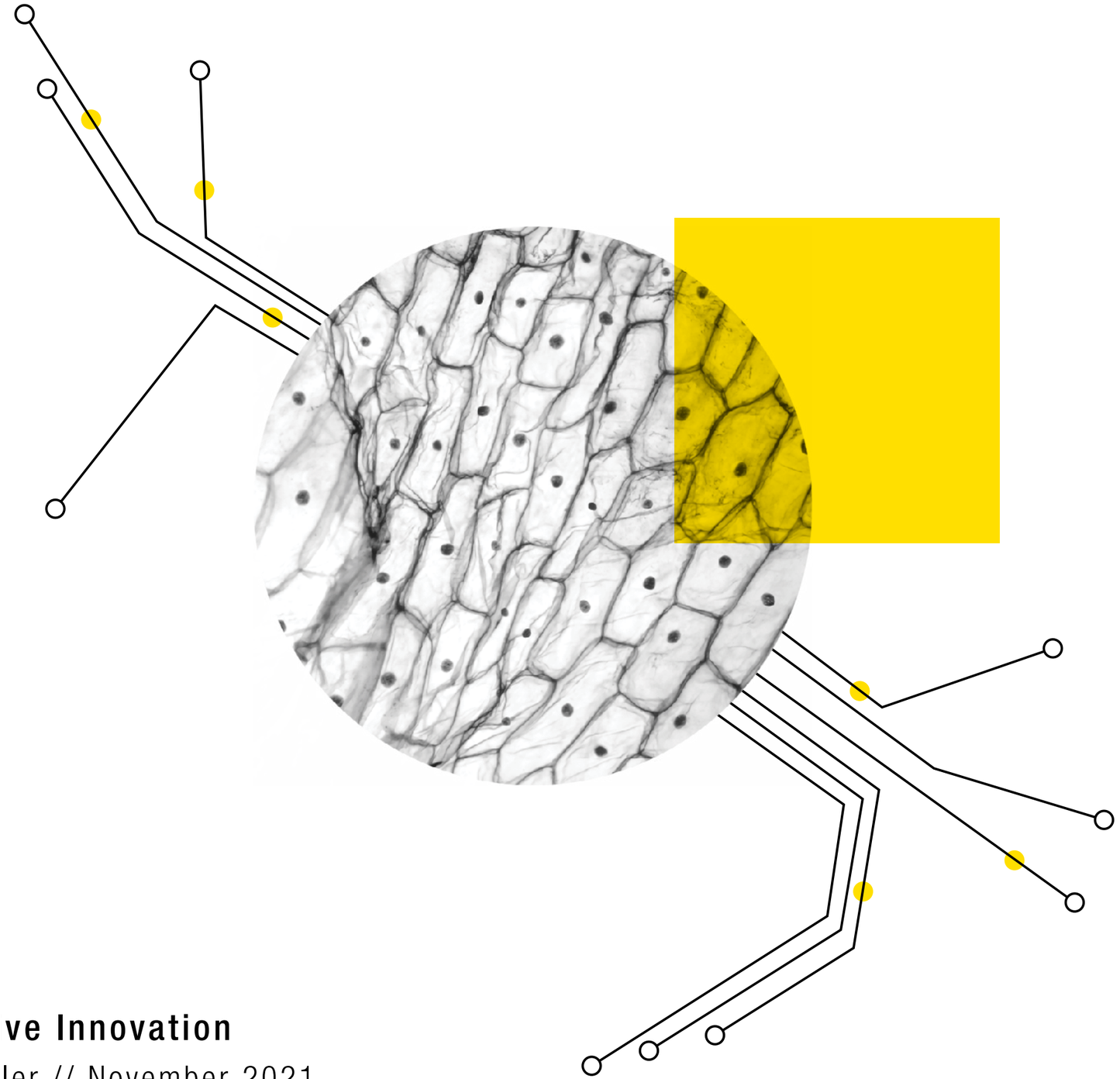

Ag Science: Using Data to Drive Innovation

Chuck Mummert // Chad Zuberbuhler // November 2021

Flad

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INTRO

Never has there been such urgency within the agricultural industry to address the steep challenges threatening a stable food system. Changes in our weather and climate, an increasing world population, a finite amount of farmable land, a complex food distribution system – these are just a few of the obstacles producers and scientists are facing as they strive to feed our global society in a manner sustainable for the planet.

But at the same time, never has there been a greater ability to connect, using technology to communicate, work, innovate, and learn together on a global scale. Data analysis and automation have solved problems and ushered in advancements across retail, finance, business, entertainment, travel, and many other sectors. This knowledge, combined with a growing realization of its wide-ranging applications in agriculture, is paving the way to new methods of farming that lessen its environmental impact while producing resilient crops with greater yields.

“THE WORLD IS ONE BIG DATA PROBLEM.”

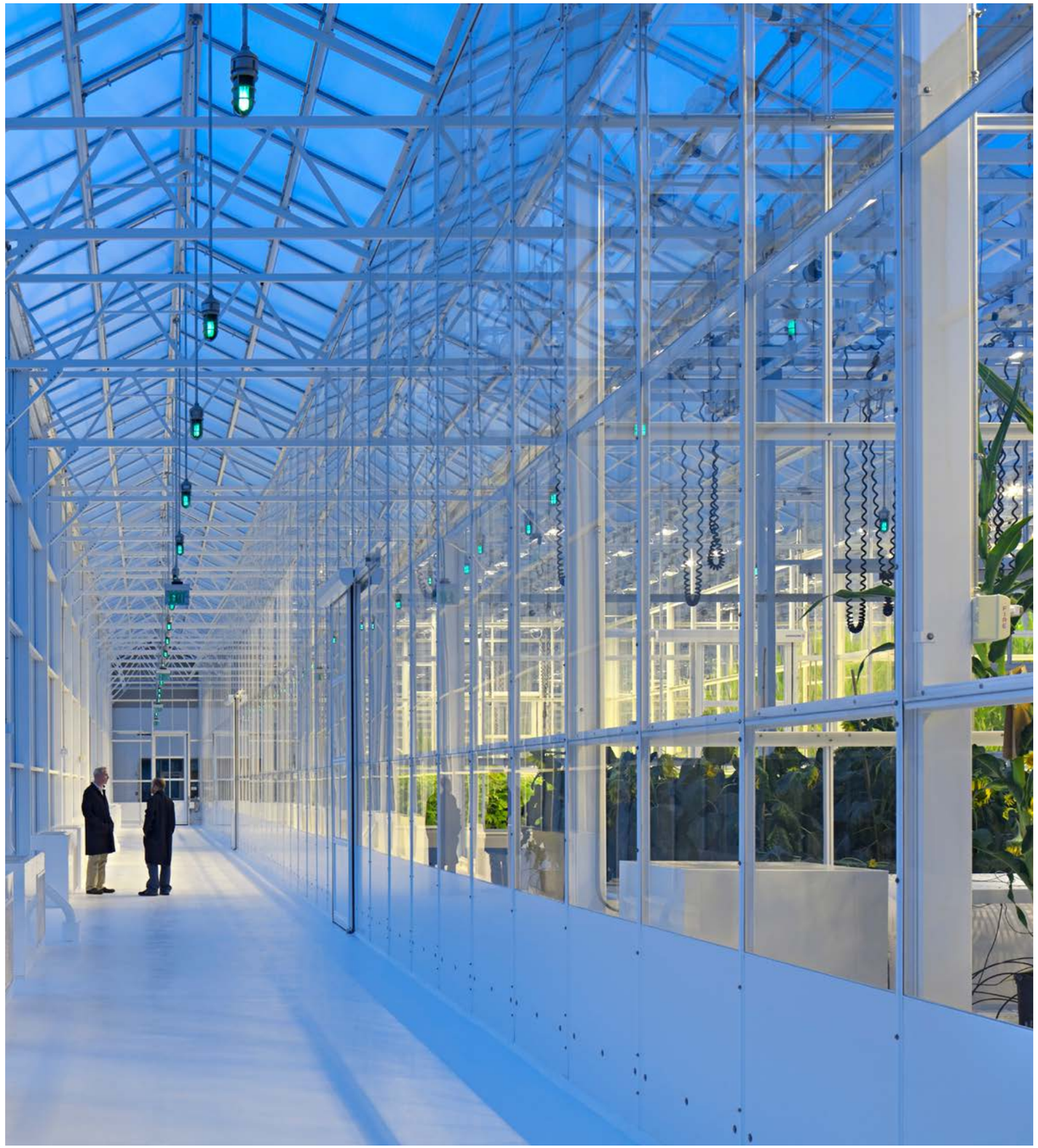
– ANDREW MCAFEE,
PRINCIPAL RESEARCH SCIENTIST, MIT

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 innovation 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 convened a panel of experts from various industry sectors to explore the current and future application of digital capabilities in Ag Science.

Right from the start, the optimistic conversation found consensus in many areas, each panelist contributing to the discussion with specific insights on how data science is already transforming agriculture and quickly accelerating to impact our future. We would like to share a few highlights from this engaging exchange of ideas.

LEARN MORE ABOUT THE PANELISTS >



01

DIGITAL AG'S BIGGEST BENEFITS AND MOST PROMISING OPPORTUNITIES

Data and analytics are agriculture's partner in determining the best ways to use the tools we already have.

Agriculture is multi-faceted with many available data inputs such as plant genetics, weather, economic forecasting, soil conditions, and agronomic characteristics, to name a few. All of these can be integrated to increase efficiency, reduce ups and downs in yield from year to year, and increase crop resiliency. We can turn data into information – and information into insights.

Data enhances a farmer's many years of direct experience, removing some of the uncertainty. Even though farmers have deep knowledge of the land they work, agriculture regularly presents situations that extend beyond this expertise. But supported by data and data-driven insights, farmers can make more informed decisions to increase yield, decrease costs, reduce waste of resources, and adapt to a changing climate.

Digital agriculture enables individual farms to connect and communicate with each other, collaborating to learn and solve problems together.

The power of collective knowledge cannot be overstated. Someone – somewhere – has the solution to the problem you are facing. And with the ability to easily share insights, farmers can learn and progress together rather than individually starting from scratch each time.

THE DECISIONS A FARMER HAS TO MAKE - WHEN TO PLANT, WHEN TO HARVEST, WHEN TO IRRIGATE, WHAT AND WHEN TO FERTILIZE - IT'S ALL BASED ON A LOT OF GUESSWORK. BUT DIGITAL AGRICULTURE CAN AUGMENT A FARMER'S KNOWLEDGE ABOUT THESE FACTORS WITH DATA SO THEY CAN MAKE THE BEST DECISIONS POSSIBLE. IT'S ALSO BETTER FOR THE ENVIRONMENT - THEY CAN TARGET THE APPLICATION OF RESOURCES SUCH AS WATER, FERTILIZER, AND PESTICIDES TO REDUCE NEGATIVE IMPACTS TO THE LAND."

RANVEER CHANDRA, CHIEF SCIENTIST
MICROSOFT AZURE GLOBAL

02

COLLABORATION IS KEY TO DIGITAL AG'S ADVANCEMENT

When we think about innovation, we need to bring all the sciences together to drive it forward.

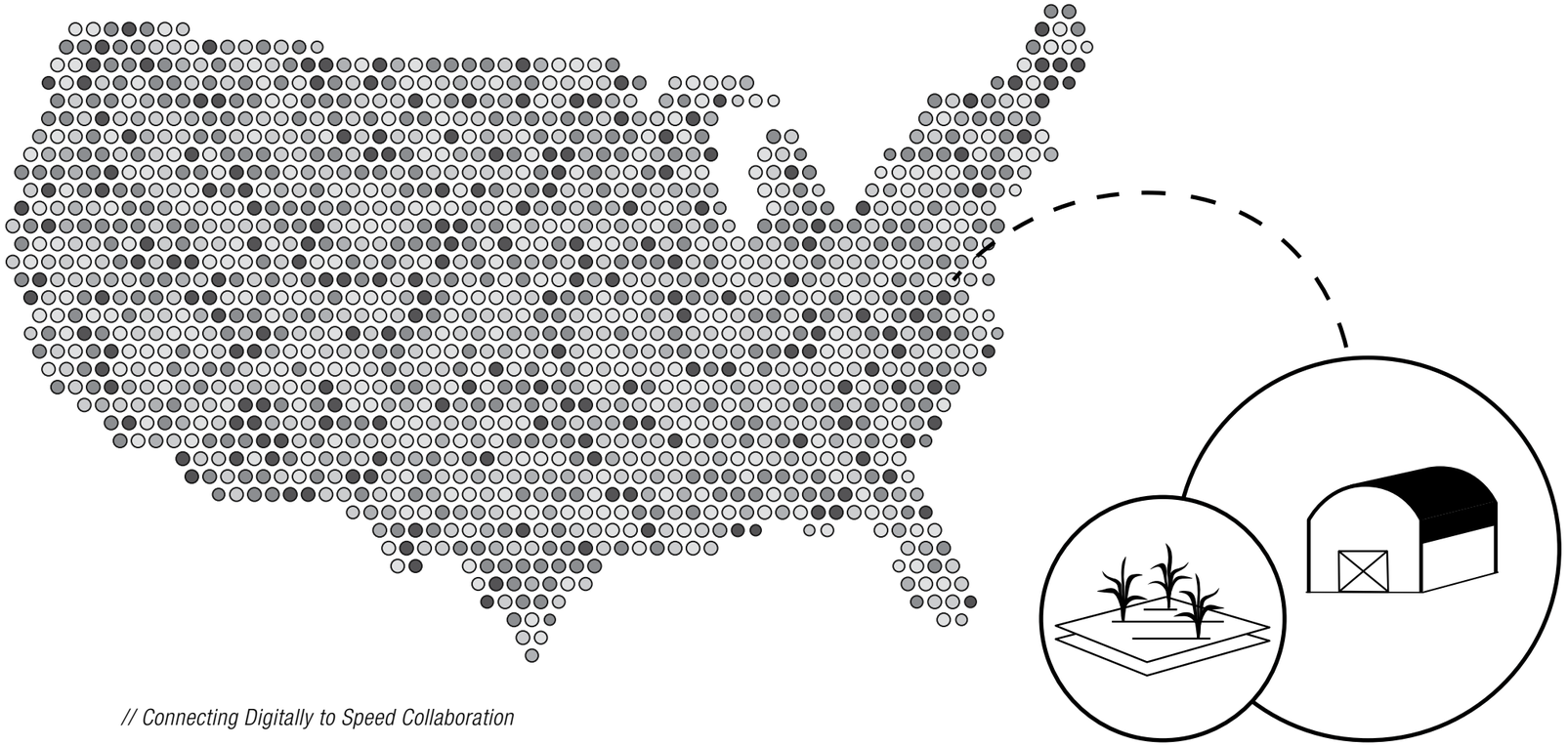
From ag bioscience to engineering, computer science to statistics, economics to mathematics and beyond – a convergence of disciplines and industries is crucial to creating a structure and framework that brings all facets of expertise together to solve the different sides of the agriculture problem.

New partnerships are forming to support new pathways to problem solving.

Think university plant virology researcher teaming up with a major technology company. Not a traditional pairing, but these experts are finding common ground with the ultimate goal of a sustainable global food system. Working to understand the variables produced by complex living systems and turning them into meaningful, robust data sets, agriculture can move closer to a digital transformation.

COLLABORATIVE SCIENTIFIC EXPLORATION

Designed as a direct response to Texas A&M's vision of making agriculture and life sciences relevant and meaningful in the daily lives of Texans, the new Dallas AgriLife Research Center supports scientific research, industry collaborations, and community programs focused on improving the sustainability of urban living through responsible use of natural resources. Key initiatives of the program seek innovation in the areas of urban agriculture and forestry, water and land resource management, and overall healthy living. The design purposefully engages the public while supporting collaborative scientific exploration of these important issues affecting our planet. LEARN MORE >



// Connecting Digitally to Speed Collaboration

Digital agriculture allows connection of fields to farms and farms to each other.

As farm operations connect digitally throughout their own fields, within regions, and even across the world, rich data sets are being built and widely shared to leverage knowledge gained in one environment for use in another. In this way we can achieve wider implementation of increasingly efficient and sustainable practices. What solutions are best suited to a specific environment given the data we already collectively have? A very exciting opportunity exists at this global level as more farms come online and farmers can share and interpret data together.

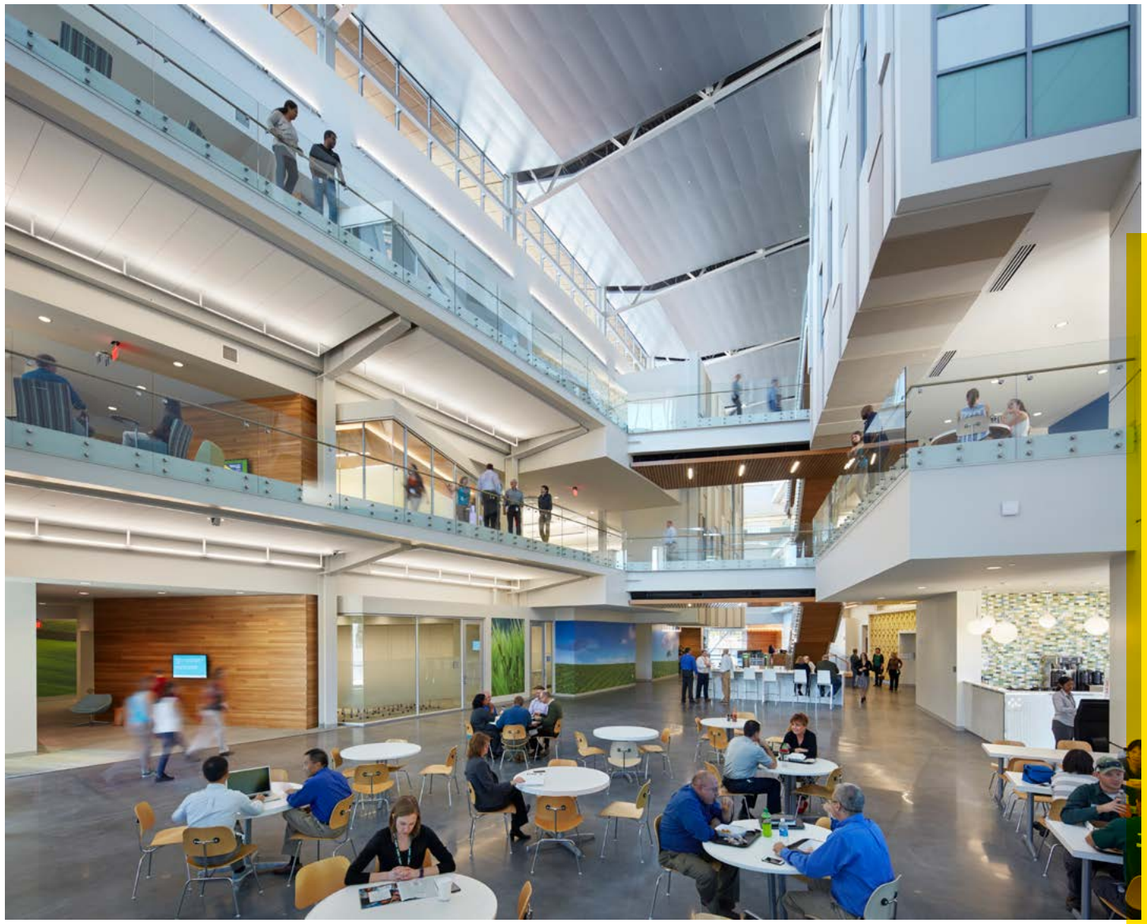
> *"THIS MOMENT WE ARE CURRENTLY IN – THIS IS AS EXCITED AS I'VE BEEN IN MY CAREER. THERE ARE ENORMOUS OPPORTUNITIES OUT THERE TO COLLABORATE IN PARTNERSHIPS AND INTERDISCIPLINARY APPROACHES TO ACHIEVE IMPROVEMENTS NOT ONLY FROM A PRODUCT STANDPOINT, BUT FOR THE GROWER STANDPOINT AS WELL."*
>
> GREG DOONAN,
> HEAD OF ADVANCED ANALYTICS FOR SEEDS DEVELOPMENT
> SYNGENTA

03

DATA APPLICATIONS THAT DRIVE INNOVATION

Artificial Intelligence (AI) can perform a highly thorough and efficient analysis of large data sets, allowing researchers to make both faster and better-informed decisions.

Consider the seed development process – there are countless genetic variables at play that can ultimately impact the success and quality of a final product. AI can be employed to process and analyze this high volume of data with an efficiency that humans simply can't. Researchers are then able to spot valuable insights that might otherwise have been missed, ultimately driving improvements in decision making while reducing development time to meet market demand.



DESIGNED FOR CHANGE, CHAMPIONING INNOVATION

Syngenta's reinvented agricultural biotechnology research environment in Research Triangle Park is simple, lean, and highly adaptable. Scientists work in teams to solve specific issues related to genomic research and new product development – once project goals are achieved, these researchers are reorganized into new teams to solve the next challenge. The architecture and infrastructure supporting them is designed for quick reconfigurations to ensure constant access to the right people, equipment, and technology.

LEARN MORE >

Sensors deployed throughout fields are enabling more accurate surveillance and assessment of real-time crop conditions.

Across a single large field, conditions can vary widely. But by distributing sensors throughout the field to continuously gather data about the soil, moisture, crop health, and other variables, a farmer can use this information to make highly targeted applications of water, fertilizer, pesticides, and other resources – resulting in reduced costs, waste, and environmental impact. Our imagination is the limit when it comes to sensors – the more complete a data set of a plant's environment that can be gathered, the more accurate and beneficial decisions a farmer can make.

// Pin-point Field Conditions Available 24x7

Technology advancements that enable reliable Wi-Fi connections to the internet are a must.

Unreliable connection to the internet in rural locations – where farms are located – is not a new problem. And while service providers continue to expand network range, technology innovation is at work on this level as well, seeking creative ways to bring farms online. One solution currently being explored involves employing unused TV channels to send and receive Wi-Fi signals. While these transmissions only travel a few miles, they have great potential at the individual farm level.

04

THE ROLE OF ROBOTICS AND AUTOMATION

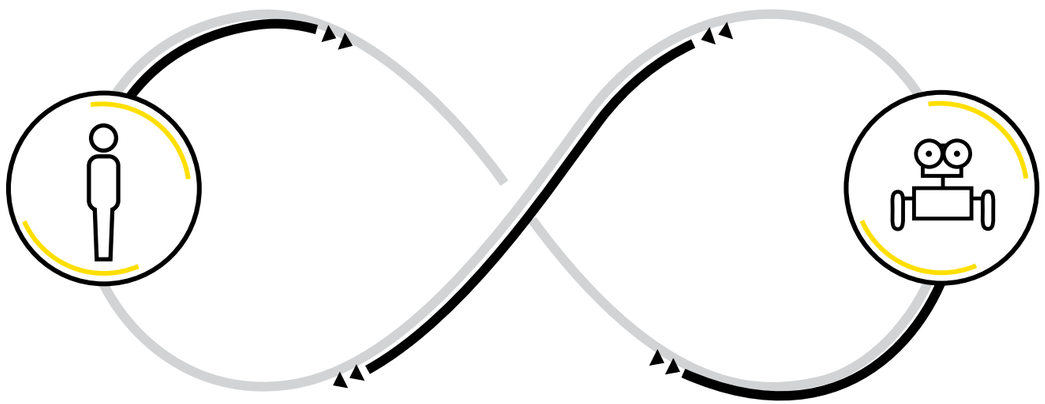
The robotics space is so exciting right now – the potential for them to do work on an as-needed basis is revolutionizing the agricultural industry.

For example, consider work needed to be done in the field. Mechanical planting, weeding, and harvesting could take place 24/7 and be done more efficiently than with human labor. Automated devices that do not need to accommodate an operator can be smaller, lighter, and less expensive than traditional equipment. Micro devices could be deployed for pest control, reducing the use of chemical applications. A fascinating set of possibilities exists as robotics innovation progresses.

> *"WE NOW HAVE ROBOTS WITH THE NECESSARY DEXTERITY TO PICK STRAWBERRIES. THERE'S TRADITIONALLY A LOT OF WASTE WITH THIS CROP – LABOR IS ONLY AVAILABLE AT A CERTAIN TIME AND ONLY FRUIT THAT IS RIPE AT THAT TIME IS HARVESTED AND THE REST IS LEFT ON THE VINE. BUT WITH ROBOTS, YOU CAN HAVE THEM GO THROUGH A FIELD NON-STOP, HARVESTING EACH FRUIT INDIVIDUALLY AS IT RIPENS. GREATER EFFICIENCY WITH MUCH LESS WASTE."*
>
> *SIMON TRIPP, SENIOR DIRECTOR, TECONOMY PARTNERS*

In talking with farmers, labor is consistently their biggest variable.

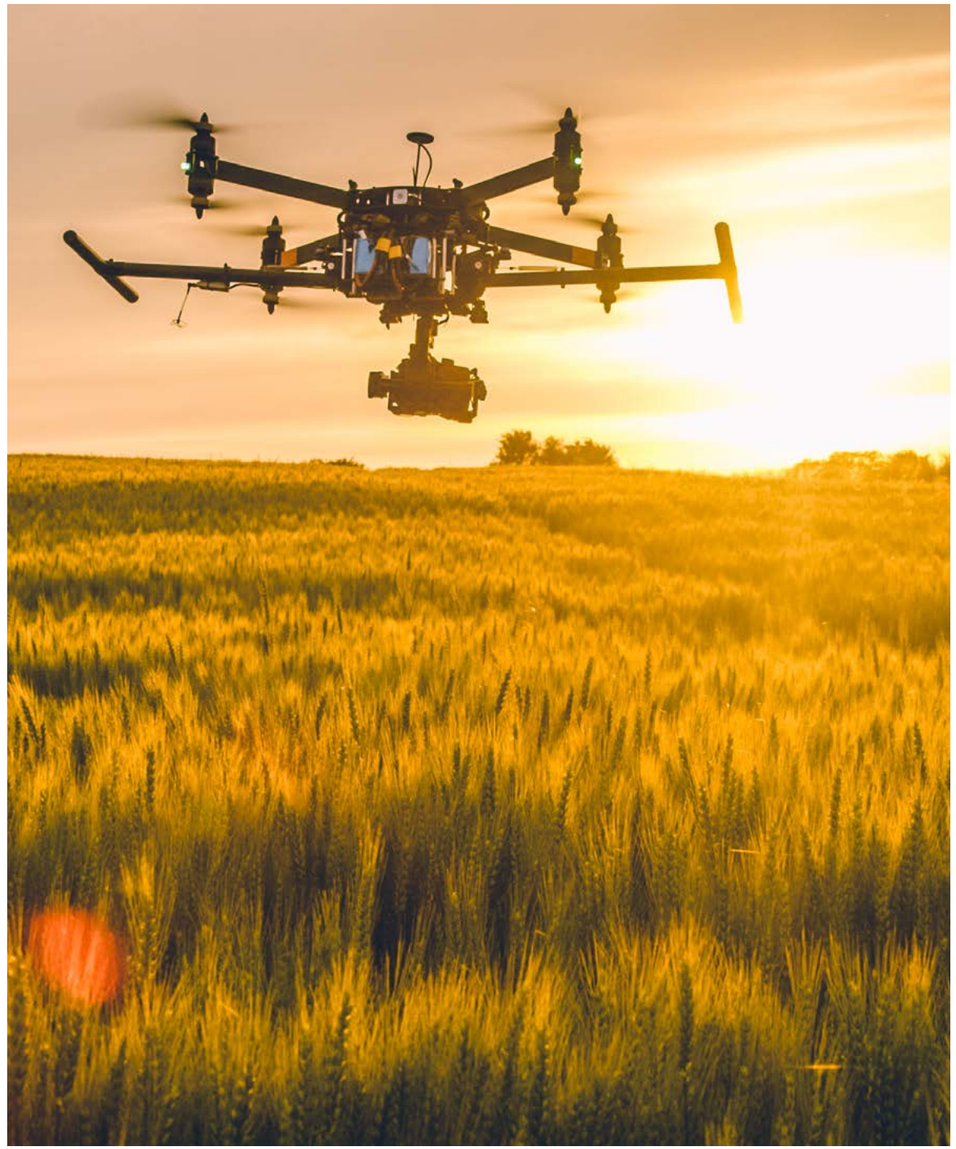
When working with human systems there are always many unknowns to navigate. Availability of labor at precise times, worker health and other individual considerations, the effect of policy changes, and unpredictable events such as the current pandemic are just a few of the issues that can have a cascading effect on farm operations. When robotics become aligned with a reasonable price point, and can accurately perform the required tasks, farmers will surely start to buy in, and it will be game changing – a time that is quickly approaching.



// Continuous Improvement in Quality and Efficiency through Automation Advancements

Huge advances in robotics capabilities are coming as different disciplines collaborate and innovate.

Think about what's happened with the advent of the electric car – someone who did not develop the car, or the battery, took the two and put them together, creating an entirely new application. That's what we are going to see in the robotics sphere as nontraditional sectors unite and these crosses in thinking continue to occur. And facilities with flexibility that support the question *what if…?* are imperative.



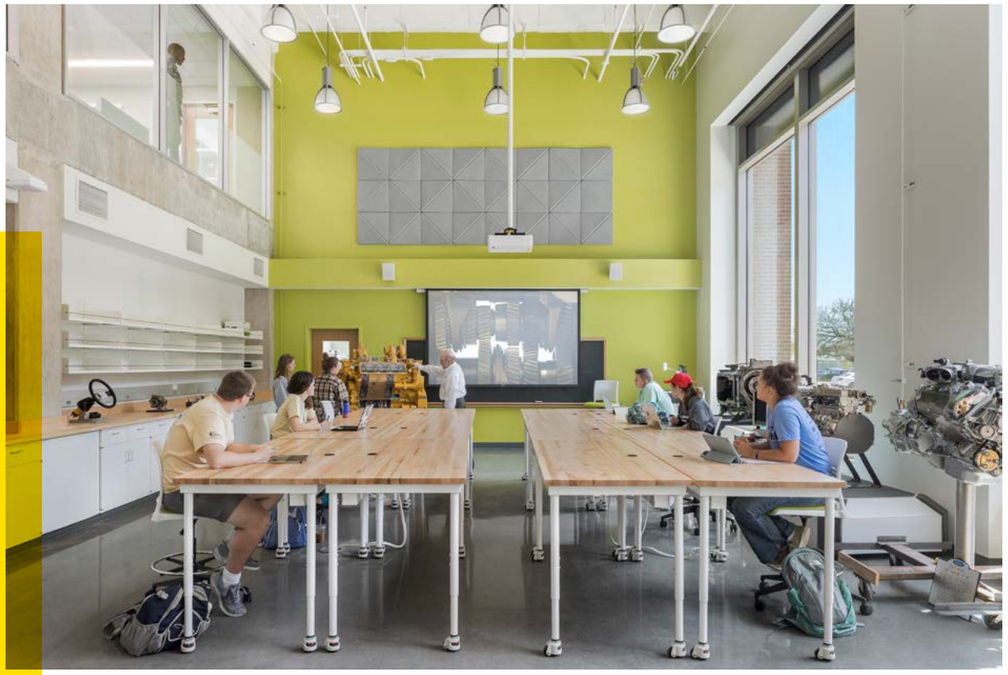
"WE ARE SEEING TEAMING OF UNIVERSITY ENGINEERING AND AGRICULTURE PROGRAMS TO FOCUS ON PRECISION USES FOR DRONES, EXPLORING THE ADAPTATION OF TRACTORS TO RUN ON ALTERNATIVE FUELS, AND USING SOLAR POWER TO RUN WEED-TRIMMING ROBOTS IN FIELDS. WE REALLY ARE AT THE TIP OF THE ICEBERG IN TERMS OF WHAT ROBOTICS WILL DO FOR FARMING – UNIVERSITY RESEARCH FACILITIES WITH MAKERSPACES WILL BE CRUCIAL ENVIRONMENTS FOR HOSTING COLLABORATIONS TO SEE WHERE THESE CROSSES CONTINUE TO OCCUR."

CHAD ZUBERBUHLER, PRINCIPAL AND LABORATORY PLANNER
FLAD ARCHITECTS

05

LEADERS IN A DATA-AUGMENTED FARMING FUTURE

Universities are embracing interdisciplinary programs that bring different departments together, creating new opportunities for students. We are seeing schools of agriculture teaming up with engineering, data and computer science, business, life sciences, and other departments within their institution to offer students new channels to learn and discover in an environment that foresees the direction industry is headed. And students are interested, motivated, and excited to take on the big agricultural problems of the world – they seek careers that allow them to do something valuable and contribute to making a healthy, sustainable society for all.



TEACHING THE NEXT GENERATION

Consolidating department functions that were spread among nine separate buildings on the Purdue campus, the new Agricultural and Biological Engineering Building brings this highly collaborative science community together. It also provides the perfect environment for exposing students to real-world research across a multitude of disciplines, igniting a passion at the beginning of their academic journeys. Highly flexible teaching spaces, combined with involvement with ongoing research, builds excitement through meaningful hands-on learning opportunities.

Partnerships between the industry and university spheres, in both education and research, are on the rise.

These effective collaborations are demonstrating paths toward mutually beneficial outcomes. For example, by participating in the funding of industry research, a university can open the door for students and faculty to work on intriguing real-world problems, and in turn, industry can work with highly skilled investigators and gain exposure to talented future graduates. In addition, grant programs are increasingly looking to fund these types of partnerships – another benefit for both entities.

> *"THE WHOLE PURPOSE OF OUR PLANT SCIENCES INITIATIVE IS TO CONVERGE – TO CREATE A FRAMEWORK AT THE UNIVERSITY TO GET OUR ENGINEERS, MATHEMATICIANS, ECONOMISTS, AND THEIR CORPORATE PARTNERS TO WORK TOGETHER TO SOLVE GRAND CHALLENGES LIKE DROUGHT AND YIELD."*
>
> DR. STEVEN LOMMEL, ASSOCIATE DEAN FOR RESEARCH IN THE COLLEGE OF AGRICULTURE AND LIFE SCIENCE AT NORTH CAROLINA STATE UNIVERSITY

ACADEMIA AND INDUSTRY IN PARTNERSHIP

The new Plant Sciences Building at NC State introduces modern infrastructure for plant science advancement at the university, creating connections and collaboration among the many agricultural enterprises across the state. With a goal of becoming the premier plant science research center in North America, design was informed by the need to accommodate unassigned research faculty and rotating industry partners; the space program was developed around scientific capabilities and evolving initiatives, rather than specific investigators. Corporate partner suites function as incubator labs with access to the rooftop greenhouse, support spaces, offices, and building amenities. The spacious ground floor supports visitors and events featuring a glass-lined demonstration lab showcasing research and extension programs and an education area that celebrates the future of cutting-edge ag bioscience.

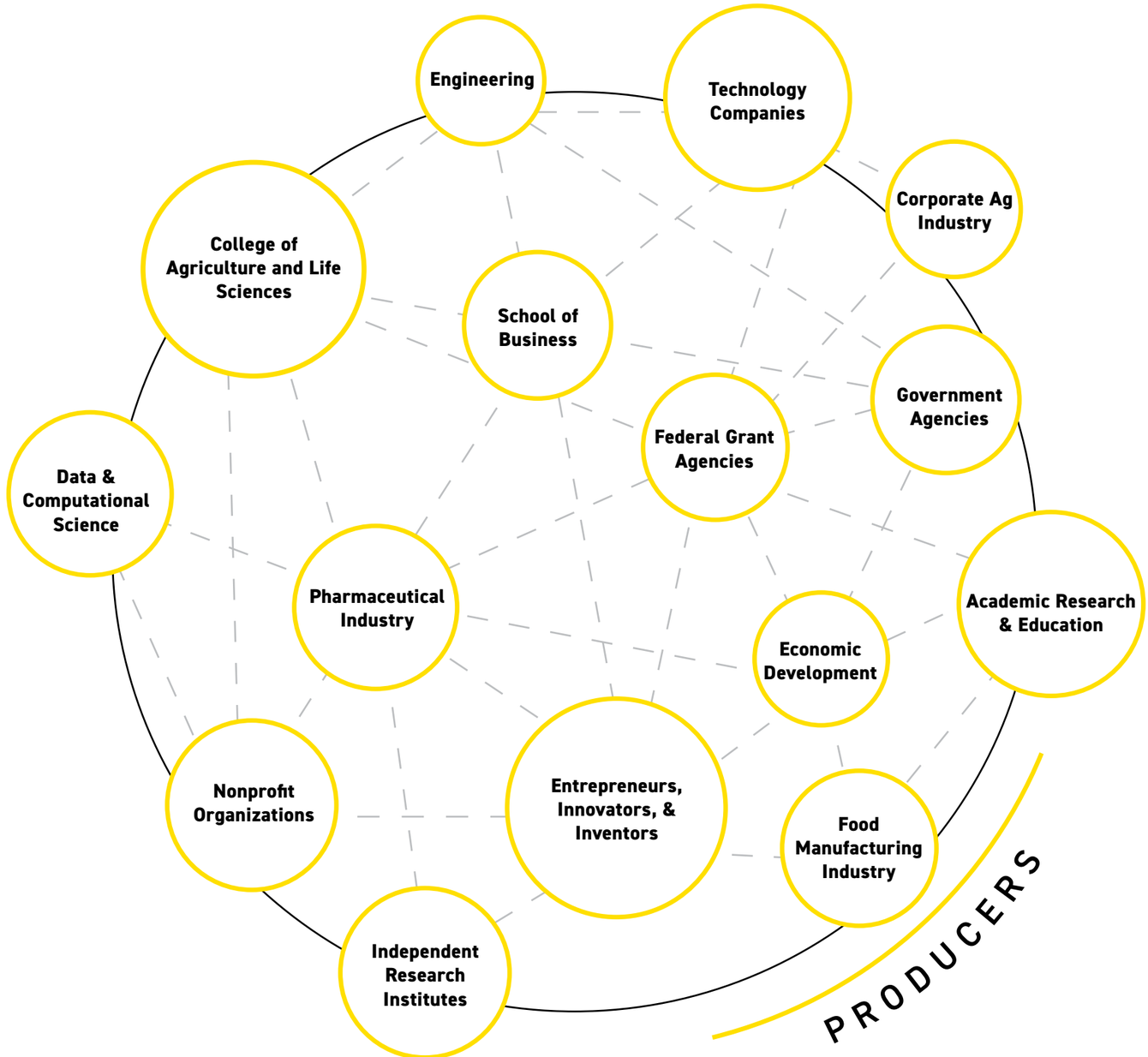
LEARN MORE >

Nonprofit and university programs are developing methods for emerging digital ag companies to pilot and demonstrate new technology to producers.

Producers are looking for the proof of concept for these new advances and how they might be applied to their own farm operations. At the same time, more and more emerging companies are coming from outside the traditional agricultural perspective and need pathways to test, pilot, and demonstrate their innovations.

One model solution taking shape involves a nonprofit organization developing a cooperative network of partner farmers and then contracting with new companies to test and demonstrate their equipment directly with the partner farmer operations.

Additionally, many universities are developing makerspaces and farms of the future where technologies can be tested, monitored, and perfected before wider deployment – an ideal proving ground for new collaborations. This important connection point between technology innovation and real-world production only further demonstrates the need for robust partnerships that involve the entire agricultural chain.



// Agricultural Innovation through Interdisciplinary Connections

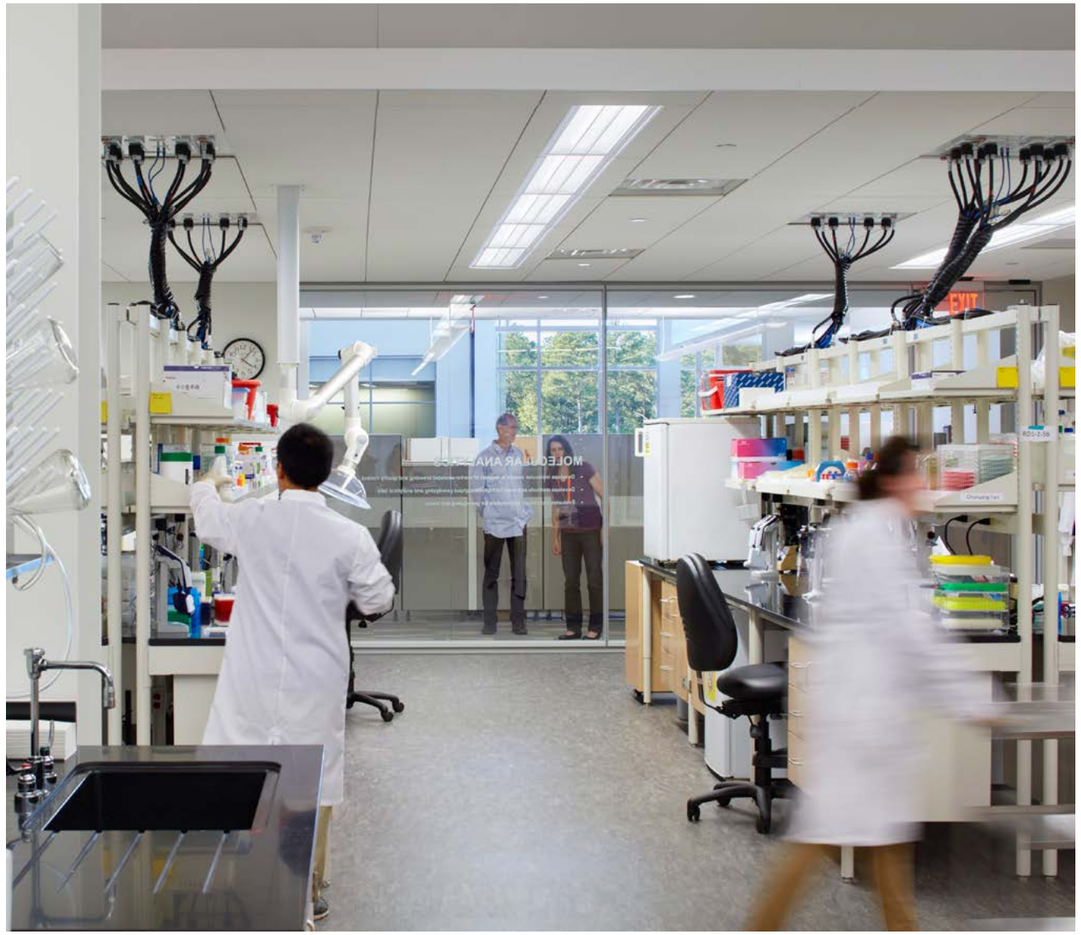
0 6

WHAT LIES AHEAD

Our discussion concluded with a query to our experts about the magnitude of change these advances in digital agriculture might hold – could we be so bold as to call this the next Green Revolution? Their response was an enthusiastic *YES!*

Agriculture has a compelling and noble story to tell. Farmers literally help feed the world and have done so for thousands of years. As we enter this next period of population growth the urgency to do things better and smarter cannot be understated. Consider the issues of soil erosion, deforestation, decreasing biodiversity, and many other grand global-scale challenges – digital agriculture is proving that it can be a major force toward improving productivity while doing it sustainably.

And these challenges call to those who want to be part of something greater than themselves. The ability for one's ideas to have an impact at this scale is what inspires many in these sectors to come to work each day. The opportunity for experts from different fields to partner together, drive change, and see the results of this work in real-world applications is an exciting and extraordinary step forward for agriculture.



"WE ARE CONTINUOUSLY STRIVING TO SUPPORT OUR CLIENTS WITH AGILE AND ROBUST SCIENCE ENVIRONMENTS. LEARNING FROM THEIR FIRST-HAND EXPERIENCES IN THE FIELD AND IN THE LAB PLAYS A CRUCIAL ROLE IN DESIGNING FACILITIES FOR THIS NEXT GENERATION OF BREAKTHROUGHS."

CHUCK MUMMERT, PRINCIPAL DESIGNER
FLAD ARCHITECTS

CONTRIBUTORS

The ideas in this white paper are derived from the panel discussion “Looking to the Future of Ag Science: Digitization and Automation”

VIEW FULL WEBINAR HERE >

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CHUCK MUMMERT

Principal Designer
Flad Architects

Chuck’s extensive design experience includes work with a variety of Ag Science research facilities for academic institutions and corporate clients, creating inspiring spaces for collaboration and advancement in the field. His design work articulates each client’s goals and aspirations while addressing complex programmatic requirements, sustainability goals, and issues of image and identity.

CHAD ZUBERBUHLER

Principal and Laboratory Planner
Flad Architects

Chad specializes in planning and programming during a project’s initial phase to help organizations better understand the resources they have and how to organize their assets for the foreseeable future. His work focuses on complex laboratory environments including facilities specific to research and education in Ag Science.

RANVEER CHANDRA

Chief Scientist
Microsoft Azure Global

Ranveer leads research and innovation across different industry verticals. He started the FarmBeats project in 2015, a technology focused on enabling data-driven farming, and also leads research on battery tech and TV white spaces.

GREG DOONAN

Head of Advanced Analytics for Seeds Development
Syngenta

Responsible for delivering insights and solutions to improve speed, quality, efficiency, and productivity of the product pipeline, Greg’s team drives improvements in the areas of operations research, artificial intelligence, and image analytics.

DR. STEVEN LOMMEL

Associate Dean for Research in the College of Agriculture and Life Sciences
North Carolina State University

As a William Neal Reynolds Distinguished Professor of Plant Pathology and Director of the North Carolina Agricultural Research Service, Dr. Lommel’s research focuses on plant virus pathogenesis, evolution, and taxonomy.

SIMON TRIPP

Senior Director
TEConomy Partners

Simon designs and manages research, strategy, and implementation projects for business development. He has extensive experience in cluster-based and technology-based economic development, leading major state and regional projects across the globe.

Chuck Mummert
Principal
cmummert@flad.com

Chad Zuberbuhler
Principal
czuberbuhler@flad.com

Flad.com