

## REMARKS, STATE OF THE CENTER 2014

### **John McDonnell, Chairman, Board of Trustees**

Welcome to the 2015 State of the Center. I am John McDonnell, Chairman of the Board of Directors for the Danforth Plant Science Center. Thank you all for coming out this early mid-winter morning. You will learn about substantial progress being made in each area of our mission. In 2014 the Center team produced important scientific discoveries, helped to generate new business opportunities around plant science, and expanded K-12 science education opportunities in local schools.

The St. Louis community faced major challenges in 2014. From its start, the Danforth Center has seen itself not simply as located in St. Louis but as a committed participant in the region's success. That success has many forms, including growing a workforce with the education and skills to succeed in science and technology careers and strengthening of the local economy in agriculture, biotechnology, and other industries that create opportunities for many St. Louisans. Last week KWS of Germany hosted a grand opening of its Gateway Research Center at BRDG Park. That is a tangible example of what we can accomplish when people and organizations come together for the advancement of our region.

It is one example among many, and we are fortunate to be part of an outstanding innovation ecosystem. BioSTL, Cortex, Helix Center, BRDG Park, the Danforth Center, and others share a vision of a prosperous and successful St. Louis region created through scientific and technological innovation that will improve the lives of people around the world. Several years ago, Bill Danforth said it very eloquently:

"Here we are with an unusual opportunity to take part in and, more important, to help lead wonderful advances for our world and for our home community. If we continue to work together for the common good, if we care more about who does the work than who gets the credit, if we continue to attract and support the most able scientists, and if we provide opportunities for entrepreneurs, we will succeed in writing a new chapter in human history and in the story of our community."

With that theme of collaboration and teamwork in mind, this morning we will hear about the State of the Danforth Center from Bill Danforth and Jim Carrington.

After their remarks, the program will conclude with a question and answer session with Jim Carrington and Sam Fiorello. It will be moderated by Dr. Molly Cline, who as most of you know, is a plant scientist by academic training, and was the Senior Director of Industry Affairs at Monsanto before retiring in 2010. She is a past president of the St. Louis Agribusiness Club and a long-time volunteer at the Danforth Center in various capacities. Molly, thank you for joining us again this year as moderator.

And now, please join me in welcoming to the podium our Founding Chairman, who I am pleased and relieved to say is still actively and energetically involved in the life of the Danforth Center – Bill Danforth.

## **William H. Danforth, M.D., Founding Chairman**

In order to keep myself focused on essentials I occasionally ask myself, “What in a few words is central to our goals?” My answer today is something typically American, “to build an institution.”

I often use Alexis de Tocqueville’s classic Democracy in America, published in 1835 to understand continuities in American behavior. He noted that, when something broke down in France, the locals called on the authorities to fix it. In America, people summoned their neighbors and joined in fixing it themselves. The French method often seemed better for the specific job, but the American local action achieved more overall.

When this Center began, those who felt St. Louis should have a plant science center followed the American example. We asked our friends and neighbors to help. Their response was magnificent. They became excited by the vision of contributing to the progress and survival of humankind, of ending starvation, preserving a livable environment and bringing more science based jobs to our region. They gave time and energy; spread our story; invited people in; provided counsel and ideas; served on working committees; and, when appropriate, joined their institutions for the common cause. And importantly they, you, we have been generously providing essential dollars that the feds and foundations will not. Thank you.

Like it or not, first class science is expensive. And here we are 17 years later having worked with others to build what we immodestly consider the greatest plant science community in the world.

Why build an institution rather than just rally around a single problem a la de Tocqueville.

I’ll give three reasons.

- 1) We can form an institution to embody the goals closest to our hearts.
- 2) If we are not as talented as Mozart, Tolstoy, or Vermeer, we must pursue our hopes and dreams not alone, but in partnership with others, who have talents we do not.
- 3) A successful institution can carry forward our ideals and hopes long past our brief life spans evolving and building as new times and challenges require.

One point -- Having faith in those who come after is essential to those who build for the future.

Of course, we imagined that our institution would be successful, that it would fit St. Louis, drawing on the strengths of the regional institutions and that we, in turn, would serve them and our community. One boon that we did not fully appreciate at the start was our community’s wonderful spirit of cooperation and common purpose. We have been lucky to be in St. Louis, but that alone will never be enough. We will succeed or fail on the quality and importance of the science and on making progress in our missions to benefit the world and our region.

Soon you will hear from our president, Jim Carrington, about what is most important; then he and Chief Operating Officer and President of BRDG Park, Sam Fiorello, will be ready for questions.

But first a brief intermission -- For the 3<sup>rd</sup> time in our history we will present the Newell S. "Jim" Knight award to a superstar volunteer, recognizing exceptional dedication, manifested by:

- 1) Unusual diligence and willingness to take on tasks,
- 2) An inspiring vision for the center that attracts new people to join us and stimulates the rest of us to work harder and more creatively, and
- 3) Widespread affection and respect.

We all know the two past awardees. First, amazingly enough, the person whose name the award bears; Jim Knight, please stand and remain standing. Second, George Fonyo. George will you please stand. Thank you both for helping select today's awardee, James Lee Johnson, III.

Jim is a life-long St. Louisan and senior vice president of Stifel, Nicolaus. He gives time and energy to worthy organizations, including St. Louis Children's Hospital, City Academy, St. Peter's Episcopal Church, and important to me, coach of a grandchild's soccer team. Jim is charming, delightful, interesting and fun. He has a great and generous heart.

He became interested in our Center after hearing a talk of Howard Buffett and soon became active. Since then he has brought over fifty new people to learn about our Center. He was the founding leader of the Danforth Leadership Committee, one of our Center's very important groups. Jim was active in recruiting great people, in planning early agendas and in setting the tone. He stimulated the members to donate to the Center and set a personal example. At one meeting his enthusiasm was so infectious that all of us began wishing to clone him. I hate to admit this, but even the scientists of this Center, as great as they are, don't know how to clone him, nor does anyone else.

Perhaps no one ever will, but that underscores how fortunate we are to have the original, the one and only, and to be able to thank him and recognize him today as a champion of the Donald Danforth Plant Science Center...and to thank his family for participating. Daughter, Carlie, has worked in the Carrington Lab. With him today are his wonderful wife, Suzanne, and his mother and a friend of the Center, Bettie. Will Jim's family please stand? Now Jim, will you and Jim Carrington please join me on the stage.

**James C. Carrington, Ph.D., President**

Congratulations, Jim. We wouldn't be where we are today without you. And thank you, Dr. Danforth, for your remarks. And THANK YOU, our scientists, staff, friends and supporters, for coming out this morning. It means a lot that you're here.

Before my remarks about the state of the Center, I want to recognize one more person who has served us so well, and that is the outgoing chairman of our Friends Committee. For the past two years, Jay Nouss has worked tirelessly to chair quarterly meetings, to host lunches with guests, to ensure that Friends-sponsored events are of the highest quality, and on occasions too numerous to count, to represent our Friends for the purpose of advancing the Center. Please join me in thanking Jay for all that he's done for the Danforth Center.

The needs to feed and power a growing, changing world, while also preserving the environment and vital natural resources, are among our greatest global challenges. *Sustainably* providing for over 9 billion healthy people by the year 2050 will require that we increase available food by at least 50%, dramatically lower the environmental footprint of agriculture, and achieve a major shift toward renewable sources of energy.

Over the next 40 years, the world needs to produce more food than all that was produced over the last 8,000 years combined. That means worldwide productivity will need to increase by roughly 50%, but without any more land and water dedicated to agriculture, with fewer greenhouse gas emissions, and we'll need to do it in the face of climate change and increased pressure from pests and diseases.

These challenges are not solvable, in a sustainable way, using CURRENT capacity, current systems, and current technology. But make no mistake, these are not only year 2050 challenges...these are TODAY challenges. Consider that:

- TODAY, nearly 900 million people are food insecure.
- An alarming 26.4 billion tons of soil is ALREADY being lost to erosion each year. Erosion rates are 10 times faster than the rate of soil replenishment.
- Agriculture ALREADY contributes to 10% of our overall greenhouse gas emissions, and that needs to come down
- And 70% of the freshwater used by the world is ALREADY used for agriculture, primarily irrigation.

Water is a particularly intriguing problem for two major reasons as we move forward – rainfall will be less predictable in agricultural growing regions, and sources of irrigation will become more depleted, restricted, and expensive. Just to put some reality on the need for water, consider the following:

- Gallons to produce 1 orange: 14, or 5 MIN 36 sec of running faucet
- Gallons to produce an avocado: 28, or 11 MIN 12 sec of running faucet
- Gallons to produce a loaf of bread: 150, or 60 MIN of running faucet
- Gallons to produce a chicken: 400, or 2 HOURS 40 MIN of running faucet
- Gallons to produce 4 hamburgers: 4,080, or almost 27 HOURS of running faucet

Meeting Global Challenges at the nexus of food, water and energy today AND tomorrow will require significant new investment in science and technology. That's why the Danforth Center was formed, and that's what motivates us every day.

Now, IF the Center does its part, we'll understand better how plants work in changing environments, for example when water is scarce, and then we'll USE that knowledge to improve productivity and sustainability of food, energy and industrial crops. We'll develop technologies that are taken up by the private sector, but we'll give that technology to those most in need in developing regions. We'll help create innovative start-ups and attract leading-edge companies to THIS region. And, we'll produce well-trained plant scientists who will guide the next generation. These are OUTCOMES that matter to us.

How are we doing it? How do we ensure that our work and OUTPUT actually leads to important OUTCOMES? The magic ingredient, the secret in the sauce, is TEAMWORK, COLLABORATION and PARTNERSHIP, our theme today.

You need to understand that science, our primary function, is a TEAM SPORT. That's because scientific research, building new technologies and solving problems are really difficult. They require teams of interactive scientists, mathematicians and statisticians, engineers, practitioners, and educators. TEAMS at the Danforth Center develop unique platforms for discovery, application and outreach, and then they partner with organizations that are best positioned in the region, nation and world to solve problems where they exist.

We were very productive in 2014. Our research programs made amazing discoveries that were described and disseminated in 99 journal articles. We advanced several crop improvement programs through 10 important field trials in three countries. We were successful competing for grants, \$13.9M for the year, and in training our young scientists. In fact, we hosted our 529<sup>th</sup> trainee since inception. And through our Science Education program, we reached 1,968 students in 38 schools, 16 of which were city of St. Louis public schools.

And it was nearly all done in collaborative teams. 88% of our published research articles were collaborative works between two or more labs or institutions. Two-thirds of our grant funding is for multi-institutional collaborative projects. And as I'll discuss later, much of our education and outreach program involves teams comprised of Education and Outreach professionals and scientists in our labs. For us, collaboration is bedrock!

In fact, if you chart WHO interacts with WHO in teams at the Center, you get this fascinating map that shows we are a large, interconnected network. Show IICI team.

Let's talk about a few of these groups to show the Power of Team at the Danforth Center.

First, the Bellwether Phenotyping Team. This is a remarkable group that has developed a new platform for discovery to understand how environment interacts with plant genetics to affect plant performance. The Team involves 21 people from 7 labs and 2 core facilities at the Center, and it is this part of the Danforth Center Network .

In 2014, they took a new, automated system to continuously measure plant traits and turned it into a productive tool that works around the clock. They tackled the issue of water, more specifically, why some plants are more sensitive to drought than others.

They studied the differences in drought sensitivity between domesticated and wild species of *Setaria*, which includes Millet. Work here at the Center is diving deep into the genetic variation of *Setaria* from different geographies. The Team captured nearly 80,000 images over 4 weeks using three types of cameras, and then mined information about 9 traits using computer vision software developed at the Center. They discovered that different *Setaria* species respond differently, over time, to low water conditions, and that this is a genetically programmed trait that affects plant growth. That's information that breeders can use to improve millet, an important food security crop for millions in the semi-arid tropics.

Many of the Bellwether Phenotyping Team are also part of **the Maker Team**, a group of 45 Danforth Center scientists, staff and trainees who are spearheading the design and construction of low-cost instruments and software engineering tools to address specific research needs. The Maker Group helps with cross disciplinary training for postdoctoral scientists, graduate students, undergraduates, technicians and high school students in the areas of computer science, engineering, 3D printing, and instrument prototyping.

Maker instruments are low-cost, but accurate, sensors, cameras and other devices connected to cheap \$35 Raspberry Pi microcomputers. They're alternatives to expensive commercial equipment, and they're adaptable to both laboratory and field settings. On the screen is an example of an ultrasensitive fluorescence imaging system that Meter Nusinow built to show spread of a virus in two infected plants. Over 60% of labs, as well as the education and outreach program, are designing, producing and using Maker instruments and tools at the Center. And our new building will have a dedicated, collaborative Maker Space to encourage and expand the program.

Several Team members are bringing the Danforth Center Maker Movement to the public, this Saturday, with the 1<sup>st</sup> Raspberry Pi Jam here at the Center. The event, which has over 250 registrants, will provide an unintimidating atmosphere to introduce plant science, computer science and the Maker culture to the public. The Jam will include tours, demonstrations with imaging stations, robots, a learn-to-solder station, and much more. You're all welcome to attend. Now, I want to recognize some of the key people who are leading the Bellwether Phenotyping Team, the Maker Group, and the Raspberry Pi Jam event this week. Please join me in recognizing Dmitri Nusinow, Ivan Baxter, Malia Gehan, Noah Fahlgren, Kerri Gilbert, Mindy Wilson and Tom Brutnell.

Some of our Teams join even larger consortia. This is the case for three of our PIs, Todd Mockler, Chris Topp, and Terry Woodford-Thomas, who joined with 31 Investigators from 9 other Missouri institutions in a \$20M, National Science Foundation-funded program called **Missouri Transect**. This project, which is led by the University of Missouri-Columbia, is building infrastructure and knowledge to understand the impact of changing environments on agricultural and native plants. Already, this project has resulted in development and testing of instrumentation to better image roots and root metabolism in real time. As the needs intensify to lower water use in agriculture, understanding root biology help to develop traits that increase water uptake efficiency from the soil. Would the Missouri Transect Team of Todd Mockler, Chris Topp, Terry-Woodford-Thomas and Sandra Arango-Caro please stand and be recognized.

The Missouri Transect project has brought us closer to key collaborators and partners like Robert Pless, a leading expert in computer vision and image analytics at Washington Univ. Ties have been strengthened most with Mizzou, eventually leading to our recently announced agreement to hire four joint faculty members between our two institutions.

Our Education and Outreach program has never been stronger, thanks to the tremendous efforts of Terry Woodford-Thomas. So let me introduce the **STEAM Team**, eight of our scientists working to engage more young women in science, technology, engineering, arts and mathematics, or STEAM, fields. In June, the team will lead Girls STEAM Ahead 2015, a partnership with the Girl Scouts of Eastern Missouri. Girls STEAM Ahead will bring 80 girl scouts from the city of St. Louis, St. Louis County, and rural areas to the Community College labs at BRDG Park. Over three days, girl scouts will

work together with our scientist mentors to hone their STEAM skills by doing experiments that support creativity, build confidence and promote communication. The STEAM Team is Sona Pandey, Becky Bart, Andrea Eveland, Toby Kellogg, Sarah Fentress, Terry Woodford-Thomas, Malia Gehan and Toni Kutchan. Please stand and be recognized.

Our role in building the region as a world center for plant science innovation is entirely collaborative and team-oriented. On our campus, BRDG Park now houses 14 companies and the St. Louis Community College's lab training program. As many of you know, BRDG was selected as the new home for a major North American research center for the German seed company KWS. Yes, they wanted to be near the Danforth Center, interact with our scientists and access our facilities, but they also wanted to be part of what THEY expressed as a unique St. Louis innovation ecosystem. Last week, we were pleased to attend the grand opening of the new KWS facilities at BRDG. The space, which underwent a \$6 million redesign and renovation, contains new lab, office and plant growth facilities, and will house nearly 75 new employees within a few years.

Although we're not making any formal announcements this morning, I encourage you to stay tuned in the months ahead for what will be exciting news.

On the start-up side, Helix Center, our neighboring plant and ag-technology incubator run by the St Louis Economic Partnership, achieved full occupancy of its phase-one lab build-out. This important BRDG Park sister facility plays a vital role in growing early stage companies that will one day graduate to BRDG Park. Three of the Helix Center's tenants, Benson Hill Biosystems, Kultevat, and Arevgenix were either started by, or have close research ties to, past or present Danforth Center scientists. We were also thrilled to see YieldLab, an accelerator for ag tech start-up companies, get off the ground at Helix.

And we're proud to report on the success of the 6<sup>th</sup> annual Ag Innovation Showcase, held in September and attended by 350 investors, entrepreneurs, and strategic companies in the ag tech space. Since inception in 2009, companies presenting at Ag Showcase have raised more than \$360 million. Two of our BRDG Park companies, Newleaf Symbiotics, which recently closed \$17M in Series B funding, and SyMyco were first connected with BRDG via the Showcase.

So in closing, I hope I've communicated that the Danforth Center succeeds, that it delivers on its mission, ONLY when people with diverse backgrounds and talent come together for a common purpose. The culture of collaboration, of WE, is important to us; we talk about it and promote it constantly, it makes us unique in the scientific world. As we grow with the addition of the next building, due for completion in November, our challenge is not only to recruit the very best scientists, but to grow the very best TEAMS. We seek not only high achieving researchers, but entrepreneurs who understand that turning discovery into impact requires vision, risk and partnership. The expansion project is about providing our current and future scientific teams with best-in-class facilities and equipment, and with spaces that enable what is not currently possible. The Expansion is designed to ensure greater impact in the years ahead. This will not happen without YOUR partnership and YOUR support. Thank you so much.

Now, please welcome Molly Cline, chair of our Friends Committee, and Sam Fiorello, Senior Vice President and Chief Operating Officer, as they join me on the stage.