



LOOKING TO THE **FUTURE OF AG** SCIENCE

Collaboration and Convergence: Accelerating Innovation in Agriculture

Chuck Mummert // Jamie Matthys // Chad Zuberbuhler



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INTRO

The agriculture industry is facing extraordinary challenges. Climate change is causing more extreme and less predictable growing conditions while growers also face deteriorating soil quality and biodiversity. Right now one third of all human-made greenhouse gas emissions come from agriculture. Add to the equation a global population expected to grow to nearly 10 billion by the year 2050, and the need has never been greater for innovative solutions to sustainably increase crop yield and resiliency in order to feed a growing population and ensure economic stability for farmers and rural communities.

None of these problems have a simple solution on the immediate horizon, and they likely won't be solved by a single person, organization, or industry alone, underscoring the pressing need for collaboration and convergence.

How do we define convergence? *Convergence is bringing together people across disciplines and industries with different experience, expertise, and viewpoints. This deliberate sharing of ideas and experiences sparks innovation and cultivates an environment for future breakthroughs that wouldn't be possible in siloed environments.*



***THERE ISN'T A SINGLE PRODUCT
OR CONCEPT OR INNOVATION OUT
THERE IN THE WHOLE INDUSTRY
THAT DOESN'T RELY ON SOMEBODY
ELSE. ... CONVERGENCE IS
REALIZING THAT NOBODY HAS THE
ONE ANSWER."***

***LAURA WESTBY, J.D.
CHIEF LEGAL AND OPERATIONS OFFICER
OERTH BIO***

ENGAGING WITH THE FIELD'S EXPERTS

As architects who specialize in environments that support scientific discovery, we actively pursue an understanding of where the next innovations will occur and how the design of research facilities can propel discovery forward. With an established expertise in bio-agricultural research and education facilities that spans more than 30 years, Flad partnered with North Carolina State University to co-host a two-day symposium featuring experts from various industry sectors in an effort to share ideas and build and strengthen connections that can help boost convergence and innovation in ag science. We would like to share a few highlights from this engaging exchange of ideas.

LEARN MORE ABOUT THE PANELISTS >



ADDRESSING THE UNSOLVED GRAND CHALLENGES —

- » RESTORING SOIL HEALTH
- » CAPTURING CARBON AND REDUCING EMISSIONS
- » INCREASING CROP YIELD
- » IMPROVING FARMERS' LIVES AND THE ECONOMIC STABILITY OF FARMING



RESTORING SOIL HEALTH

Only 3% of the Earth's surface is available for farming, and each year nearly 30 million acres of agricultural land is lost through land degradation. As continued tilling has depleted soil of nutrients, growers have been forced to respond with more inputs such as nitrogen and phosphorus fertilizers. Each year, growers apply 22 million pounds of nitrogen fertilizer, which is a major contributor to climate change and pollutes the environment.

Current research initiatives are studying the microbiome of important crops like wheat, corn, and rice and how it can be modified to help farmers raise yields with less reliance on chemical treatments and irrigation. With modifications to microbiome, current farmland can be used more efficiently with fewer inputs, and underutilized, marginal soils can be converted to productive farmland. This also prevents deforestation as a result from the need for more tillable land.

30 million

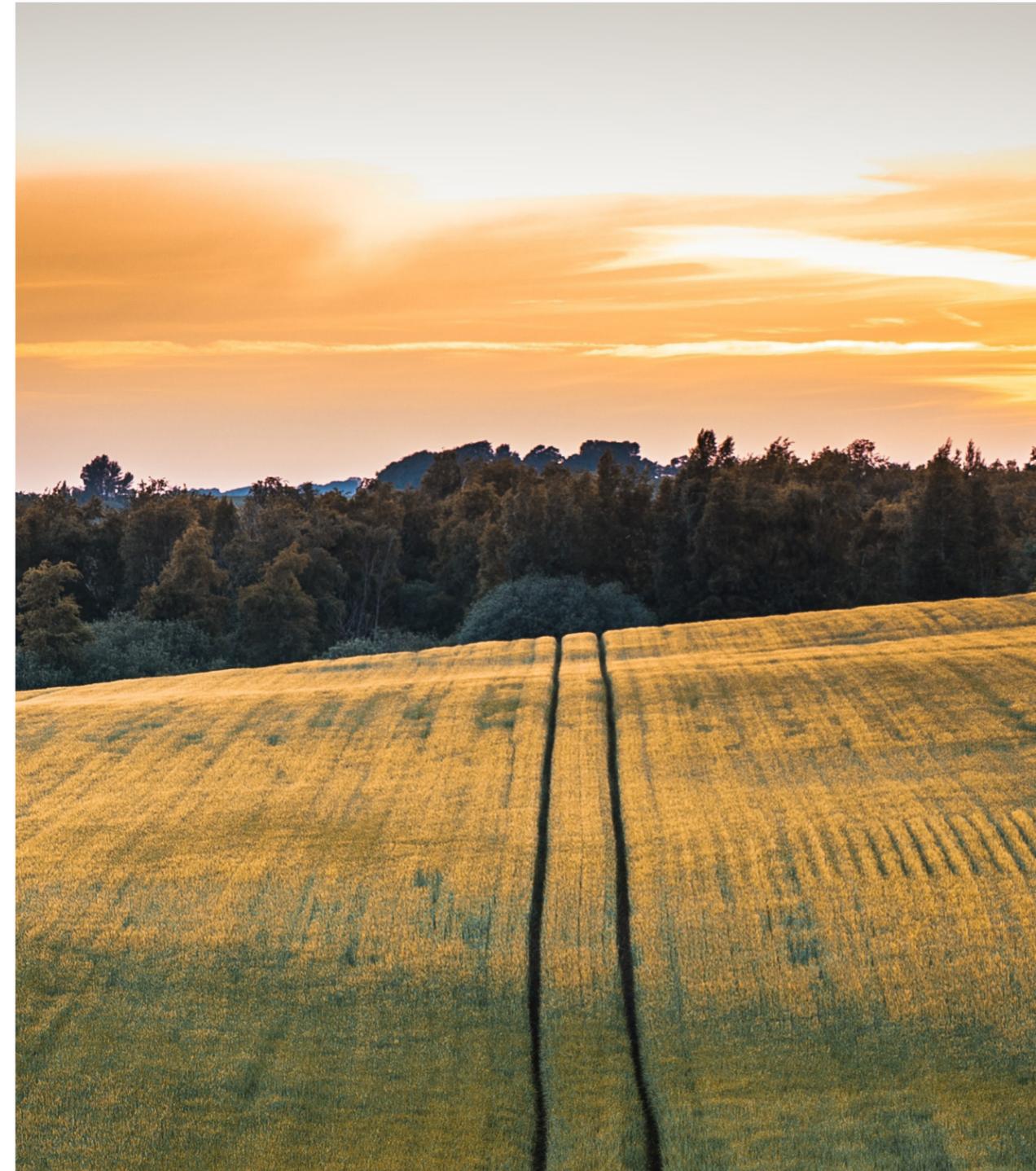
acres of agricultural land is lost through land degradation each year

3%

of the Earth's surface is available for farming

22 million

pounds of nitrogen fertilizer are applied annually by growers



CAPTURING CARBON AND **REDUCING EMISSIONS**

Since the advent of modern agriculture, nearly 500 gigatons of carbon have been removed from the planet's agricultural soils. However, we can recapture that carbon and return it to the soil with more efficient plants. In fact, agriculture may be one of the quickest solutions to carbon capture because it's already scaled across the globe and rejuvenates each year with a new growing season. Gene editing technology can enhance photosynthesis to capture more carbon; produce crops with deeper, denser roots that pump more carbon out of the atmosphere deeper into the soil; and improve soil microbes.

Cows and rice are two of the largest contributors to food-related greenhouse gas emissions and in both cases, microbes are the true source of the emissions. Identifying the metabolic sources of methane and developing targeted interventions without impacting yield could hold the biggest key to eliminating these emissions.

500 gigatons

(nearly) of carbon have been removed
from the planet's agricultural soils

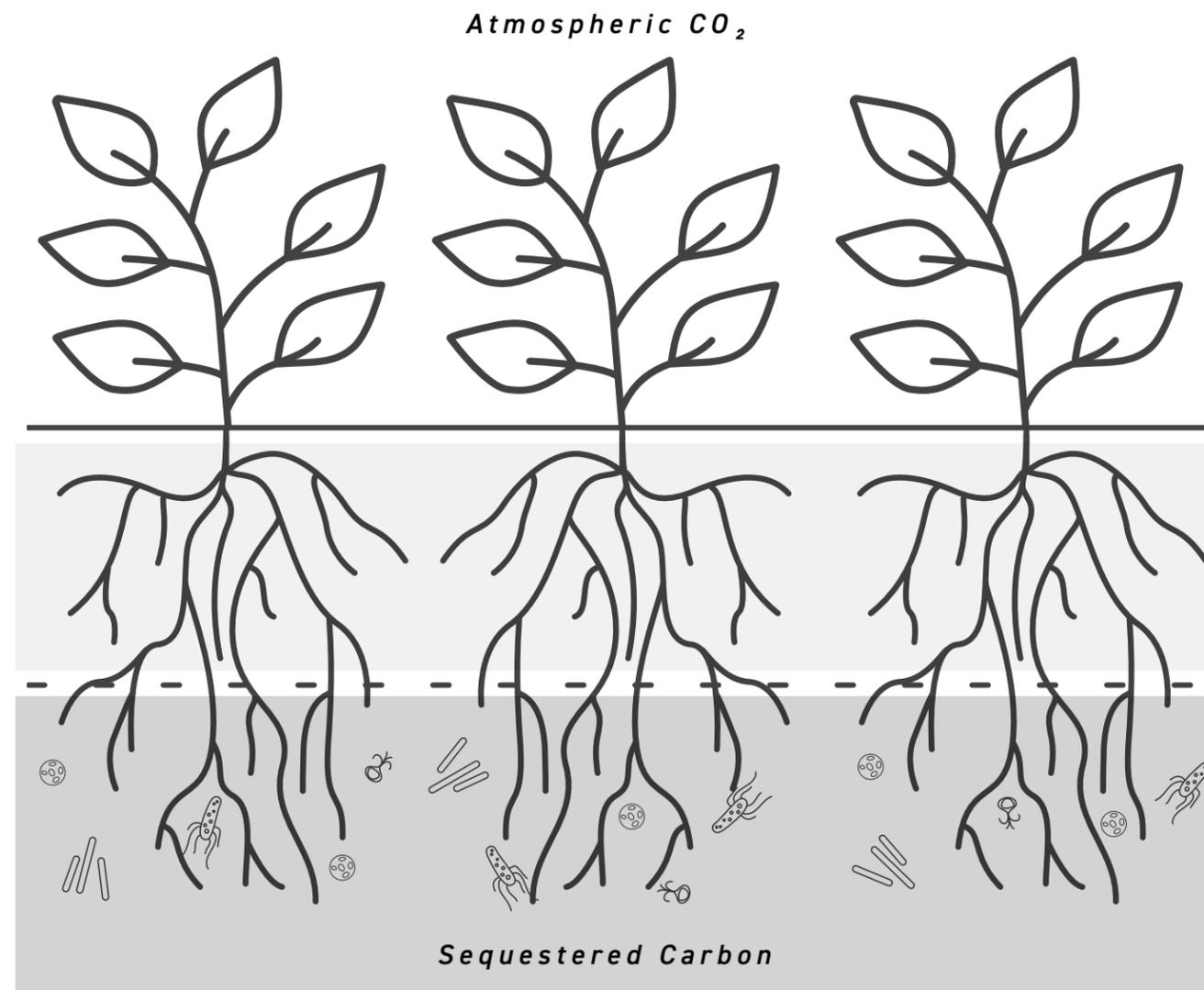




MICROBES ARE THE MOST IMPORTANT COMPONENT. IT'S THE REASON AG HAS EMISSIONS, BUT AT THE SAME TIME, IT UNLOCKS THE SECRET OF SOIL CARBON."

BRAD RINGEISEN, PH.D.
EXECUTIVE DIRECTOR
INNOVATIVE GENOMICS INSTITUTE
UC BERKELEY

Opportunities to Enhance Carbon Capture and Storage



1 Atmospheric CO₂ Removal

Edit plants for optimized photosynthesis

2 Plant Carbon Flow

Edit plants to promote carbon flow underground, targeting root architecture and exudates

3 Soil Carbon Sequestration

Promote plant/microbe iterations that stabilize carbon in the soil

INCREASING CROP YIELD

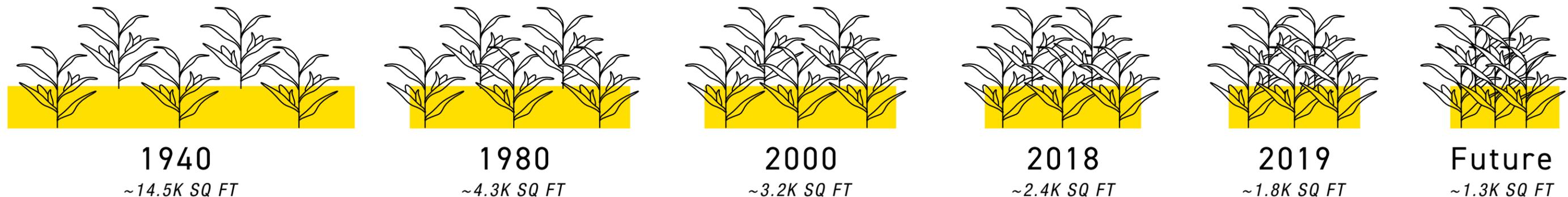
As previously mentioned, the world's population is expected to approach 10 billion within the next 30 years. Meanwhile, the United Nations projects that climate change could result in a 17% reduction in crop yield worldwide by 2030, raising the stakes and the demand to increase crop production with more efficient farming.

Advancing technology has already significantly increased efficiency over the past century. With the introduction of herbicides, hybrid corn, seed protections, and other technologies, the footprint needed to produce 10 bushels of corn is now less than 15 percent of what was required to produce the same yield in 1940.

In addition to gene-editing technology, the next frontier is led by advances in digital farming fueled by data, providing farmers with even more targeted solutions. By identifying the precise timing and quantity of inputs for subsets within each field, applications can be tailored for individual farmers, improving yields while saving costs and energy.

less than **10%**
of the land footprint needed in 1940 is expected to be needed to produce 10 bushels of corn in the future

Land Required for 10 Bushel Yield





THE GREAT OPPORTUNITY WE NOW HAVE IS TO BRING ALL THE PIECES TOGETHER IN THE CONTEXT OF THE DIGITAL OPPORTUNITY TO USE DATA SCIENCE AND DIGITAL TOOLS TO REALLY CONNECT ALL THE PIECES AND HELP FARMERS MAKE THE RIGHT DECISIONS WITH THE RIGHT TOOLS AT THE RIGHT TIME FOR THEIR OPERATION. FOR THEM, IT'S NOT GLOBAL. IT'S LOCAL."

*PHIL TAYLOR, PH.D
DIRECTOR OF OPEN INNOVATION AND OUTREACH
BAYER CROP SCIENCE R&D*



“I THINK IT’S IMPORTANT THAT WE GET CLOSE TO THE GROWER AND FIND OUT WHAT THEIR PROBLEMS ARE, NOT JUST THINK ABOUT WHAT WE THINK THEIR PROBLEMS SHOULD BE.”

*KAREN LEVERT, MBA, CO-FOUNDER, AG TECHINVENTURES
AND VENTURE PARTNER, PAPPAS CAPITAL*

IMPROVING FARMERS’ LIVES AND ECONOMIC SUSTAINABILITY OF FARMING

Small-scale, independent farmers are on the frontlines of climate change, directly experiencing the effects of droughts, floods, and extreme temperatures. The many promising developments to address global climate challenges like decreasing carbon emissions and improving soil health will have an obvious positive impact on public health. Just as important, the efforts to create more resilient crops and higher yields have the potential to make a real difference in the lives of farmers in the U.S. as well as low- and middle-income countries; however, from a simple economic perspective, farmers will only adopt these innovations if they provide cost savings or improve yield in the near term.

Data analytics research efforts are also poised to empower farmers to make more informed decisions. From a smartphone app that combines data from scanning images of hundreds of thousands of sweet potatoes with their growth conditions to in-field sensors that detect early warning signs of plant stress and suggest mitigation strategies, these innovations can save farmers time and resources.

RECOGNIZING THE URGENT NEED FOR COLLABORATION —

» INTERDISCIPLINARY COLLABORATION

» CROSS-SECTOR PARTNERSHIPS



INTERDISCIPLINARY COLLABORATION

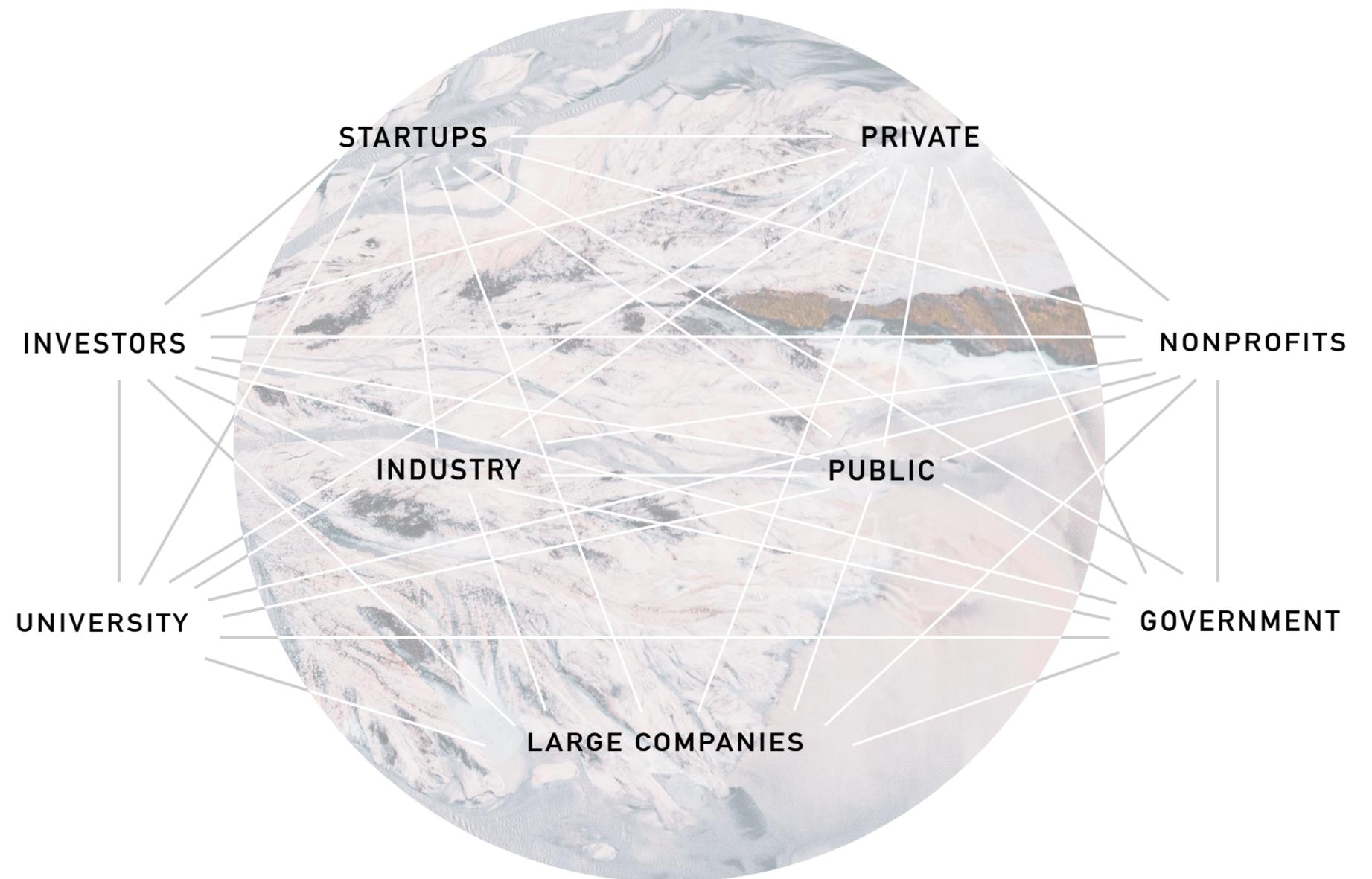
Collaborative research creates more powerful results than working individually. Bringing together researchers and experts from across disciplines as diverse as plant sciences, education, data science, engineering, social sciences, and economics provides different viewpoints, opening the door for innovations that would not otherwise be considered. These hubs can include different schools at the university level or can even be scaled up to the city level.

North Carolina State University is one school on the leading edge of interdisciplinary agriculture research. The N.C. Plant Sciences Initiative, located in the Plant Sciences Building, is an interdisciplinary research effort reaching across the entire NC State campus. The building features bespoke spaces for a variety of scientific disciplines including engineers, data scientists, and plant biologists, all working to solve some of the biggest challenges facing agriculture and the environment.



**LEARN MORE ABOUT THE NC STATE
PLANT SCIENCES BUILDING >**





CROSS-SECTOR PARTNERSHIPS

In recent years, there has been a transformation in public-private partnerships. Traditionally, large companies sought to simply acquire smaller companies with new technologies or innovations. Now large companies, universities, and non-profits alike have formed incubators to support early research and start-up companies. For example, the NC State Plant Sciences Building houses a number of major ag science companies in the Partners' Suite, which features dedicated office, meeting, and ideation space. These mutually beneficial partnerships support open innovation in a setting where students and researchers can connect with ag companies and their resources, and companies can test products and ideas in the precompetitive stage to understand their potential.

These partnerships are about creating an ecosystem of collaboration and innovation. For life sciences such as agriculture, more than other industries, an actual physical hub is crucial for researchers and industry to work together. A researcher may not know the next steps to move a potential breakthrough forward to market, or a startup may not have the resources to navigate public policy and regulations. These partnerships and ecosystems are helping to fill in these gaps from idea to breakthrough research to commercializing and distribution, which helps grease the wheels for more innovation.

LOOKING TO THE FUTURE —

“THERE’S A REAL URGENCY FOR SCIENTIFIC TEAMS TO COME TOGETHER AND FOCUS ON SOLVING THE GRAND CHALLENGES THAT WE’RE FACING. IT’S NOT JUST ABOUT TEAMS WITHIN THE HIGHER ED SETTING, BUT ALSO WITH ALL OF THESE DIFFERENT CORPORATE AND FEDERAL PARTNERSHIPS COMING TOGETHER, THE BEST MINDS, FOCUSING ON THE THINGS THAT WE’RE FACING AS A SOCIETY.”

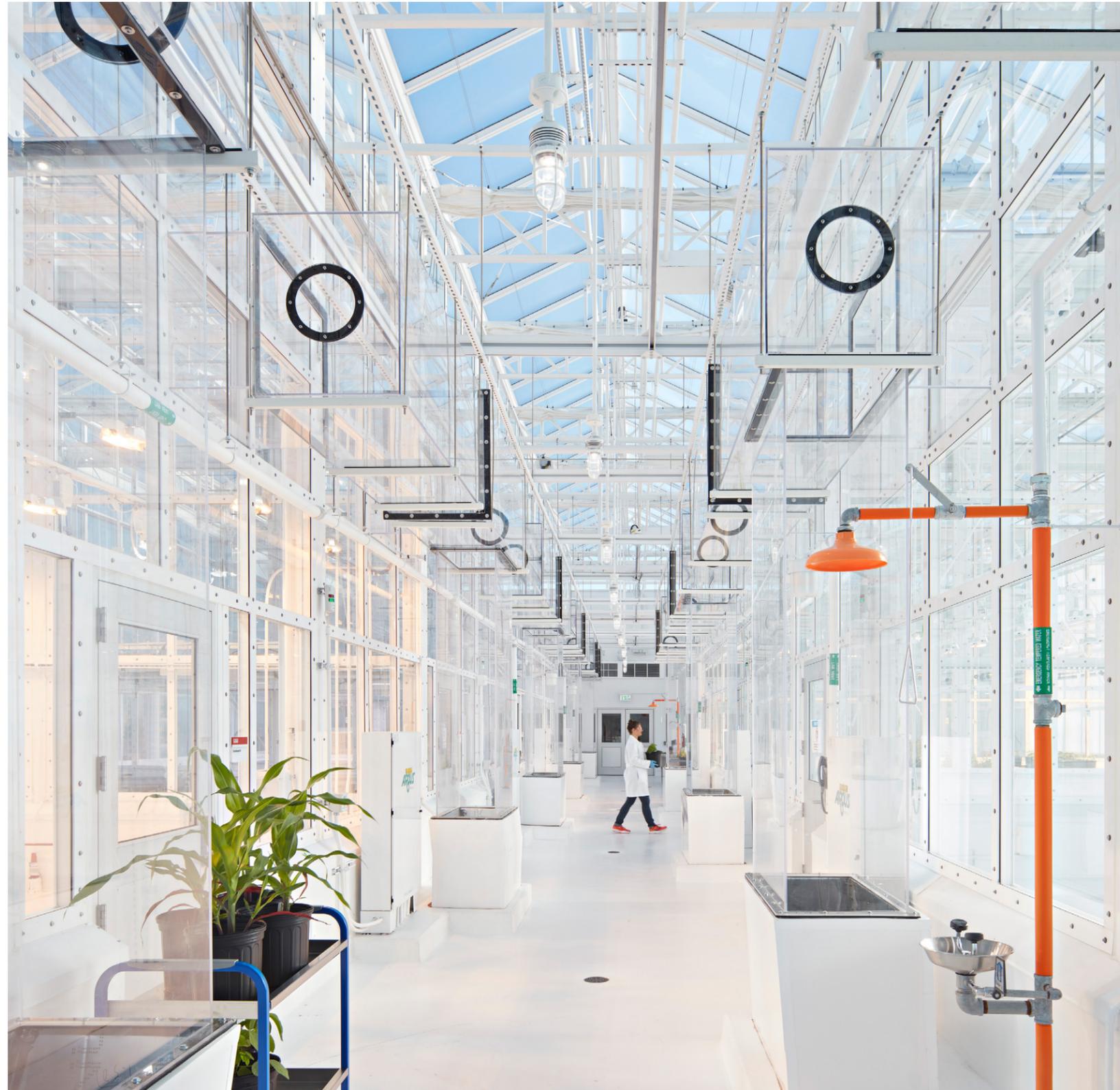
*ELLIOTT KELLNER, PH.D.
SENIOR PROGRAM MANAGER
DONALD DANFORTH PLANT SCIENCE CENTER*



SUPPORTING FUTURE BREAKTHROUGHS

Over the past few years, there has been considerable progress in public policy with respect to lifting restrictions on genome-edited crops. The European Union is reconsidering legislation that regulates all genome-edited crops as GMOs, while progress is also being made in China and India. These policy changes will help open the door for more research and the ability to implement potential breakthrough discoveries globally.

When considering breakthrough innovations and what the future holds, some industry leaders envision a shift in the way companies think about products. Much like the healthcare industry's shift toward value-based care, ag firms have the tools to focus on selling outcomes, rather than products. This grows more possible with advances in technology that allow for more personal, targeted solutions.



While cross-discipline convergence has the potential to produce major breakthroughs, we don't need to pin all our hopes on massive, game-changing breakthroughs. These collaborative ecosystems are well-positioned to steadily move agriculture forward, and it's incremental progress that will lead to long-term changes.

"We need to do things differently and quicker than we've done previously. We need to bring together different people with different backgrounds to solve these challenges. It's not an initiative or university that will solve this. It's all of us working together in a concerted, thoughtful manner and leveraging all the different skill sets we have in order to be successful."

ADRIAN PERCY, PH.D.
EXECUTIVE DIRECTOR
NORTH CAROLINA PLANT SCIENCES INITIATIVE
NC STATE UNIVERSITY



CONTRIBUTORS —

The ideas and content in this white paper are derived from the roundtable event “Looking to the Future of Ag Science: Connecting industry leaders to address the core agricultural challenges of today and tomorrow.”

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SPEAKERS



ADRIAN PERCY PH.D.

Executive Director, North Carolina Plant Sciences Initiative
NC State University

An advocate for modern agriculture, Adrian oversees the NC PSI, which aims to leverage interdisciplinary science and technology through public-private partnerships to advance the plant sciences to the benefit of growers, consumers, and other food chain stakeholders. In addition, he is a Venture Partner at technology and life sciences venture capital investor Finistere Ventures LLC and serves on the board of directors of multiple biotech firms.



BRAD RINGEISEN PH.D.

Executive Director, Innovative Genomics Institute
UC Berkeley

Brad is a physical chemist and pioneer in live cell printing. He guides the scientific and development strategy of the Innovative Genomics Institute, whose mission is to bridge revolutionary gene editing tool development to affordable and accessible solutions in human health and climate. Previously, Brad was Director of the Biological Technologies Office at DARPA, where he managed a division working at the cutting edges of biology, physical sciences, and engineering.



PHIL TAYLOR PH.D.

Director of Open Innovation and Outreach
Bayer Crop Science R&D

With over 15 years of AgTech industry experience, Phil plays a central role in fostering strategic relationships around the globe and developing programs to accelerate innovation. A strong champion for both external and pre-competitive partnering as a driving force for innovation and change, Phil has held multiple leadership roles at Bayer focused on delivering collaborative approaches to enable R&D. He is a member of multiple advisory boards and professional society committees.



ELLIOTT KELLNER PH.D.

Senior Program Manager
Donald Danforth Plant Science Center

Elliott manages the Danforth Center's Wells Fargo Innovation Incubator (IN2) and Center for AgTech and Location Science Technologies (CATALST) programs, which support early-stage AgTech companies on their path to market and further develop the regional innovation ecosystem. Previously as Chesapeake Bay Science Advisor, he spent three years supporting the efforts of USDA Natural Resources Conservation Service to mitigate the impacts of agriculture on water resources.

PANELISTS



JOHN GOTTULA PH.D.

Director of Crop Science, Agriculture US-Based
SAS

John is an AgTech innovator with an applied crop science background and a passion for analytics. Holding a doctorate from Cornell University, John formerly directed crop biotechnology studies and led global agronomic development programs. John is the co-creator of #AgileAg, a movement to link agile processes with crop science to drive analytics adoption in the agriculture industry.



KAREN LEVERT MBA

Co-founder, Ag TechInventures and Venture Partner
Pappas Capital

Dedicated to advancing early-stage technologies to the marketplace, Karen co-founded both Southeast TechInventures, an innovation lab focused on developing promising technologies from university labs, and Ag TechInventures, which focuses solely on technology innovation in agriculture. Her leadership experience runs the gamut from start-ups to a Fortune 500 company. In addition to her professional duties, Karen serves on the board of several organizations, including the North Carolina Biotechnology Center and NC IDEA Foundation.



LAURA WESTBY J.D.

Chief Legal and Operations Officer
Oerth Bio

A seasoned general counsel, Laura has deep experience managing intellectual property and providing strategic business and legal counsel for AgTech companies. Her passion for agriculture was cultivated during 15 years at Syngenta in various positions in the U.S. and Switzerland, including the global role of Associate General Counsel for Crop Protection. Prior to joining Oerth Bio, Laura was SVP, Legal and IP for agriculture-based startup Invaio Sciences, a Flagship Pioneering company.



DR. WAYNE HONEYCUTT PH.D

President and CEO
Soil Health Institute

Wayne leads the Soil Health Institute's programs to safeguard and enhance the vitality and productivity of soils. Previously he served as Deputy Chief for Science and Technology with USDA-NRCS in Washington, D.C. and as a Research Soil Scientist and Research Leader with the USDA-ARS New England Plant, Soil, and Water Laboratory. Wayne was a 2018 recipient of the Hugh Hammond Bennett Award, the Soil and Water Conservation Society's highest individual honor.



DEBORAH THOMPSON PH.D.

Director of Research Partnerships, College of Agriculture & Life Sciences
Assoc. Faculty, Dept. of Agriculture and Resource Economics, NC State University

A biotechnology and agricultural biotechnology professional with over 15 years of research and development experience, Deborah builds collaborative research relationships between CALS faculty, staff, and students as well as industry partners across the state, the nation, and the world. She has worked for academic, corporate (from startups to multinational companies), government, and not-for-profit institutions and mentored over 30 interns from high school, undergraduate, and graduate student to postdoctoral fellow.

FLAD ARCHITECTS



CHAD ZUBERBUHLER ASSOC. AIA

Principal Planner

Flad Moderator

Chad is a laboratory planner who works with project teams to support the development of facility design and program solutions. He contributes to program and planning of academic and corporate research spaces and knows that, above all, these spaces need to function well. Therefore, his primary goal is to understand how each researcher best utilizes lab space and how the design team can help facilitate the client's research.



JAMIE MATTHYS MBA

Principal, Director of Strategic Planning

Flad Moderator

With a background in business as well as design, Jamie engages clients to deliver a process that is flexible and immersive. She takes into account each client's specific needs and marshals the firm's resources and capabilities to build project teams that achieve impactful outcomes. As an effective process leader, Jamie is ideally suited to be a bridge between subject-matter experts and clients, as well as a resource for employees in all sectors of Flad's business, with a charge of elevating a vital area of our planning practice.



CHUCK MUMMERT AIA, LEED AP BD+C

Principal Designer, Plant Sciences Building

Event Host & Facilitator

Chuck sees design as a tool to encourage the kinds of social interactions that lead to scientific collaboration. He thinks about how people do their work, whether singly or in groups, and how design can have a positive impact on the daily experience of the people using the building. Whether in a corporate setting, where oftentimes the goals are to reinforce the corporate culture and speed research and new product delivery, or in an academic setting where the focus is on the student and faculty connection, his attention to social ecology of buildings emphasizes communication and collaboration.

cmummert@flad.com

ABOUT THE HOST SITE

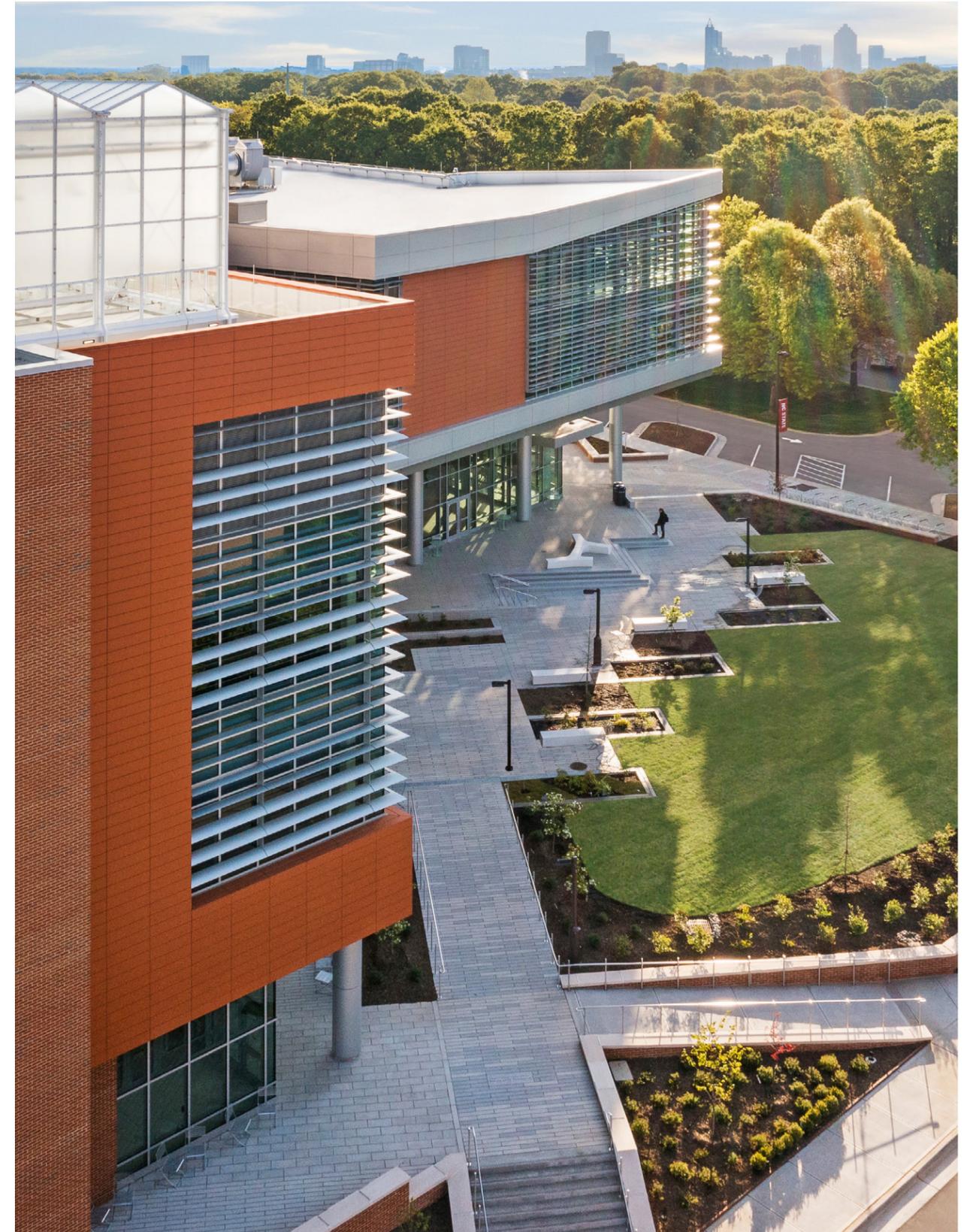
Flad and NC State University collaborated to design the university's new state-of-the-art Plant Sciences Building, where the event was held. Located on NC State's Centennial Campus, the research facility is designed to provide modern infrastructure for plant science advancement at the university, create connections and collaboration among the many agricultural enterprises across the state, and become the premiere plant science research center in North America.

From the project's beginning, design was informed by the need to accommodate unassigned research faculty and rotating industry partners, and the space program was developed around scientific capabilities, rather than specific investigators. Corporate partner suites function as a collaborative hub with access to support spaces, offices, and building amenities.

The facility is organized around accommodating visitors both inside and out. An exterior porch provides outdoor event space adjacent to demonstration plots and an open lawn. Inside, the ground floor supports events with a multi-height hearth, a transparent demonstration lab supporting research and extension programs, and education area that celebrates the future of cutting-edge ag bioscience, and a flat-floor assembly space. Among the building's many innovative components are BL-2P and BL-3P rooftop greenhouses and headhouses. The facility has been awarded LEED Gold. In addition, the Department of Energy's Building Envelope Campaign recognized the building with a Novel 20 Award for demonstrating building envelope performance 20 percent over code.

[LEARN MORE ABOUT THE NC STATE PLANT SCIENCES BUILDING >](#)

[WATCH VIDEO >](#)



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