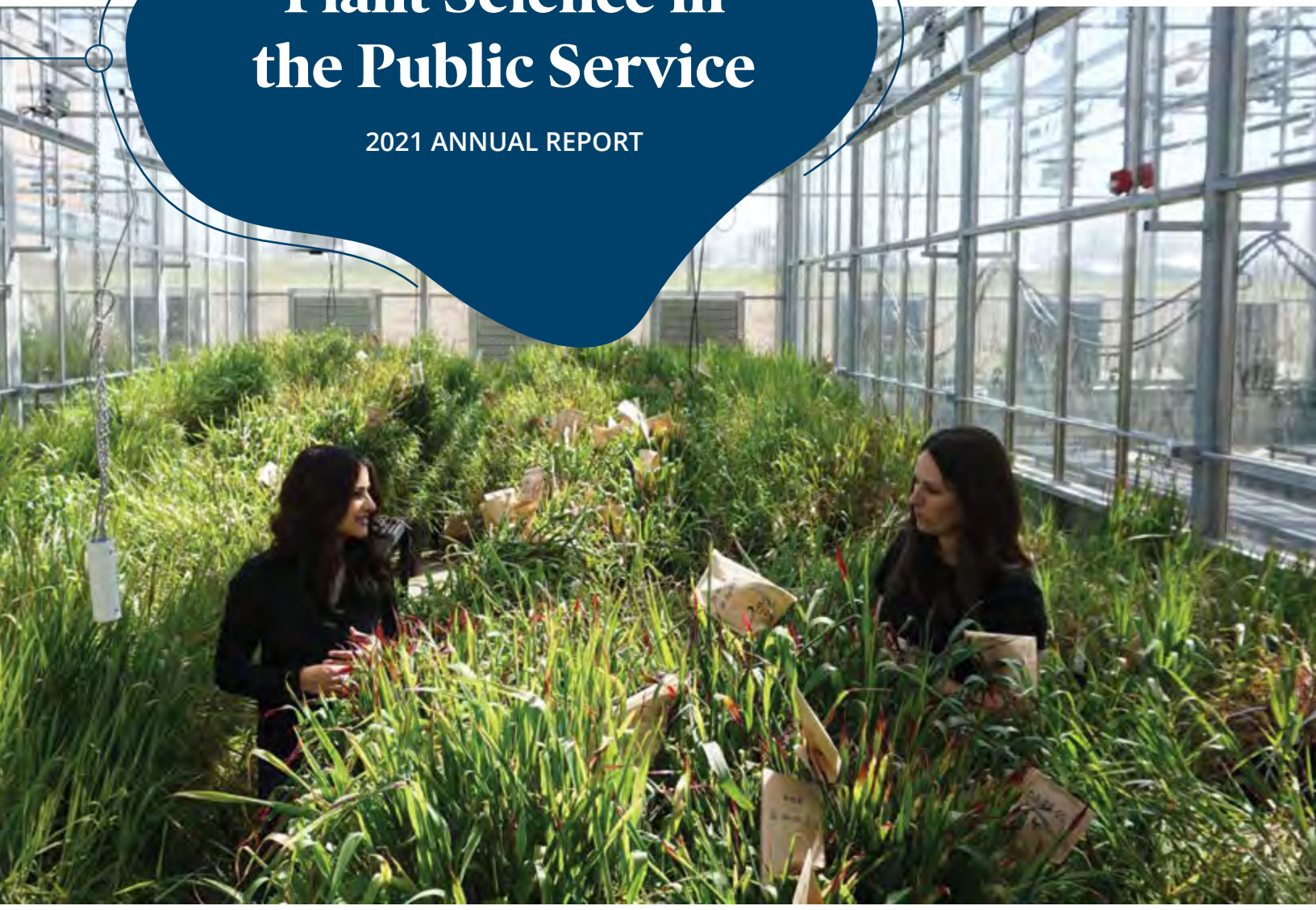
# Plant Science in the Public Service

2021 ANNUAL REPORT



DONALD DANFORTH
PLANT SCIENCE CENTER

# Plant Science in the Public Service

**Our founder, Bill Danforth, believed that people united for a common purpose could do great things—and that plant science could solve humanity's greatest challenges. People and plants working together.... but mostly people. In 2021, the people of the Danforth Center community proved resilient and diligent in the pursuit of life-changing, world-saving science. This groundbreaking work is helping to feed people sustainably, preserve the planet, and catalyze innovation and opportunity.**

## Contents



## Letter from the Chair

Hunger, a major focus of the Danforth Center mission, is on the rise. Nearly one in every three people worldwide did not have access to adequate food in 2020, a startling increase brought about by the disruptions of the pandemic.

The Danforth Center community of scientists is passionate about food security. They also care deeply about environmental sustainability, which makes sense because climate change is also a leading cause of food insecurity. As you will read in these pages, in 2021, new and ongoing work at the Danforth Center is already having an impact. Insect-resistant cowpea is now in farmers' hands in Nigeria, and other new crops and technologies are harnessing plants' innate powers to create a better future for us all.

And this drive toward innovation also yields dividends for our region. Danforth Center spinout Benson Hill went public in 2021 and today employs more than 450 workers here. A cutting-edge new greenhouse is attracting more companies, and a turn toward geospatial collaboration could be another gamechanger for our local economy.

The outcomes of 2021 show the Danforth Center approach is working and our team is strong. Thank you for your support and interest in the work of the Danforth Center.

Todd R. Schnuck

## Letter from the President

Survey after survey of Danforth Center community members reveals the same thing: We really identify with our mission *to improve the human condition through plant science*. This translates into an overwhelming desire to see meaningful outcomes from our work. I am thrilled to share the impact we made in 2021.

Our scientific teams set a high-water mark for numbers of publications of discoveries in 2021, and it was our best year ever for winning competitive grants to support our research efforts. With support from Phil and Sima Needleman, we initiated a new Center of Excellence (SINC Center) to harness the power of plants and microbes to significantly lower greenhouse gas emissions from agriculture. We set in place new mechanisms to move discoveries from the lab to the marketplace with implementation of a start-up initiative, with the goal of accelerating new company formation based on our technologies. And our committed efforts to deliver improved crops for smallholder farmers took major steps forward with commercialization of insect-resistant cowpeas in Nigeria and approval of virus-resistant cassava in Kenya.

In addition, the Danforth Center was selected as one of the "Top Places to Work" in the annual survey of hundreds of organizations in the region. This recognition reflects the incredible people at the Danforth Center, our generous supporters, and our collective purpose to deliver on our mission.

James C. Carrington

# Our People

## Principal Investigators

Our principal investigators lead cutting-edge research in plant biology and genetics to create solutions for food security and environmental challenges. In 2021, the Danforth Center welcomed Dr. Tessa Burch-Smith from University of Tennessee, Knoxville, and Dr. Nadia Shakoor, formerly of the Mockler lab.

**Doug Allen, PhD**
*Member and USDA Research Scientist*
The Allen lab uses isotopes combined with computational methods to assess plant growth and productivity at the molecular level that contribute to enhanced biomass production and value-added seed compositions.

**Rebecca Bart, PhD**
*Associate Member*
The Bart lab combines genetics with molecular and computational biology to study host-microbe interactions in important crops including cassava, sorghum, and cotton.

**Ivan Baxter, PhD**
*Member*
The Baxter lab uses advanced technologies to understand the diverse ways plant genetics interacts with the environment to enable growth.

**Tessa Burch-Smith, PhD**
*Associate Member*
The Burch-Smith lab studies communication between plant cells and between plants and viruses to improve crop yield and resistance to infection.

**Kristine Callis-Duehl, PhD**
*Sally and Derick Driemeyer Director of Education Research and Outreach*
The Education Research & Outreach lab studies how to effectively engage students in authentic STEM research at all grade levels, K-16, in formal, informal, and virtual learning environments in an effort to recruit, train, and retain the next generation of diverse STEM and agtech scientists and leaders in St. Louis and around the world.

**James Carrington, PhD**
*President and CEO*
The Carrington lab focuses on how plants respond to viruses, mechanisms of epigenetics, and how crops can be improved to increase productivity.

**Kirk Czymmek, PhD**
*Director, Advanced Bioimaging Laboratory*
The Czymmek lab uses advanced imaging approaches to understand the inner workings of plants, microbes, and their interactions with each other and the environment.

**Bradley Evans, PhD**
*Director, Proteomics and Mass Spectrometry*
The Evans lab uses high-performance mass spectrometry, proteomics, and metabolomics for connecting molecular phenotypes with the macroscopic form and function of organisms.

**Andrea Eveland, PhD**
*Associate Member*
The Eveland lab uses experimental and computational approaches to investigate the regulation of architecture traits and yield potential in cereal crops.

**Noah Fahlgren, PhD**
*Director, Data Science Facility*
The Data Science team is a computing and data analytics hub that develops and deploys technologies in computational biology, computer science, mathematics, and statistics to accelerate discoveries from data and models in plant science.

**Malia Gehan, PhD**
*Assistant Member*
The Gehan lab develops high-throughput phenotyping approaches to study mechanisms of crop resilience under temperature stress.

**Elizabeth Kellogg, PhD**
*Member, Robert E. King Distinguished Investigator*
The Kellogg lab studies genomes, growth, and development of sorghum, maize, and their wild relatives, using biodiversity research to make ecosystems and agriculture more sustainable.

**Toni Kutchan, PhD**
*Member, Oliver M. Langenberg Distinguished Investigator, VP for Research*
The Kutchan lab studies the production of the anticancer compound cyclopamine in corn lily, the modification of plant medicinals by the soil microbiome, and the oilseed crop camelina as a source of renewable fuel.

**Mao Li, PhD**
*Senior Research Scientist and Principal Investigator*
The Li lab develops mathematical methods, models, and computational tools to extract and analyze comprehensive plant morphological features from 2D and 3D imaging data to fully utilize new technologies and accelerate biological discoveries.

**Donald MacKenzie, PhD**
*Executive Director, Institute for International Crop Improvement*
Dr. MacKenzie leads the Institute for International Crop Improvement (IICI). The IICI is committed to delivering precision genetics technologies to meet the most significant food and nutritional security challenges faced by smallholder farmers everywhere.

**Blake Meyers, PhD**
*Member and Professor, Division of Plant Science and Technology, University of Missouri – Columbia*
The Meyers lab uses experimental and computational approaches to study plant reproduction and fertility to enhance yield gains in crop plants.

**Allison Miller, PhD**
*Member and Professor of Biology, Saint Louis University*
The Miller lab explores how long-lived plants respond to dynamic environments, with the goal of developing perennial crops that support ecologically sustainable agricultural systems.

**Todd Mockler, PhD**
*Member, Geraldine and Robert Virgil Distinguished Investigator*
The Mockler lab uses genomics, high-resolution phenotyping, and computational biology to understand plant responses to environmental stresses to improve productivity in food and energy crops.

**Dmitri Nusinow, PhD**
*Associate Member*
The Nusinow lab focuses on finding new genes that have the potential to increase productivity in response to daily and seasonal changes in light and temperature.

**Sona Pandey, PhD**
*Member*
The Pandey lab uses molecular, biochemical, and functional studies to understand the mechanisms of stress tolerance and yield improvement in plants by heterotrimeric G-proteins.

**Dilip Shah, PhD**
*Associate Member*
The Shah lab investigates modes of action of antifungal plant defensins and defensin-like peptides to enable development of fungal disease resistant crops for yield protection.

**Nadia Shakoor, PhD**
*Senior Research Scientist and Principal Investigator*
The Shakoor lab develops and uses integrated digital agriculture systems to study the effects of phenotype, genotype, and the environment on crop productivity and resiliency.

**R. Keith Slotkin, PhD**
*Member and Associate Professor, Division of Biological Sciences, University of Missouri – Columbia*
The Slotkin lab seeks to uncover how plants determine which regions of their genomes should be expressed, which regions should not be expressed, and to create new technologies in plant biology.

**Nigel Taylor, PhD**
*Associate Member, Dorothy J. King Distinguished Investigator*
The Taylor lab applies biotechnology to enhance disease and pest resistance, and to improve nutritional quality of the African staple crop, cassava. Activities include all steps from the laboratory and greenhouse to field trials, regulatory approvals, and the deployment systems required to deliver these products to benefit smallholder farmer households in East and West Africa.

**Christopher Topp, PhD**
*Associate Member*
The Topp lab deploys X-ray-based imaging and analysis of corn and other root systems to develop more robust and sustainable crops.

**James Umen, PhD**
*Member, Enterprise Rent-a-Car Institute for Renewable Fuels and Joseph Varner Distinguished Investigator*
The Umen lab investigates the genetics and cell biology of green algae to enable development of sustainable sources of biofuel and other high-value compounds.

**Veena Veena, PhD**
*Director, Plant Transformation Facility*
The Veena lab explores novel approaches for plant genetic engineering and genome modification technologies to enable plant biology research for crop improvement.

**Xuemin (Sam) Wang, PhD**
*Member and E. Desmond Lee Professor, University of Missouri – St. Louis*
The Wang lab focuses on lipid signaling in plant response to environmental changes, including nitrogen/phosphorus/water deficiencies; and regulation of lipid metabolism and vegetable oil production.

**Bing Yang, PhD**
*Member and Professor, Division of Plant Sciences, University of Missouri – Columbia*
The Yang lab uses enhanced genetic and molecular tools to increase the understanding of plant responses to biotic and abiotic stresses that can be coupled with enabling technologies to develop improved crops.

**Ru Zhang, PhD**
*Assistant Member*
The Zhang lab studies how photosynthetic cells, especially photosynthesis, responds to high temperatures in order to engineer more heat-resistant crops and algae for improved food and biofuel production.

# Now in Farmers' Hands

**Crop improvement is challenging and many years long. Success is not guaranteed. But improved crops are a long-term gamechanger in the life of a subsistence farmer and her family and community. As the climate continues to change, Danforth Center scientists are racing on the journey from crop development to distribution and real-world impact.**



*Cowpeas are a crucial source of dietary protein for more than 200 million people. In 2021, an improved pest-resistant variety was distributed to farmers in Nigeria.*

"All the seed was sold within the first week. It's a tremendous indicator of how smallholder farmers are looking forward to new technology and are ready to adopt it."

***-Donald MacKenzie, PhD, Executive Director, Danforth Center IICI***

## History Made in Nigeria

*PBR Cowpea the First Ever Publicly Developed Biotech Food Crop in Africa*

In a historic first, pod-borer-resistant (PBR) cowpea has been released to farmers in Nigeria. Cowpeas (black-eyed peas) are a staple for more than 200 million people, but can be devastated by the pod borer insect. The new variety is insect-resistant and marks the first commercial launch in Africa of a wholly public-sector developed biotech food crop—a major achievement in delivering plant science innovation to smallholder farmers.

**Don MacKenzie, PhD**, executive director of the Danforth Center's Institute for International Crop Improvement (IICI), was present for the seed release at a special ceremony in Kano, Nigeria. The IICI was instrumental in securing final approval from the Nigerian government. The Danforth Center is partnering with the Nigerian National Agricultural Seeds Council to ensure consistent high-quality, high-yield seeds in order to achieve ambitious goals for scaling and distribution. The Center anticipates regulatory applications in Ghana and Burkina Faso soon and is already working with Nigerian farmers to determine the next generation of cowpea innovations.

*Danforth Center's Don MacKenzie attends the PBR cowpea seed release in Kano, Nigeria in June 2021. The Center is partnering to ensure high-quality seed production. (MOU signing at far left).*

*Cassava is a staple crop for more than 500 million people in Africa. The Danforth Center's VIRCA Plus disease-resistant cassava entered the final phase of approvals in Kenya in 2021.*

The **Institute for International Crop Improvement** translates plant science discoveries and technology into food security solutions for the people who need them most.

*Vitamin A deficiency is the leading preventable cause of childhood blindness worldwide. In 2021, Golden Rice with vitamin A was approved for commercial propagation in the Philippines.*

"With biotechnology, we can improve the productivity of crops grown by smallholder farmers, empowering them to improve their livelihoods and their lives."

***-Nigel Taylor, PhD, Dorothy J. King Distinguished Investigator, director of VIRCA Plus***

## Healthy Roots

*Improved Cassava Clears Important Hurdle in Kenya*

In another historic milestone, VIRCA Plus disease-resistant cassava was approved in 2021 for national performance trials in Kenya, the final test of new varieties before they can be registered and released to farmers. Cassava is a staple crop for more than 500 million people in Africa, but it is threatened by cassava brown streak disease, which causes devastating losses of up to 100%. The approved variety shows high and stable defense against the disease after evaluation for more than five years. Breeders in Kenya and Uganda have crossed the approved disease-resistant line with local cassava varieties to produce a range of new varieties suited to farmer and consumer needs. VIRCA Plus is an international project led by Danforth Center scientist **Nigel Taylor, PhD**. The project is also field testing the improved varieties and pursuing approval in Rwanda.

## Finish in Sight

*Golden Rice a Step Closer to Market in Philippines*

A major milestone has been reached in the journey toward improving the health of millions of people: Golden Rice has been approved for commercial propagation in the Philippines. This nutritionally enhanced crop was developed to help treat vitamin A deficiency, the leading preventable cause of childhood blindness worldwide. Currently, eight of ten Filipino households do not meet daily minimums for vitamin A. If approved, Golden Rice could become part of a suite of interventions. The Danforth Center IICI is leading the regulatory application process and is also pursuing approval in Bangladesh.

**THANKS TO OUR PARTNERS**

***Each of these projects is a multinational partnership with funding from governmental agencies, private and corporate foundations, and donors like you. To learn more, visit danforthcenter.org.***





# Plants are powerful.

In the fight against climate change, plants are a powerful ally. Plants naturally remove carbon from the air and store it underground. Their roots prevent soil erosion. Their diverse ecosystems offer benefits we don't fully understand. Danforth Center scientists are working to unlock these mysteries and to improve plants to preserve and renew our planet.

*Observing root performance as part of SINC Center research. The new center of excellence seeks to improve plants' nitrogen uptake and use efficiency to diminish the need for synthetic fertilizer.*

# Firing on All (Green) Cylinders

*Danforth Center Scientists Launch Numerous Collaborations to Combat Climate Change*

Climate change is the biggest challenge we face. Farmers have a major role to play in solving the climate crisis: they need improved varieties, improved techniques and technology. Science to address challenges at the nexus of agriculture and the environment has never been more important, and that's where the Danforth Center comes in. The year 2021 saw the launch of major new initiatives to harness the power of plants in the fight against climate change.

## LESS FERTILIZER FOR A BETTER ENVIRONMENT

Modern farmers rely heavily on synthetic nitrogen fertilizer, but this practice is polluting our air and water and contributing to climate change. The new **Subterranean Influences on Nitrogen and Carbon** (SINC) **Center** is dedicated to developing technology that will reduce the amount of synthetic nitrogen fertilizer used in agriculture without sacrificing crop yield. Under the leadership of Principal Investigator **Becky Bart, PhD**, the SINC Center aims to unlock the secrets of the plant-microbe-environment interaction to improve plants' use of atmospheric nitrogen, thus diminishing the need for fertilizer. *SINC was made possible with a founding gift from Phil and Sima Needleman and with support from Bank of America.*

"Climate change is the biggest grand challenge facing our generation. The SINC Center is an opportunity to take science, apply it to a problem, and create real solutions."

***- Becky Bart, PhD***
***Danforth Center***
***Principal Investigator***

## PUTTING DOWN (NEW) ROOTS

Human activity has impacted 75% of the world's land, contributing to the loss of nearly 50% of the world's topsoil. The **New Roots for Restoration Biology Integration Institute** seeks to find ways to restore agricultural and natural ecosystems by discovering and integrating knowledge about roots, soil, and microbiome communities. Danforth Center Principal Investigator **Allison Miller, PhD**, is the director of this nine-institution collaboration. By increasing our understanding of natural ecosystems, the New Roots Institute can harness wild perennial plants to help heal the planet while feeding the world with resilient agriculture. *New Roots is funded by the National Science Foundation.*

## FOOD CROPS TO FIGHT CLIMATE CHANGE

All plants naturally sequester carbon. What if we could enhance that ability so that we can feed ourselves and help the Earth at the same time? Danforth Center Principal Investigator **Nadia Shakoor, PhD**, is leading an initiative to breed a better sorghum for capturing and storing carbon from the atmosphere. Why sorghum? It's one of the top five cereal crops in the world and is naturally among the most heat- and drought-tolerant of all grains. *Improved sorghum is funded by Salk Harnessing Plants Initiative with support of the Bezos Earth Fund and Sempra Energy.*

## IMPROVED TECHNIQUES

Cover crops are plants grown between cycles of cash crops. They offer many "ecosystems services": they suppress weeds, reduce loss of soil, decrease fertilizer runoff, reduce flooding, and store carbon. Once common, they fell out of use with the advent of synthetic fertilizer and suffered from lack of improvement. Danforth Center Principal Investigators **Chris Topp, PhD**, and

*New Roots project field site. Allison Miller, PhD, is leading the collaboration to deploy knowledge about natural ecosystems to restore degraded landscapes.*

*Sorghum, a drought-tolerant ancient grain. Nadia Shakoor, PhD, is working to improve sorghum for enhanced carbon capture to combat climate change.*

*The Topp lab is working to improve cover crops, which enrich soil and prevent erosion, as another tool in the fight against climate change.*

The Enterprise Rent-A-Car Institute for Renewable Fuels explores the potential of oilseed crops, algae, and bioenergy grasses to sustainably replace fossil fuels.

*Malia Gehan, PhD, and research scientist Jose Tovar, PhD, with quinoa in the greenhouse. The Gehan lab is working to unlock crop resilience to heat and drought—traits needed in a changing climate.*

**Dmitri A. Nusinow, PhD**, are both working to provide improved varieties and a menu of options for farmers. *Cover crops receive support from IN² (see page 12) and from the Danforth Center's donor-supported Innovation Fund.*

### IMPROVED FOUNDATIONS

Danforth Center researchers undertake broad research aimed at providing crucial knowledge for crop breeding in a changing climate. Principal Investigator **Keith Slotkin, PhD**, leads a collaboration with Washington University to reveal the impacts of our climate's increasing carbon dioxide levels on plants over parent-to-offspring generations. In 2021, his team also published their findings on the causes behind gene silencing, a major hurdle for crop breeders. Principal Investigator **Malia Gehan, PhD**, and her lab focuses on abiotic stresses, such as heat and drought, to make plants more resilient—and they are developing the cutting-edge data science and software tools needed to speed up analysis. **Xuemin (Sam) Wang, PhD**, and his team this year published the pathways to more lipid storage, a crucial component of bioenergy production. The lab of **Chris Topp, PhD**, also published their three-dimensional X-ray microscope method, which has enabled their pioneering study of living plant roots.

Arabidopsis thaliana, *a tiny and fast-growing member of the mustard family often used in research. The lab of Sam Wang, PhD, uses the plant to discover crucial aspects of lipid metabolism needed for development of bioenergy.*

**YOU ARE HELPING**

***These projects to preserve our planet are funded through governmental grants, corporate support, and by donors like you. Thank you.***






# Spinout Success

**The Danforth Center was founded *to improve the human condition through plant science*. Our discoveries feed people while preserving the planet, and if done right, they enhance the region. Our innovation ecosystem, leading-edge infrastructure, and top-tier talent attract companies and investors from around the world. And our spinouts employ local workers and speed new ideas to market.**

*Previous page: Todd Mockler and Matt Crisp, co-founders of the Danforth Center spinout Benson Hill, which went public in 2021.*

*Danforth Center's partnership with Wells Fargo Innovation Incubator is helping to speed sustainable ag. This year's focus was indoor growing.*

"The agtech story in St. Louis is one of our best stories to tell... and we are not done telling it."

***- Stephanie Regagnon, Executive Director of Innovation Partnerships***

# A New Public Company

*Benson Hill Goes Public as Unicorn, Employs Hundreds*

Benson Hill, the food-tech innovation company co-founded by Danforth Center Principal Investigator **Todd Mockler, PhD**, and Matt Crisp in 2012, went public in 2021 after merging with Star Peak Corp. II, a special-purpose acquisition company (SPAC). At the time, the pre-money valuation was $1.35 billion, making Benson Hill only the second ever "unicorn," a privately held startup valued at over $1 billion, in St. Louis history. Today Benson Hill is acquiring strategic targets toward vertical integration, with a focus on plant-based proteins, and employs more than 450 people at their St. Louis headquarters. Dr. Mockler credits the Danforth Center's "culture of innovation" as a big part of the Benson Hill success story.

# Jumpstart Sustainable Ag

*Wells Fargo IN² 2021 Cohort Focuses on Indoor Ag*

Danforth Center scientists are helping to speed promising tech to market through an ongoing partnership with Wells Fargo **Innovation Incubator (IN²)**. This sustainable agriculture initiative pairs innovative agtech startups with Danforth Center principal investigators to accelerate the companies' progress. The third agtech cohort focused on indoor agriculture. The five companies from around the country announced in 2021 were: Atlas Sensor Technologies, GrowFlux, Motorleaf, New West Genetics, and Sunpath.

*Agtech and geospatial combine in the new CATALST program, a collaboration with BioSTL and T-REX funded by the US Department of Commerce.*



*The Michael W. and Quirsis V. Riney Family Greenhouse opened in 2021. The cutting-edge facility's tall ceilings and light controls provide new research opportunities.*

# Room to Grow

*New Riney Family Greenhouse Provides for New Possibilities*

The new **Michael W. and Quirsis V. Riney Family Greenhouse** opened in 2021, providing much-needed space for Danforth Center researchers and for agtech and biotech startups in our region. The new range features 20-foot ceilings to allow researchers to grow tall crops like maize and sorghum to their natural height. An automated blackout system better accommodates short-day crops like soybeans, cotton, and rice. These and other high-tech features enable our scientists and partners to do remarkable things for the world. *The greenhouse was made possible by leadership donors Quirsis and Michael Riney and contributors to the Danforth Center Innovation Fund.*

# Mapping the Future

*New Grant a CATALST for Change*

In an exciting new fusion of agtech and geospatial science—two areas in which the St. Louis region is a recognized leader—the Danforth Center received a grant in 2021 to establish a new **Center for AgTech and Applied Location Science and Technology (CATALST)**. CATALST is part of the US Department of Commerce's "Build to Scale" program, which supports technology entrepreneurship, and represents a partnership of the Danforth Center, BioSTL, and T-REX. The funding supports testing and validation partnerships, training, and internships.

The **39 North** innovation community is a 600-acre district anchored by the Danforth Center, BRDG Park, Helix, Yield Lab, Bayer Crop Science, and Benson Hill. Visit 39northstl.com.

**SEEING THINGS DIFFERENTLY**

*An AgTech NEXT™ Focused on Climate Change*

In 2021, AgTech NEXT, the Danforth Center's agtech innovation summit, featured three days of presentations and roundtables focused on climate change with sessions on carbon and environmental markets, geospatial, and food security. Gates Ag One CEO Joe Cornelius, PhD, delivered a keynote address. The virtual conference was free to the public with more than 1,800 attendees from 46 countries (agtechnext.org).

Empower Students

# Superheroes for Science

**Education is key to advancement. High-quality STEM education, where children are empowered to see themselves as scientists, can open the door to scientific careers that change lives. The Danforth Center Education Research and Outreach lab is partnering around the country to bring plant science into the classroom—and scientists into the field.**



## ARE You a Scientist?

*Authentic Research Experiences (AREs) Bridge Urban-Rural Divide*

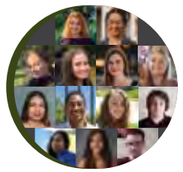
The Danforth Center offers multiple Authentic Research Experiences (or AREs) for local students. These courses get students involved with actual research happening at the Danforth Center, empowering students to see themselves as scientist collaborators. In 2021, this program received a grant from the USDA to create a partnership bridging the urban-rural divide. Student scientists from the St. Louis area participating in the brand-new Jackie Joyner-Kersee Food, Agriculture, & Nutrition Innovation Center are being paired with students at the University of Illinois Extension Center in Waterloo, Illinois, to learn about bioengineering and plant monitoring technology to study the impacts of climate change on agriculture.

*At far left: Graduate student Taylor Harris (left) and Technical Writer Lisa Walsh (right) with Principal Investigator* ***Kris Callis-Duehl, PhD****, Sally and Derick Driemeyer Director of Education Research and Outreach.*


*Students at the Jackie Joyner-Kersee Center in East St. Louis participate in the Authentic Research Experience "Plants Fight Back," which pairs students with actual researchers and projects at the Danforth Center.*

### 2021 WHD FELLOW

Final year PhD student at Ohio Statue University **Diego Cuerda-Gil** was named the 2021 William H. Danforth Plant Science Fellow. The fellowship was endowed in honor of Dr. Danforth by Dr. P. Roy and Diana Vagelos and supports outstanding PhD students whose research demonstrates great promise for advancing plant science. Cuerda-Gil was a member of the Slotkin lab and studied the role of small RNA in gene silencing. Diego is now a post-doc for genome editing at Bayer Crop Science.



### 2021 REU INTERNS

Cancelled in 2020 for the first time in its nearly 2-decade history, the National Science Foundation Research Experience for Undergraduates (REU) returned in 2021. The Danforth Center welcomed 13 interns from around the country for a first-ever hybrid program that included a variety of workshops, trainings, and lab opportunities. The program was managed by Principal Investigators **Sona Pandey, PhD**, and **Ru Zhang, PhD**, with support from Cathy Kromer and Judy Mitchell.

### @REAL_TIME_SCIENCE

Science education can take many avenues. **Katie Murphy, PhD**, a postdoc in the Allen and Gehan labs, wants to show that "science is for everyone," so she documents her work on Instagram and TikTok under the handle @Real_Time_Science. Her trendy, entertaining posts show off experiments, gear hacks, and scientist-life humor. *The Washington Post* featured Dr. Murphy and her outreach in a 2021 article.

# Supporters

## Friends Committee

*The Danforth Center is grateful to the Friends Committee, which promotes the work of the Center and grows membership and financial support through annual giving.*

2021 FRIENDS COMMITTEE

Tim Rodgers, *Chair*
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John Rowe

"In 2021, the Friends Committee made significant inroads in four key areas identified during the first year of the pandemic, to improve our reach and better engage the public during a second year of virtual events."

*- Tim Rodgers,*
*Chair, Friends Committee*



In 2021, Conversations continued to be virtual. Both events were recorded and may be viewed at **danforthcenter.org**.

## Conversations Series

Organized by the Friends Committee since 2003, Conversations is a series of free public events that provide the opportunity to learn about the world of the Center and the partners who help to sustain it. In 2021, Conversations continued with two virtual events.

ACHIEVING THE IMPOSSIBLE | MAY 13

More than 215 unique households joined the conversation with **Dr. Patrick O. Brown**, founder and CEO of Impossible Foods, maker of the Impossible Burger. During the discussion Brown presented evidence that animal-based meat production is damaging our planet and discussed his company's plant-based meat as part of the solution. **Stephanie Regagnon**, the Danforth Center's executive director of innovation partnerships, moderated.

FROM THE GROUND TO YOUR GUT | AUGUST 19

Within both plants and humans, microbes (bacteria, fungi, etc.) form communities called microbiomes that have a major impact on our health. Biologist and expert on human gut flora, **Dr. Jeffrey Gordon** of Washington University spoke about the "microscopic rulers of your health" with **Becky Bart, PhD**, Danforth Center principal investigator. **Darryl M. Chatman** of the United Soybean Board moderated.

Media sponsorship by:

*Dr. Pat Brown, founder and CEO of Impossible Foods, explained how plant-based meat can lead to a better future at virtual Conversations.*

*Socially distanced: Chatman, Bart, and Gordon in the McDonnell Atrium of the Danforth Center. The discussion about health and the microbiome was livestreamed.*

# Young Friends

*The Young Friends is a group of professionals, 40 and under, who raise friends and funds to advance the mission of the Danforth Center.*

**2021 YOUNG FRIENDS STEERING COMMITTEE**

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Michael Williams
Monica Zawicki

"The Grow Challenge online week of giving was a tremendous success in its second year. Despite the continuing pandemic, Young Friends rose to the challenge in support of a great cause."

***- Davey Oetting***
***Chair, Young Friends***



# Grow Challenge

*The Grow Challenge is a peer-to-peer, online giving campaign founded by the Danforth Center Young Friends in 2020. In 2021, the second annual week of giving started September 27 and raised more than $70,000.*

**2021 DONORS**

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David Alpers
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# Danforth Leadership Council

*The Danforth Center is grateful to the Danforth Leadership Council, a group of prominent St. Louisans interested in the role of plant science in the future of the region.*

**2021 EXECUTIVE COMMITTEE**

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Heather Wood
Amadou Yattassaye
Jackie Yoon

"The Danforth Leadership Council was delighted to host Dr. Susan Hockfield in our return to Seeds of Change. Her message of innovation as the key to solving our greatest challenges was filled with hope."

***- Chris Danforth***
***Danforth Leadership Executive Committee***





## Seeds of Change

Organized by the Danforth Center Leadership Council since 2010, Seeds of Change is a free annual lecture by a renowned thought-leader, designed to inspire and unite people to make positive change. Seeds of Change 2021, "The Age of Living Machines," was held virtually on March 11. Neuroscientist **Dr. Susan Hockfield**, the first woman president of MIT, discussed some of the daunting problems facing our planet and how we can solve them by reinvesting in science and innovation. Danforth Center President and CEO **Jim Carrington, PhD**, moderated the discussion with more than 300 unique logins from 8 different countries tuning in.

*Jim Carrington and Dr. Susan Hockfield, president emerita of MIT, discussed how science and innovation can lead to a better future during virtual Seeds of Change.*

Media sponsorship by:

stl|pr

## Corporate Partners

*The Danforth Center is grateful to companies big and small who play a pivotal role in our mission. Together we are building a brighter future for St. Louis and the world.*

***$100,000+***

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***$50,000+***

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Wednesday Club of St. Louis

# WHD Legacy Society

*The Danforth Center is grateful to donors who have planned for future needs of the Center by designating an estate gift. The Society was renamed in 2021 to memorialize our founder, Dr. William H. Danforth. Learn more: legacy.danforthcenter.org.*

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Mr. & Mrs. John J. Wolfe, Jr.
Aleene Schneider Zawada

† Deceased

*Founding members of the society include Dr. William H. Danforth†, Mary† and Oliver† M. Langenberg, and Mrs. Jefferson L. Miller†.*

"The Danforth Center makes a difference. It helps people around the world and here in St. Louis. It also keeps Bill Danforth's memory alive, and that's important to me."

*- Karen Kalish, WHD Legacy Society Member*

## Legacy Advisory Council

*The Danforth Center is grateful to these legal and financial planning experts who provide assistance with the promotion of planned gifts to the Center.*

Kenneth J. Bower, Clayton Financial Group
Stephen B. Daiker, Harrison & Held, LLP
Matthew G. Perlow, Husch Blackwell LLP
Bud Strong, Husch Blackwell LLP



# Tributes

*The Danforth Center is grateful to donors who choose to honor or memorialize their friends, loved ones, and colleagues with a gift to the Center in 2021. To make a tribute, visit danforthcenter.org/donate.*

***In Honor of...***

**Phillis Adams**
Susan & Robert Levin

**Jane Bond**
Ms. Martha W. Bond
Mr. & Mrs. Lary Bozzay

**Joan & David Culver**
Mr. & Mrs. Sam Pyne

**Keith Duncan**
St. Charles County University of Missouri Extension Council

**Ted Guhr**
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**Timothy Halls**
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Mary Ellen Miller

**Davey Oetting**
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**Leigh Pratter & William Kelly**
Ms. Katherine Bell
Mr. John Friedman

**Janet Sicking**
Ms. Libbyanne Nguyen

***In Memory of...***

**Rosemarie Becker Waldkirch**
Ms. Renee Denlow

**Betsy Boles**
Andrew Boles

**Mrs. Elizabeth Gray Danforth**
Mrs. Charles Guggenheim

**William H. Danforth**
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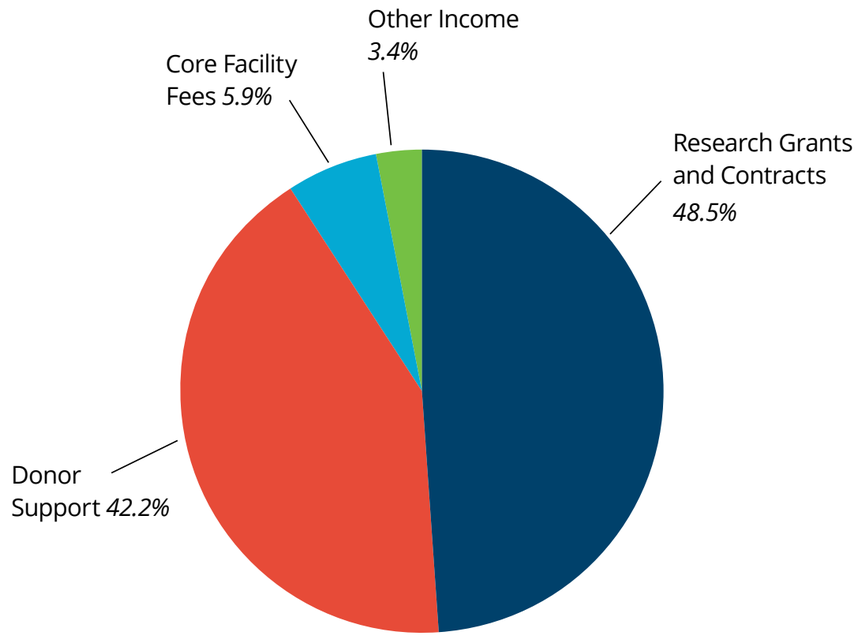
# Selected Financial Data

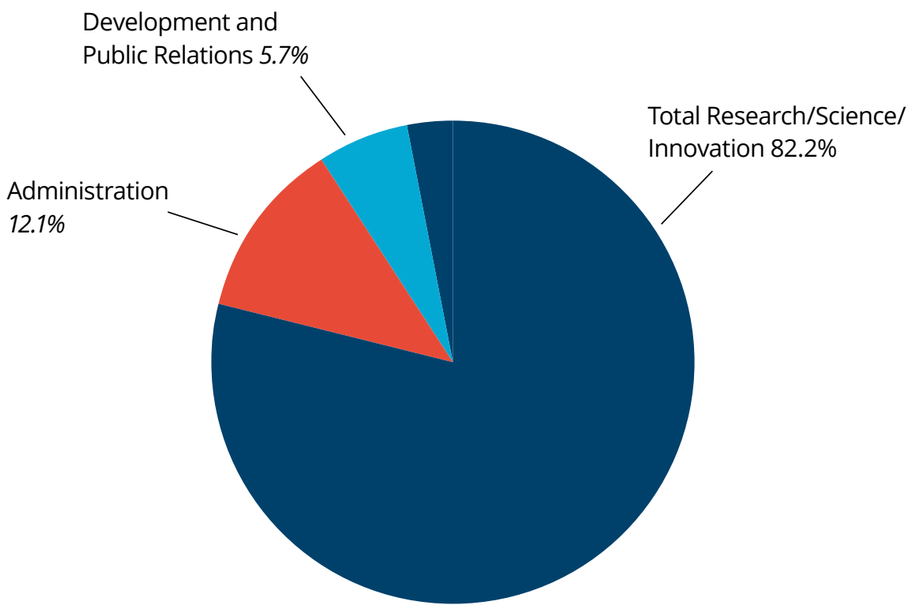
Fiscal Year Ended December 31, 2021
(Unaudited)

| | | | 2021 ($000's) | |
|---|---|---|---|---|
| **OPERATING REVENUES[1]** | | | **Revenue** | **Source %** |
| Research Grants and Contracts | | | $18,176 | 48.5% |
| Donor Support | | | $15,827 | 42.2% |
| Annual Gifts | $2,323 | 6.2% | | |
| Endowment Draw | $13,504 | 36.0% | | |
| Core Facility Fees | | | $2,229 | 5.9% |
| Other Income | | | $1,259 | 3.4% |
| Total Operating Revenues | | | $37,491 | 100% |
| **OPERATING EXPENSES[2]** | | | **Expenditures** | **Expenditure %** |
| Total Research/Science/Innovation | | | $28,943 | 82.2% |
| Administration | | | $4,270 | 12.1% |
| Development and Public Relations | | | $2,038 | 5.7% |
| Total Expenses from Continuing Operations | | | $35,251 | 100.0% |
| **CAPITAL EXPENDITURES** | | | | |
| Lab and Core Facility Equipment | | | $1,768 | |
| Greenhouse Expansion | | | $1,569 | |
| All Other | | | $850 | |
| Total Capital Expenditures | | | $4,187 | |
| **REPLACEMENT AND RENEWAL EXPENDITURES** | | | **$531** | |
| **NON-OPERATING EXPENDITURES** | | | | |
| Debt Principal Payments | | | $459 | |
| **DEPRECIATION EXPENSE** | | | | |
| Depreciation of Fixed Asset | | | $7,139 | |

## 2021 Operating Revenues[1]




## 2021 Operating Expenses[2]




[1] Cash basis and excludes income(loss) on Endowment investments and reimbursement for subcontracted research.
[2] Excludes subcontracted research on Grants and Contracts and Depreciation Expense.

# 2021 By the Numbers

**375**
Danforth Center community members

**29**
countries represented

TOP WORK PLACES 2021 ST. LOUIS POST-DISPATCH

**#1**
midsize STL nonprofit workplace[1]

**30**
principal investigators

**13** disclosures filed
**17** patents pending
**9** patents filed

**87,934**
unique website visitors

**$24.9M**
new grant awards
**(a record!)**

**$377M**
annual economic impact of the Danforth Center campus and Helix

**42**
graduate students

**133**
publications
*(1,700 total since inception)*

**24**
publications by the top-publishing Meyers lab

[1] Voted by employees in St. Louis Post-Dispatch Top Workplace 2021.



# 2021 Leadership

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## Land Acknowledgment

**The Danforth Center acknowledges that it is located on the ancestral and unceded homeland of the Osage people, who were removed unjustly. By recognizing the Osage people and their traditional homeland, we seek to express gratitude for their enduring stewardship of the land. We pay honor and respect to Osage ancestors past and present by committing to building a more inclusive and equitable space for all.**

***In 2021, this statement was added to the Danforth Center website and placed in location with the flag of the Osage Nation in our flag gallery.***

**OUR MISSION**

## Improve the human condition through plant science

As a world center for plant science research, our discoveries will help:

| Feed the hungry and improve human health | Preserve and renew our environment | Enhance the St. Louis region |
|---|---|---|

DONALD DANFORTH
PLANT SCIENCE CENTER

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St. Louis, Missouri 63132
danforthcenter.org