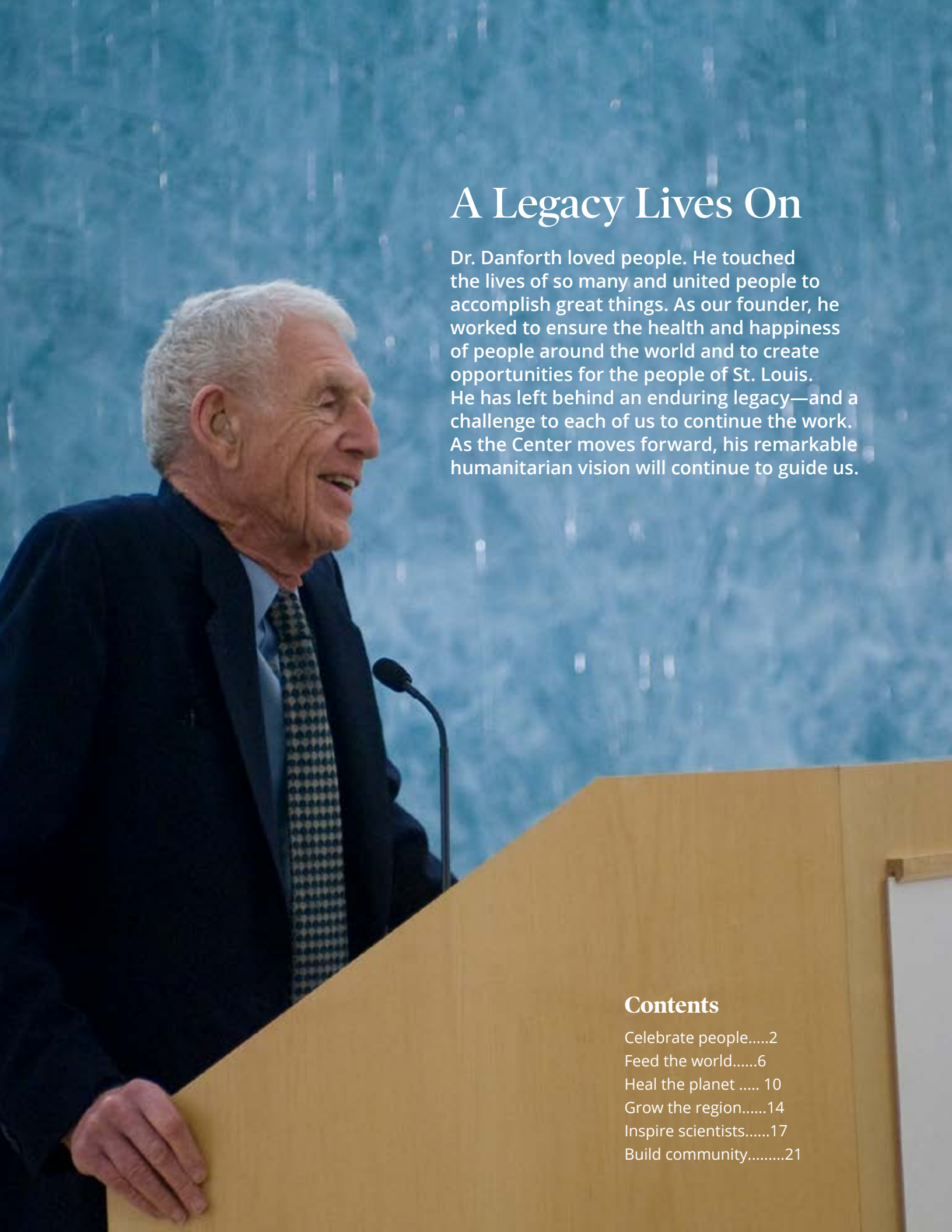




DONALD DANFORTH
PLANT SCIENCE CENTER

A Community Responds in a Pandemic Year

2020 ANNUAL REPORT



A Legacy Lives On

Dr. Danforth loved people. He touched the lives of so many and united people to accomplish great things. As our founder, he worked to ensure the health and happiness of people around the world and to create opportunities for the people of St. Louis. He has left behind an enduring legacy—and a challenge to each of us to continue the work. As the Center moves forward, his remarkable humanitarian vision will continue to guide us.

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Letter from the Chair

The year 2020 provided many of us with time for reflection. The pandemic, which continues even now, shined a light on the impact our actions have on others. It also called many to consider what we can do to improve the lives of those around us. It is something our Founding Chair, Dr. William H. Danforth, dedicated his life to doing.

We were deeply saddened in 2020 by the loss of Dr. Danforth. Bill was a shining example of selflessness, humility, and dedication to the greater good. He believed passionately in people, especially the people of St. Louis. He once said, "Our people are willing to work together for a common good. That's a rare plus not present in every community." With the support of our donors, partners, scientific community, and the public, the Danforth Center has been able to continue progress, even during a tumultuous year.

As you will read in these pages, important scientific discovery continued, and a new research field site opened. The new EDGE@BRDG building was completed, and Benson Hill moved in. The greenhouse range expansion got underway and is soon to be opened as the new Michael W. and Quirsis V. Riney Family Greenhouse. The Danforth Center continues to help renew and strengthen our local economy.

We are grateful for your support and interest, and we invite you to learn more about the work of the Danforth Center.



A handwritten signature in black ink that reads "Todd R. Schnuck".

Todd R. Schnuck

Letter from the President

To say that 2020 was a notable year would be a monumental understatement. Yes, we confronted a global pandemic that caused countless challenges, but that was only part of the story. Despite the disruptions and unprecedented circumstances, the Danforth Center had one of its most productive years ever! Though we shifted much work to home offices and kitchen tables, we maintained more grant-funded research activity, and published more scientific discoveries, than in any prior year. We established new ways to reach the public through creative outreach and built new greenhouse facilities on our campus. We celebrated the opening of the EDGE@BRDG building, now headquarters for Benson Hill, on our campus. And we implemented better ways to grow as a more diverse and inclusive community.

None of this happened by chance, but rather by the Center community working collaboratively, inventively, and with purpose to deliver on our mission to *improve the human condition through plant science*. These achievements were made possible through remarkable financial support from the Center's committed friends, who despite the turbulence of the past year, understood that our work is more relevant now than ever before.

Our Danforth Center community of scientists, staff, and supporters gets better every year. Thank you for joining us!



A handwritten signature in black ink that reads "James C. Carrington".

James C. Carrington

A photograph of three scientists in a greenhouse. A woman with short brown hair, wearing a teal shirt and a smartwatch, is in the foreground, carefully examining a green plant. Behind her, a woman with dark curly hair, also in a teal shirt, looks on. To the right, a man with a beard is partially visible, looking towards the plant. The background is filled with lush green foliage.

Science in a Pandemic

Despite facing a whirlwind of challenges unlike any faced before, Danforth Center principal investigators accomplished remarkable things this pandemic year. Together with the talented scientists in their labs, they made breakthrough discoveries and publications, landed significant grants, and achieved national recognition for their work. They are the solution-creators of our Center, our region, and our world.



A screengrab of the Danforth Center's first online Scientific Seminar after the pandemic forced an end to in-person events.



Principal Investigator Elizabeth Kellogg, PhD, was elected this year to the most prestigious scientific group in the US, the National Academy of Sciences.

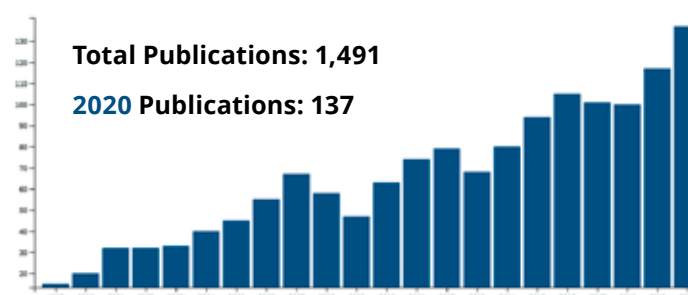
Making History

The Danforth Center is a scientific institute with a mission to improve the human condition through plant science. Our mission demands constant innovation and nimble responsiveness to emerging threats within the plant and agtech world. When lab access was limited by the threat of COVID-19, scientists pivoted to publish the greatest one-year total of articles in Danforth Center history. (See publication highlights on page 5.)

Onsite work continued, with Minimum Basic Operations (MBO) teams in place to maintain essential experiments. Learning opportunities, like the Center's weekly Scientific Seminar, transitioned rapidly from in-person to online, and the new virtual format allowed expanded participation from institutions across the country.



With great, but virtual, celebration, **Dr. Elizabeth "Toby" Kellogg**, the Danforth Center's Robert E. King Distinguished Investigator, was elected to the National Academy of Sciences (NAS). She joins Danforth Center President Jim Carrington in this highest honor for scientists in the US. Kellogg is one of the foremost experts on grasses, and her election to the NAS signifies the importance of her contributions to our world.



With lab work curtailed by the pandemic, Danforth Center researchers pivoted to publish a record number of scientific articles.

Principal Investigators



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.



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 Sciences, 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.



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 has advanced virus-resistant cassava into regulatory field trials in East Africa as a critical step toward delivering enhanced planting materials to farmers.



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.



Sam Wang, PhD

Member and E. Desmond Lee Professor, University of Missouri – St. Louis

The Wang lab focuses on lipid metabolism and signaling in plant response to nitrogen/phosphorus/water deficiency and seed 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.

2020 PUBLICATION HIGHLIGHTS

The year 2020 saw more Danforth Center scientific publications than ever before: 137 in total. *Here are just a few highlights.*

Antunez-Sanchez J, Naish M, Ramirez-Prado JS, Ohno S, Huang Y, Dawson A, Opasathian K, Manza-Mianza D, Ariel F, Raynaud C, Wibowo A, Daron J, Ueda M, Latrasse D, Slotkin RK, Weigel D, Benhamed M, Gutierrez-Marcos J. A new role for histone demethylases in the maintenance of plant genome integrity. *Elife*. 2020 Oct 27;9:e58533. doi: 10.7554/eLife.58533.

AuBuchon-Elder T, Coneva V, Goad DM, Jenkins LM, Yu Y, Allen DK, Kellogg EA. Sterile Spikelets Contribute to Yield in Sorghum and Related Grasses. *Plant Cell*. 2020 Nov;32(11):3500-3518. doi: 10.1105/tpc.20.00424. Epub 2020 Sep 1.

Herron SA, Rubin MJ, Ciotir C, Crews TE, Van Tassel DL, Miller AJ. Comparative Analysis of Early Life Stage Traits in Annual and Perennial Phaseolus Crops and Their Wild Relatives. *Front Plant Sci*. 2020 Mar 10;11:34. doi: 10.3389/fpls.2020.00034.

Li M, Shao MR, Zeng D, Ju T, Kellogg EA, Topp CN. Comprehensive 3D phenotyping reveals continuous morphological variation across genetically diverse sorghum inflorescences. *New Phytol*. 2020 Jun;226(6):1873-1885. doi: 10.1111/nph.16533. Epub 2020 Apr 16.

Liu P, Slotkin RK. Cis-regulatory units of grass genomes identified by their DNA methylation. *Proc Natl Acad Sci U S A*. 2020 Oct 13;117(41):25198-25199. doi: 10.1073/pnas.2017729117. Epub 2020 Oct 2.

Nam JW, Jenkins LM, Li J, Evans BS, Jaworski JG, Allen DK. A General Method for Quantification and Discovery of Acyl Groups Attached to Acyl Carrier Proteins in Fatty Acid Metabolism Using LC-MS/MS. *Plant Cell*. 2020 Apr;32(4):820-832. doi: 10.1105/tpc.19.00954. Epub 2020 Feb 14.

Nimmo HG, Laird J, Bindbeutel R, Nusinow DA. The evening complex is central to the difference between the circadian clocks of Arabidopsis thaliana shoots and roots. *Physiol Plant*. 2020 Jul;169(3):442-451. doi: 10.1111/ppl.13108. Epub 2020 Apr 29.

Parvathaneni RK, Bertolini E, Shamimuzzaman M, Vera DL, Lung PY, Rice BR, Zhang J, Brown PJ, Lipka AE, Bass HW, Eveland AL. The regulatory landscape of early maize inflorescence development. *Genome Biol*. 2020 Jul 6;21(1):165. doi: 10.1186/s13059-020-02070-8.

Teng C, Zhang H, Hammond R, Huang K, Meyers BC, Walbot V. Dicer-like 5 deficiency confers temperature-sensitive male sterility in maize. *Nat Commun*. 2020 Jun 9;11(1):2912. doi: 10.1038/s41467-020-16634-6.

Velivelli SLS, Czymmek KJ, Li H, Shaw JB, Buchko GW, Shah DM. Antifungal symbiotic peptide NCR044 exhibits unique structure and multifaceted mechanisms of action that confer plant protection. *Proc Natl Acad Sci U S A*. 2020 Jul 7;117(27):16043-16054. doi: 10.1073/pnas.2003526117. Epub 2020 Jun 22.

A photograph of three children in a rural, hilly landscape. The child in the foreground is a young boy wearing a blue patterned jacket and yellow shorts, holding a large, thick, brown root vegetable (possibly a cassava root) horizontally across his chest. Behind him are two other children, a girl in a white dress and another child partially visible. They are standing on a dirt path with green grass and trees in the background. The lighting is natural, suggesting daytime.

Stepping Up to the Plate

Food is a basic human right that millions of people around the world are denied each day. As the world's population grows, and the climate continues to change, even more will face hunger and malnutrition. Danforth Center scientists are harnessing the power of plant science to find sustainable solutions to this critical problem.

Cassava brown streak disease can cause losses of up to 100%. The Danforth Center's VIRCA Plus project is developing a variety that is not only disease resistant, but also enhanced with micronutrients to combat malnutrition.

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

Improved Cassava: First in the World

VIRCA Plus Cassava Combines Disease Resistance and Enhanced Nutrition for Food Security

“Farmers should not have to make difficult choices between crops that either improve nutrition or allow productive harvests. With improved cassava, they will have both.”




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

This year, the Danforth Center's VIRCA Plus improved cassava became the first ever non-cereal crop to stack the traits of disease resistance and biofortification. The improved cassava is enhanced with higher levels of the micronutrients iron and zinc to combat malnutrition. It also includes the traits of resistance to two major cassava diseases—cassava mosaic disease and cassava brown streak disease—to increase harvests.

Danforth Center scientists **Nigel Taylor, PhD**, Dorothy J. King Distinguished Investigator, and **Andrew Kiggundu, PhD**, Danforth Center project manager, have completed field trials in Puerto Rico. Trials are now underway in Nigeria under the oversight of Ihuoma Okwuonu, PhD, of the National Root Crops Research Institute in Nigeria, who trained previously in the Taylor lab at the Danforth Center. The VIRCA Plus project is showing that by applying cutting-edge technology to orphan crops like cassava, we can create a better, healthier world.



*Danforth Center partner
Dr. Ihuoma Okwuonu, who
trained at the Danforth
Center in the Taylor lab,
oversees the improved
cassava field trials in Nigeria.*



Rice is grown in more than 100 countries around the world. Danforth Center scientists are working to defeat bacterial blight for the good of smallholder farmers everywhere.

“It’s exciting to use science and technology to help farmers protect and improve their rice production, both in Missouri and around the world.”




- Bing Yang, PhD,
Danforth Center
Principal Investigator
and Professor, University
of Missouri–Columbia

Fight the Blight

New Resistant Rice Varieties Clear Hurdle

The world depends on rice. It is a staple food for more than half the Earth’s population, but a disease called bacterial blight can reduce yields of this important crop by up to 70 percent, with the heaviest losses typically experienced by smallholder farmers in low and middle-income countries. The Healthy Crops program, a consortium made up of scientists from around the world, are working to find solutions to this problem.

Danforth Center Principal Investigator **Bing Yang, PhD**, is a member of the project. Using CRISP-R technology, his team has developed rice varieties resistant to bacterial blight. In 2020, regulators in the United States and Colombia determined the varieties were equivalent to what could be accomplished with conventional breeding, clearing the way for field tests. The varieties can also now be used to introduce the resistance trait into many different types of rice via standard breeding strategies.



Rice harvest in the Missouri Bootheel. The state is the fourth largest rice producer in the country.

A team led by Principal Investigator Blake Meyers, PhD, has discovered a way to turn pollen production off and on in corn using temperature. A better understanding of male fertility in corn is crucial for breeding improved varieties.



Foundational Science for Food

Danforth Center Scientists Unlock Genetic Secrets of Crop Plants

Danforth Center scientists undertake broad research aimed at providing crucial knowledge for crop breeding in a changing climate. In 2020, researchers made some startling discoveries.

A research team led by Danforth Center Principal Investigator **Blake Meyers, PhD**, discovered a way to turn pollen production off and back on again in corn using temperature, as published in *Nature Communications*.

New research conducted by a team led by Danforth Center Principal Investigator **Andrea Eveland, PhD**, has revealed regulatory features of the corn/maize genome during early reproductive development. Published in *Genome Biology*, these findings map gene regulation during the development of male and female reproductive structures.

In 2020, the lab of **Elizabeth Kellogg, PhD**, Robert E. King Distinguished Investigator, published two significant findings. The first, published in *Nature Biotechnology*, revealed her team's discovery of a gene that prevents seed shattering. The second, published in *Plant Cell*, was a collaboration with the lab of Principal Investigator **Doug Allen, PhD**. They found that infertile spikelets, once thought unimportant parts of a major group of grasses, actually collect and transfer carbon to be stored as energy in the seed.

"To create higher-yielding corn, we must learn how to adjust gene expression precisely in space and time. My lab is investigating ways to do this."



**-Andrea Eveland,
PhD, Danforth Center
Principal Investigator**





Digging Forward

The Earth is our home, and we believe plant science holds the key to its sustainable future. Danforth Center scientists seek new solutions to feed and power the world, solutions that can preserve and protect our natural environment. We are discovering the technologies today that will bring about a cleaner, healthier planet for future generations.

Danforth Center Principal Investigator Chris Topp, PhD, and members of his lab work while socially distant at the new Research Field Site. The facility will allow Danforth Center scientists to do more field research than ever before.

Our Work: Heal the Planet



Close to Home

New Field Research Site Has Successful First Season

Danforth Center teams have always undertaken field research in partnership with universities and nonprofits across North America and around the world. But they have never enjoyed a dedicated field site close to home... until now.

The year 2020 marked the first season at the new Danforth Center Field Research Site at Planthaven Farms. Pauline and John Cella, owners of grower-retailer Planthaven Farms, and supporters of the Danforth Center, made the land available. Located in O'Fallon, MO, only 35 minutes from the Center, the site is enabling new experiments in field conditions.

A nearby site is convenient and saves significantly on travel costs. It is also crucial to the control needed for long-term projects, such as an experimental vineyard where the effects of grafting are being studied, a project led by Principal Investigator **Allison Miller, PhD**. And because the Field Research Site is so convenient, it allows for more exploratory projects as well. Already six Danforth Center labs have utilized the site in its first season.

"These field experiments are helping to unlock the power of plants to feed people while healing the planet at the same time."



**-Allison Miller, PhD,
Danforth Center Principal
Investigator and
Professor, Saint Louis
University**





Principal Investigator Dilip Shah, PhD, and Siva Velivelli, PhD, from the Shah lab have revealed a new method for fighting agricultural fungus infections.

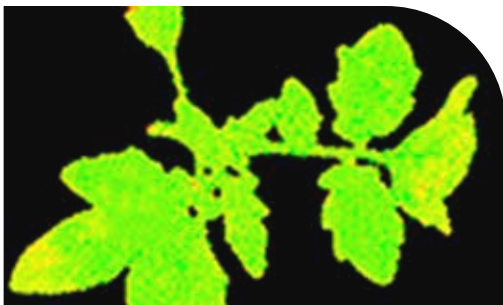


Image from the Advanced Bioimaging Lab at the Danforth Center revealing the peptide's advance against the fungus.

"Discoveries like this can provide farmers with sustainable alternatives. It's better for farmers, for consumers, and for the environment."

*-Dilip Shah, PhD,
Danforth Center Principal
Investigator*

Sustainable Solutions

Breaking News in the Fight Against Fungus

Fungal diseases cause substantial losses of agricultural harvests each year. To combat the problem, farmers must resort to dangerous and expensive chemical fungicides, which can have diminishing effectiveness. But Danforth Center Principal Investigators **Dilip Shah, PhD**, and **Kirk Czymmek, PhD**, with Postdoctoral Associate **Siva Velivelli, PhD**, and collaborators at Pacific Northwest National Laboratory, have discovered a natural alternative.

They have identified a natural substance occurring in a legume that proved effective in inhibiting growth of the fungus causing gray mold when sprayed on tomato plants. The results of their research were published in *Proceedings of the National Academy of Science*. The substance is a subclass of peptides found in the nodules of an alfalfa relative. Using these natural substances would be safer and potentially less expensive than the current chemicals used. In addition, the peptides would be positive for the environment, as they eventually break down and are used by beneficial microbes in the soil as an energy source.

Nadia Shakoor, PhD, senior research scientist at the Danforth Center, received a three-year grant to develop FieldDock, an integrated smart farm system that tracks crop performance in real time. This technology will help farmers reduce water and energy use without compromising yield.



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

Farms of the Future

Danforth Center Scientists Break New Ground in Sustainable Ag

Danforth Center researchers are constantly breaking new ground in their efforts to fight climate change and increase sustainability. In 2020, several new Danforth Center projects aimed at preserving and enhancing the environment received recognition and funding.

SMART TECH FOR ENERGY EFFICIENCY

Senior Research Scientist **Nadia Shakoor, PhD**, received a three-year grant from the National Institute for Food and Agriculture and the National Science Foundation to develop FieldDock, an integrated smart farm system. The information collected will guide researchers and breeders who are developing high-yielding, energy-efficient crops that are resilient to variable climates, and help farmers reduce water and energy use without compromising yield.

BIOENERGY OF THE FUTURE

Pennycress produces high-quality oilseed. Grown as a cover crop, it reduces soil erosion and fertilizer pollution. This year, the US Department of Energy awarded a five-year grant for a nationwide research project to genetically strengthen pennycress for use in sustainable energy efforts. Danforth Center Principal Investigators **Dmitri A. Nusinow, PhD**, and **Chris Topp, PhD** are a part of the project, and together they are working to increase the crop's tolerance to heat and drought.

AI ON THE FARM

The National Artificial Intelligence Research Institutes program awarded a five-year grant to develop an autonomous "farm of the future." **Todd Mockler, PhD**, who is the Geraldine and Robert Virgil Distinguished Investigator at the Danforth Center and the co-founder of Benson Hill, will co-lead a research team. Their goal is to use AI to accelerate crop improvement with a focus on enhancing the efficiency of nitrogen and water use in crops such as corn and soy.



Pennycress has potential as a sustainable energy crop—it is also a cover crop. Danforth Center Principal Investigators Dmitri A. Nusinow, PhD, and Chris Topp, PhD, are part of a team working to unlock its potential.



The farm of the future is coming. Danforth Center principal investigator Todd Mockler, PhD, the co-founder of Benson Hill, is part of a nationwide team using artificial intelligence (AI) to accelerate crop improvement.



From the Lab to the World

The Danforth Center was founded to feed the world and heal the planet. Our principal investigators make discoveries that generate new technology and startups. Top-tier talent, combined with leading-edge infrastructure attracts new companies and investors to St. Louis. The 39 North innovation community is speeding agtech innovation out into the world.



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

Our Work:
Grow the
Region



EDGE@BRDG, the newest building in BRDG Park on the Danforth Center campus. Completed in 2020, this state-of-the-art facility serves as the headquarters of Benson Hill, a company co-founded by a Danforth Center scientist.

A BRDG to the Cutting EDGE

BRDG Park Expands with EDGE@BRDG Building



Despite necessary health and safety restrictions, improvements to the Danforth Center campus continued this year. The new state-of-the-art

EDGE@BRDG building opened in BRDG Park, home to anchor tenant Benson Hill. Benson Hill is a “food tech” company co-founded in 2012 by **Todd Mockler, PhD**, Danforth Center principal investigator. After growing in multiple locations, last year Benson Hill chose St. Louis as their world headquarters. The Danforth Center campus anchors the 39 North innovation community. Together, the Danforth Center, BRDG Park, and Helix incubator provide a path for new companies from idea to IPO, bringing jobs and investment to St. Louis.

At left: The Plastomics team in their lab at the Danforth Center preandemic. Plastomics was one of six agtech startups selected for the 2020 IN² cohort. The program pairs startups with Danforth Center scientists to validate promising agtech solutions.

Innovators for Sustainable Ag

Danforth Center Partnership with IN² Enters Second Year



This year, the Danforth Center and the Wells Fargo Innovation Incubator (IN²) collaborated again to speed the science of six agtech startups. The collaboration paired the companies in the 2020 cohort with Danforth Center principal investigators to provide expert guidance and help validate their innovative, sustainable agriculture technologies. The six companies from around the nation were: AgroSpheres, EarthSense, mobius, Plastomics, Pluton Biosciences, and TerViva.

How do we solve this problem?



Dr. Pat Brown, founder of Impossible Foods, presented virtually at AgTech NEXT. The annual innovation summit, new in 2020, focused on the risks and rewards of agtech innovation.

The St. Louis Regional Chamber estimates that the Danforth Center campus has a \$377M annual impact on the St. Louis regional economy.



Scientists in training prepandemic at the St. Louis Community College Center for Plant and Life Sciences, located on the Danforth Center campus. Together, we are building a more diverse and inclusive workforce in our region's growing agtech industry.

"We are working to move discoveries around food and the environment quickly into the marketplace, so they can reach real people."



- Stephanie Regagnon,
*Executive Director of
Innovation Partnerships*

Meet the Innovation Team

In 2020, the Danforth Center announced the creation of a new innovation team to help speed the progress of cutting-edge agtech ideas into the hands of farmers who need them most. Joining **Claire Kinlaw, PhD, MBA**, director of innovation commercialization, were **Stephanie Regagnon**, executive director of innovation partnerships, and **Tom Laurita, PhD**, director of entrepreneurship. Together, the Danforth Center innovation team works to create an environment where it is natural for scientists to think about commercial applicability of their research—and to create a thriving community across the broader campus where those enterprises can develop and thrive.

Introducing AgTech NEXT



This year, the Danforth Center launched **AgTech NEXT**, a new annual agtech innovation summit. In 2020, the virtual event consisted of seven weeks of midday programming with thought leaders and subject matter experts from around the world. The inaugural AgTech NEXT attracted more than 300 attendees representing 22 countries.



Next-Generation Science

For students, parents, and teachers around the world, the pandemic brought about new barriers to quality education and revealed other, long-standing ones. The Danforth Center's Education Research and Outreach lab is working to overcome such barriers by providing high-quality science education for students across the St. Louis region—inspiring all students to see themselves as scientists.



Students pre-pandemic at the Jackie Joyner-Kersey Center in East St. Louis participate in hands-on science. The Danforth Center recently announced a partnership with the JJK Center to empower young scientists in the region.

I'm a Jackie Joyner-Kersey FAN!

New Danforth Center Partnership Aims to Inspire Students

Track star Jackie Joyner-Kersey holds six Olympic medals and is one of ESPN's "50 Great Athletes of All Time," but she never forgot where she came from. Growing up poor in East St. Louis, Illinois, she vowed to make a difference in the lives of children like herself. In 1988, she founded the Jackie Joyner-Kersey Foundation to inspire youth to thrive in academics and athletics, and to enhance their communities through the Jackie Joyner-Kersey (JJK) Community Center in her hometown.



The Danforth Center recently announced a partnership with the JJK Center and the University of Illinois. The new **Jackie Joyner-Kersey Food, Agriculture, and Nutrition Innovation Center (JJK FAN - I Center)** will be adjacent to the JJK Community Center. Its aim? To teach children vital information about nutrition and food production, while providing a pathway from kindergarten to adulthood of opportunities in urban agriculture, scientific research, and innovation/entrepreneurship. Through training, mentoring, and unique learning programs, the partnership will engage students in STEAM and agriculture, prepare them for college and careers, and help them transform their community.

"When students learn to see themselves as scientists, a new future becomes possible. Through this partnership, we seek to inspire students to transform their lives, while simultaneously transforming their community from a food desert to a food oasis."

*– Kristine Callis-Duehl, PhD
Sally and Derick Driemeyer
Director of Education
Research and Outreach*

Studying How Students Study

While the COVID-19 pandemic interrupted normal K-12 programming, the Danforth Center's Education Research and Outreach Lab pivoted quickly to study those very impacts. The team conducted several studies to examine the effects COVID-19 has had on education and learning. Surveying both students and teachers across different institutions, the lab found, among other things, that students were less emotionally engaged with their science courses after switching to online learning. Even more concerning, less than 40 percent of teachers reported that they had any formal training in online instruction before virtual learning began. The lab hopes to use the information they have gathered to better prepare schools for any future disruptions.



Principal Investigator James Umen, PhD, an expert in algae, works with high school educators who want to bring "Discovering Volvox" to their classrooms. This February event was the last in-person teacher training before COVID-19 pandemic restrictions went in place.



2020 WHD FELLOW

Third-year PhD student at Saint Louis University **Zachary N. Harris** was named the 2020 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. Harris is a member of the Miller lab and is studying how long-lived crop species function and adapt.



A RESET FOR REU

Each year, hundreds of students compete for spots in a rigorous training program known as the Research Experience for Undergraduates (REU). Funded by the National Science Foundation, REU interns have been welcomed to the Danforth Center for 17 years. In 2020, due to the pandemic, REU was cancelled. It is returning in 2021 as a virtual experience and all eligible 2020 interns were invited to participate.



GRADS GO VIRTUAL

At the Danforth Center, graduate students have the opportunity to participate in cutting-edge thesis research, gain interdisciplinary skills, and learn how we turn plant science discoveries into real-world solutions. In 2020, much of the mentoring went virtual, including the weekly mentoring seminar. The first Zoom presentation was by Postdoctoral Associate **Nikita Bhatnagar, PhD**, of the Pandey Lab on March 26.

2020 By the Numbers



350
Danforth Center
community
members



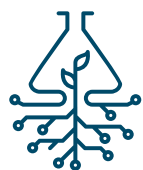
28
principal
investigators



2
National Academy of
Sciences members



74,251
unique website visitors



8,804
citations of scientific
papers authored by
Center scientists



39°N
\$377M
annual economic
impact of Danforth Center
campus and Helix

16 scientific seminars + 83 average seminar attendance



310
unique log-ins
at virtual Conversations



Our (Virtual) Community of Support

We cannot do it alone. The Danforth Center relies on the tremendous efforts of our donors, volunteers, and partners. When events turned virtual in 2020, we worried whether our community would still feel connected. We did. Together in spirit, if not in person, we continued to work toward scientific discovery and a brighter future for all.

"The year 2020 was tumultuous, but the Friends Committee used that time to reassess our methods, strengthen our resolve, and continue to engage the public through new forms of virtual events and volunteer efforts. Thank you for helping all of us at the Danforth Center emerge from a difficult year stronger than ever."



- Tim Rodgers,
Chair, Friends Committee

Friends Committee

The Friends Committee promotes the work of the Center and grows membership and financial support through annual giving.

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In 2020, Conversations pivoted to virtual for the first time to offer two events. Both livestreams were recorded and may be viewed on our blog at danforthcenter.org.

2020 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 2020, Conversations pivoted to virtual for the first time to offer two events. Both livestreams were recorded and may be viewed on our blog at danforthcenter.org.

INSPIRING TOMORROW'S SCIENTISTS | AUGUST 20

Nearly 140 households, including participants from other countries, joined the Danforth Center's first-ever virtual Conversations event. The focus was the future of education and the impact of online learning in a pandemic. Speakers included **Dr. Corey S. Bradford**, president of Harris-Stowe State University, and **Kristine Callis-Duehl, PhD**, the Sally and Derick Driemeyer director of education research and outreach at the Danforth Center. St. Louis Public Radio's **Sarah Fenske** served as moderator. The conversation was livestreamed from the McDonnell Atrium with the speakers seated more than six feet apart.

THE INNOVATION STACK WITH JIM MCKELVEY | OCTOBER 15

This Virtual Conversations sent a new high mark with more than 195 unique households tuning in for **Jim McKelvey**, cofounder of Square and serial entrepreneur, philanthropist, and artist. Jim discussed his new book, *The Innovation Stack*, an inspiring account of what it means to be an innovator and what it takes to build a resilient, world-changing company. **Natalie DiNicola**, Benson Hill chief of staff, served as moderator. The event began with a somber acknowledgment by Danforth Center President **Jim Carrington** of the recent passing of Danforth Center Founding Chair **Dr. William H. Danforth**.

Media sponsorship by:



Discussing the future of education at the first virtual Conversations event in August.



Jim McKelvey, cofounder of Square and serial entrepreneur, spoke at the October virtual Conversations.

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.

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"Our annual Party with the Plants event had to be cancelled for safety, but the Young Friends still wanted to make a difference. We pivoted to the online Grow Challenge, and thanks to all who donated and asked their friends, it became a resounding success."

-Logan O'Connor
Chair, Young Friends



Introducing... the Grow Challenge

When the Young Friends' signature event, Party with the Plants, had to be cancelled, they decided the work of the Danforth Center could not wait. Despite tough conditions during the pandemic, they launched the Danforth Center's first-ever peer-to-peer fundraising effort, the Grow Challenge. This online week of giving took place September 28 through October 2 and raised more than \$45,000 for STEM education and early-stage research. Thank you to everyone who contributed to grow our Center, help our region, and feed our world.

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“With Seeds of Change postponed, the Danforth Leadership Council focused on helping the new AgTech NEXT conference succeed. These virtual seminars drew attendees from 22 countries, positioning St. Louis and the Danforth Center as a global hub of agtech innovation.”

*-Chip Lerwick
Chair, Danforth Leadership Council*



“This Center, the brilliant and dedicated scientists and administration, are making real, every day, Dr. Danforth’s vision.”

Toast to Innovation

On November 14, the Danforth Center community acknowledged a very different year with a very different celebration. The virtual “Toast to Innovation” provided an opportunity to celebrate our innovation community—and our outstanding Danforth Society supporters, who make this work possible. With your support, the **Danforth Center** is spinning out new technologies and startups, attracting in new talent and companies, and helping our region grow.

The virtual event was attended by 132 unique households and emceed by **Stephanie Regagnon**. It featured presentations by Aker Technologies CEO **Orlando Saez**, Benson Hill Chief of Staff **Natalie DiNicola**, and VP of St. Louis Economic Development Partnership, **Janet Wilding**. There was a conversation between Danforth Center President **Jim Carrington** and former Danforth Center COO **Sam Fiorello**, who was named President and CEO of Cortex earlier in the year. The event concluded with a tribute to Danforth Center Founding Chair **Dr. William H. Danforth** by FleishmanHillard General Counsel and SVP **Ruth Kim**.



- **Ruth Kim**,
Board Secretary,
Speaker at Toast to
Innovation

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The Danforth Center is grateful for members of the Legacy Society. These generous donors have provided for the future of the Center through planned gifts. Founding members include Dr. William H. Danforth†, Mary† and Oliver† M. Langenberg, and Mrs. Jefferson L. Miller†.

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Aleene Schneider Zawada

† Deceased

"I am happy to donate to help St. Louis and the world. I know the Danforth Center is putting my investment to good use wherever it is needed most."



– Beth Early,
Legacy Society Member

Legacy Advisory Council

Legal and financial estate planning experts who generously provide assistance with the promotion of planned gifts to the Danforth Center.

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\$50,000+



\$25,000+



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The Danforth Center is grateful for donors who honor or memorialize their friends, loved ones, and colleagues with a gift to the Center. Gifts listed here were received by December 31, 2020. To make a tribute, visit danforthcenter.org/donate.

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Nancy Lee O'Leary & Mary Blair O'Leary & their good friends Jim & Janet Knight

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Financials in a Pandemic

The Danforth Center was not immune to the financial impacts of the pandemic. Closed and curtailed operations meant fewer clients for Core Facilities. Canceled events resulted in lost sponsorship and ticket revenue, as well as fewer opportunities to meet potential new donors. Many individuals and corporations were forced to make difficult decisions about their giving, while others, recognizing the need, were able to give more. The passing of our founder, Dr. William H. Danforth, was met with an outpouring of more than 100 gifts in his memory. We are grateful to our community who pulled together to keep the science going during this difficult year.



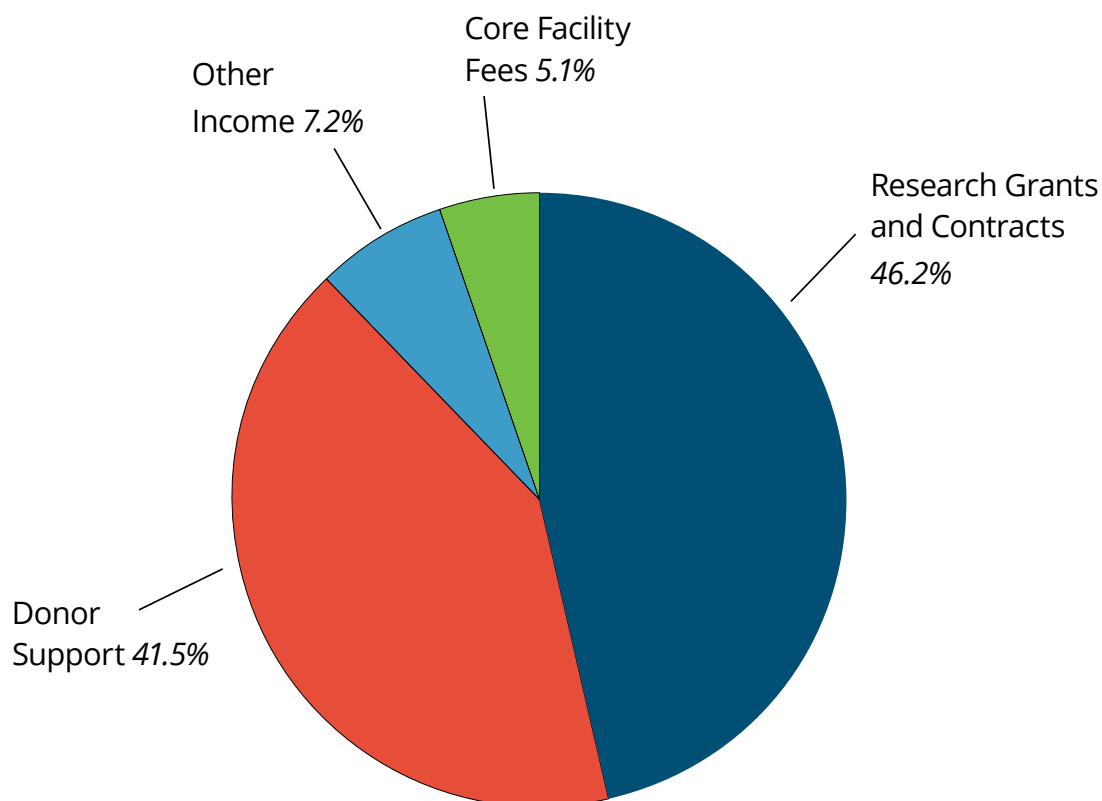
Construction to expand Greenhouse Range B continued in 2020 with pandemic safety protocols in place. The new Michael W. and Quirsis V. Riney Family Greenhouse opens in 2021.

Selected Financial Data

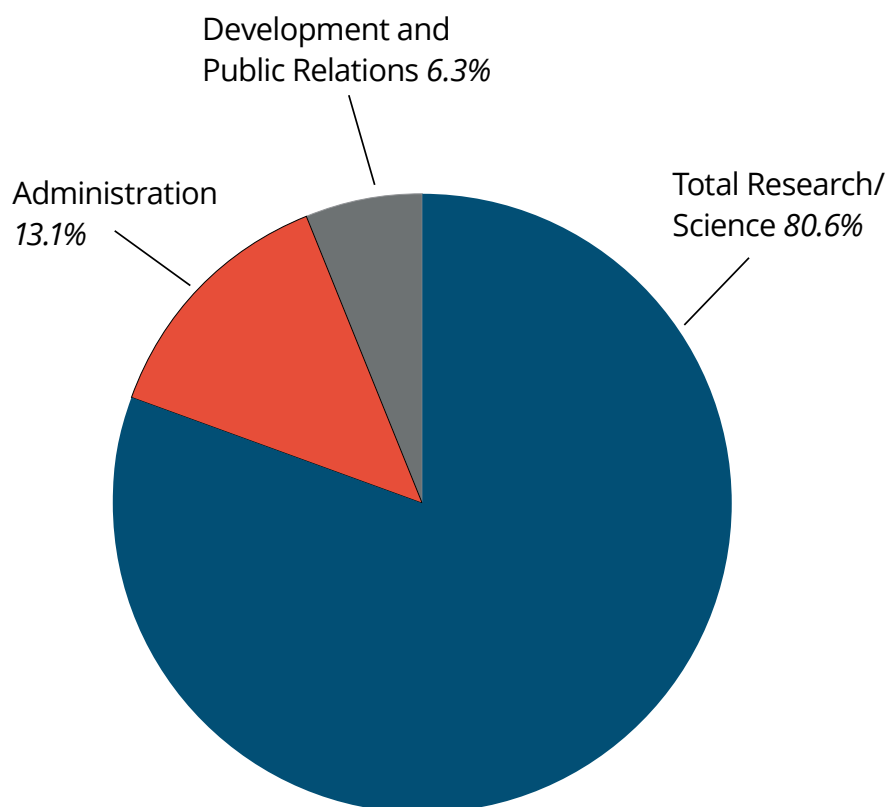
Fiscal Year Ended December 31, 2020
(Unaudited)

				2020 (\$000's)	
UNRESTRICTED OPERATING REVENUES ¹				Revenue	Source %
Research Grants and Contracts				\$17,212	46.2%
Donor Support				\$15,438	41.5%
Annual Gifts	\$2,122	5.7%			
Endowment Draw	\$13,316	35.8%			
Core Facility Fees				\$1,888	5.1%
Other Income				\$2,686	7.2%
Total Operating Revenues				\$37,223	100.0%
OPERATING EXPENSES ²				Expenditures	Expenditure %
Total Research/Science				\$25,155	80.6%
Administration				\$4,088	13.1%
Development and Public Relations				\$1,983	6.3%
Total Expenses from Continuing Operations				\$31,226	100.0%
CAPITAL EXPENDITURES					
Greenhouse Expansion				\$3,377	
Lab and Core Facility Equipment				\$809	
All Other				\$401	
Total Capital Expenditures				\$4,587	
REPLACEMENT AND RENEWAL EXPENDITURES \$435					
NON-OPERATING EXPENDITURES					
Debt Service Payments				\$797	
DEPRECIATION EXPENSE					
Depreciation of Fixed Assets				\$7,194	

2020 Unrestricted Operating Revenues¹



2020 Operating Expenses²



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.

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The Donald Danforth Plant Science Center stands unambiguously and proudly with individuals, families, and communities of color. We condemn all acts and forms of racism, and we grieve with those who are affected. The Danforth Center community commits to continuously learn about impediments to racial equality, to implement positive changes that address racial inequality, and to support our diverse communities.

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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



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