/new-biodegradable-material-could-replace-certain-microplastics-1206
Linzixuan (Rhoda) Zhang	Linzixuan (Rhoda) Zhang wins 2024 Collegiate Inventors Competition	MIT News story	https://news.mit.edu/2024/linzixuan-rhoda-zhang-wins-collegiate-inventors-competition-1114
Sara Beery	Streamlining data collection for improved salmon population management	MIT News story	https://news.mit.edu/2025/streamlining-data-collection-improved-salmon-population-management-0206
Sara Beery	MIT affiliates named 2024 Schmidt Sciences AI2050 Fellows	MIT News story	https://news.mit.edu/2024/mit-affiliates-named-schmidt-futures-ai2050-fellows-1213
Andrew Babbin	Seeking climate connections among the oceans? smallest organisms	MIT News story	https://news.mit.edu/2025/andrew-babbin-seeks-climate-connections-among-oceans-smallest-organisms-0206
Jongyoon Han,Junghyo Yoon, Bruce Crawford	How J-WAFS Solutions grants bring research to market	MIT News story	https://news.mit.edu/2025/how-j-wafs-solutions-grants-bring-research-to-market-0506
Otto Cordero, Patrick Doyle, Ariel Furst, Benedetto Marelli, Tim Swager, Matt	J-WAFS: Supporting food and water research across MIT	MIT News story	https://news.mit.edu/2025/j-wafs-supporting-food-water-research-across-mit-0219

Shoulders, Cem Tasan, Amos Winter, Retsef Levi, Dave Des Marais, John Hart, Stephen Graves, Bish Sanyal, Mark Brennan, Leon Glicksman, Eric Verploegen, Alex Slocum, Hilary Johnson, Mathias Kolle			
Aditya Avinash Ghodgaonka, Linzixuan (Rhoda) Zhang, Gokul Sampath, Jon Bessette, Catherine Lu, Daniela Morales, Arjav Shah, Vishnu Jayaprakash, Hilary Johnson, Ali Decker, Elaine Liu	MIT students advance solutions for water and food with the help of J-WAFS	MIT News story	https://news.mit.edu/2025/mit-students-advance-solutions-water-food-with-j-wafs-0410
Amos Winter	Solar-powered desalination	Other news article	https://www.technologyreview.com/2024/12/23/1107395/solar-powered-desalination-2/
David Des Marais	Which crops are most vulnerable to climate change, and in which places?	Other news article	https://climate.mit.edu/ask-mit/which-crops-are-most-vulnerable-climate-change-and-which-places
John H. Lienhard V	IDRA presents awards?at 2024 World Congress gala dinner	Other news article	https://waterwastewaterasia.com/idra-presents-awards-at-2024-world-congress-gala-dinner/
Greg Sixt	Eating the earth	Other news article	https://www.science.org/content/article/burgeoning-global-food-trade-lifeline-billions-is-it-breaking-planet

Sarah Fletcher	Water Planning for Droughts, Floods, and More	Other news article	https://alum.mit.edu/slice/water-planning-droughts-floods-and-more
Peter Godart	The power of beer cans: Boston startup says it can unleash the energy stored in aluminum	Other news article	https://www.bostonglobe.com/2024/08/06/business/beer-found-energy-aluminum-mit/?event=event12
Quantum Wei	Can desalination quench agriculture?s thirst?	Other news article	https://knowablemagazine.org/content/article/food-environment/2024/can-desalination-of-groundwater-grow-crops
Chris Voigt	Changing the DNA of Living Things to Fight Climate Change	Other news article	https://www.nytimes.com/2024/10/24/climate/farms-fertilizer-climate-change.html
Dara Entekhabi	2024 Seed Award Recipients Span Cross-Industry Innovations	Other news article	https://impactclimate.mit.edu/2024/10/21/2024-seed-award-recipients-span-cross-industry-innovations/
Kripa Varanasi	A New Spray Application Technology For Precision Agriculture	Other news article	https://www.forbes.com/sites/stevensavage/2024/07/30/a-new-spray-application-technology-for-precision-agriculture/
Heather Kulik	Gilliard and Kulik Honored with the Presidential Early Career Award for Scientists and Engineers	Other news article	https://chemistry.mit.edu/chemistry-news/gilliard-and-kulik-honored-with-the-presidential-early-career-award-for-scientists-and-engineers/
Scott Odell	'Green' energy needs metal. Can we combat climate change while reducing mining impacts?	Other news article	https://www.usatoday.com/story/news/factcheck/2024/12/01/renewable-energy-green-mining/76436837007/
Scott Odell	Governing Critical Mineral Mining and the Clean Energy Transition	Other news article	https://environmentalsolutions.mit.edu/news/governing-critical-mineral-mining-and-the-clean-energy-transition/
Sara Beery	Sara Beery	Other	https://ilp.mit.edu/read/Beery

	combines machine learning with human expertise to better understand a rapidly changing planet	news article	
Meng Li	MIT Postdoctoral Fellow Meng Li awarded U.S. Department of Agriculture fellowship	Other news article	https://cee.mit.edu/mit-postdoctoral-fellow-meng-li-awarded-u-s-department-of-agriculture-fellowship/
Mary Gehring	Meet a Whitehead Postdoc: Sonia Boor	Other news article	https://wi.mit.edu/news/meet-whitehead-postdoc-sonia-boor

Awards

- J-WAFS PI Mary Gehring was named an Investigator of the Howard Hughes Medical Institute, receiving ~$11 million in support over a seven-year term
- J-WAFS PI Sara Beery was named a 2024 AI2050 Early Career Fellow by Schmidt Sciences
- J-WAFS PI Heather Kulik received a Presidential Early Career Award for Scientists and Engineers
- Angela Belcher was awarded a National Medal of Science
- J-WAFS Fellow Linzixuan (Rhoda) Zhang won both the Graduate and People's Choice awards in the 2024 Collegiate Inventors Competition
- J-WAFS Fellow Akash Ball received the MIT School of Engineering Mathworks Fellowship

Personnel

J-WAFS Core Team

- Director
    - Director John H. Lienhard V, Abdul Latif Jameel Professor of Water and Mechanical Engineering retired in FY25 and is now referred to as J-WAFS founding director and senior advisor
    - The Vice President for Research, Ian Waitz, convened an advisory committee to search for the next J-WAFS director. The committee members were:
        - Gang Chen, Chair; Carl Richard Soderberg Professor of Power Engineering; Director of the Pappalardo Micro and Nano Engineering Laboratories

        - Mary Gehring, Professor of Biology; Core Member and David Baltimore Chair in Biomedical Research, Whitehead Institute
        - Jeffrey Grossman, Morton and Claire Goulder and Family Professor in Environmental Systems; Professor of Materials Science and Engineering
        - Christopher Voigt, Daniel I.C. Wang Professor; Head, Department of Biological Engineering
        - David Des Marais, Cecil & Ida Green Career Development Professor; Associate Professor of Civil and Environmental Engineering
        - Patrick Doyle, Robert T Haslam (1911) Professor of Chemical Engineering
    - Rohit Karnik, Tata Professor and associate director of J-WAFS, assumed the role of J-WAFS director on March 1, 2025
- Executive director Renee J. Robins ’83 will retire during the initial months of FY26 after onboarding a new executive director. At the end of FY25, J-WAFS conducted interviews for Robins’ replacement.
- Associate director: Rohit Karnik, Tata Professor moved into the role of J-WAFS director, and the position of associate director was closed
- Research manager for climate and food systems and director of FACT Alliance: Greg Sixt
- Director of external relations: Longzhen Han
- Financial and project administrator: B. Nicholas Pasinella
- Communications and program manager: Carolyn Blais was promoted to senior communications and program manager during FY25
- Communications and project assistant: Avery Plachcinski served from 7/24-1/25 and Emily Stangel from 1/25-7/25, as part of the Northeastern Co-Op Program

Visiting Scholars

- Chandra Madramootoo, Distinguished James McGill Professor, Department of Bioresource Engineering, McGill University
- Joanne Tingey-Holyoak, Associate Professor, Department of Accounting, University of South Australia
- Neda Trifkovic, Assistant Professor, Department of Economics, University of Copenhagen

Research Affiliates

- Eihab Fathelrahman, Associate Professor, Department of Integrative Agriculture, College of Agriculture and Veterinary Medicine, United Arab Emirates University
- Michael Hauser, Associate Professor, University of Natural Resource and Life Sciences, Vienna, Senior Research Associate, World Agroforestry, Nairobi
- Jaron Porciello, Global Director of Evidence and Policy, CABI

This report is prepared by:

Carolyn Blais Pinter
Senior Communications and Program Manager
Abdul Latif Jameel Water and Food Systems Lab

This report is submitted by:

Rohit Karnik
Director, Abdul Latif Jameel Water and Food Systems Lab
Abdul Latif Jameel Professor of Water & Food

Renee J. Robins ’83
Executive Director, Abdul Latif Jameel Water and Food Systems Lab