13th Annual Cornell Corteva Plant Breeding Symposium

Breeding Plants for Novel Systems and Complex Problems

Friday, April 12, 2024
Boyce Thompson Institute, Ithaca, New York

For talk abstracts, speaker biographies, and more information about the symposium, go to:
https://bit.ly/2024synapsis

8:30 am	Coffee and light breakfast, networking
9:00 am	Opening remarks
9:10 am	Frank Technow: *Back to the Future: germplasm evolution within complex genetic systems*
10:05 am	Lucas Roberts: *Adapting African Leafy Vegetables to Minnesota through Participatory Plant Breeding*
10:30 am	Coffee break
10:50 am	Solveig Hanson: *Toward 40 million cover cropped acres: Breeding fall-sown cover crops for ecosystem services and farm system compatibility*
11:45 am	Taqdeer Gill: *Eye in the Sky: Hyperspectral Imaging for Sustainable Nitrogen Management in Vegetables*
12:10 pm	**Lunch**
1:10 pm	Nolan Bornowski: *Out of the darkness: Historical challenges and modern solutions in button mushroom breeding*
2:05 pm	Sara Gonzalez: *Not your typical crop: Growing resilient seaweed for a warming ocean*
3:00 pm	Coffee break
3:20 pm	Kevin Folta: *Controlling E, Controlling G, New Crops for Controlled Environments*
4:15 pm	Closing remarks
4:30 pm	**Happy hour**

Hosted by Synapsis, the Cornell University Plant Breeding & Genetics Graduate Student Association
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Solveig Hanson

Toward 40 million cover cropped acres:
Breeding fall-sown cover crops for ecosystem services and farm system compatibility

Abstract:

Cover crops are planted between cash crop cycles to provide soil health benefits and farm-scale resiliency to climate change. In the United States, cover cropped acreage has increased steadily over the past decade, and cover cropped acreage could reasonably rise to 40 million acres by 2030. However, barriers to farmer cover crop adoption persist and some – stand establishment, cover crop profitability, and weediness caused by hard seed – can be addressed through breeding. Moreover, much of the seed currently used for cover cropping is of unidentified origin and marketed as "variety not stated." While such seed is adequate for some situations, named varieties with improved traits can offer greater reliability, especially as more growers use cover cropping as a key strategy for both ecological and agronomic management. In response to the need for improved cover crop varieties, the Cover Crop Breeding Network develops fall-sown legume cover crops and cereal rye for traits like winter hardiness, early vigor, high biomass, early flowering, seed yield, and soft seed. The CCB Network complements its nationwide field breeding pipeline – the first for cover crops – with genomic investigation, controlled-environment selection, and participatory plant breeding. This presentation will describe the Network's first variety releases, the discovery of a genetic marker for hard seed in vetch, controlled-environment breeding for cold tolerance and pea and rye, and bidirectional selection for allelopathy in rye.

Bio:

Solveig joined Virginia Moore's Sustainable Cropping Systems Breeding Lab at Cornell University in January 2023, where she coordinates research and outreach for the nationwide Cover Crop Breeding Network. Solveig received her Ph.D. in Plant Breeding Plant Genetics from University of Wisconsin-Madison in 2020, where she conducted genetic, genomic, and participatory research focused on flavor in table beet. In a subsequent postdoctoral fellowship at the University of British Columbia, she coordinated a Canada-wide farmer variety trialing network and led participatory breeding efforts in carrot. Her first decade of adulthood was spent as co-owner of a diversified vegetable farm in Northeast Iowa, and she worked in vegetable seed product development before immersing in plant breeding. She is currently enjoying watching her first winter pea crosses mature in the greenhouse while nurseries, trials, and everything else greens up outside.

Sara T. Gonzalez

Not your typical crop: Growing resilient seaweed for a warming ocean

Abstract:

Warming sea temperatures are threatening global kelp populations, and for the future of kelp aquaculture under climate change, we need to identify individuals with natural adaptations to cope with heat. If heat tolerance of adult kelp (sporophytes) can be predicted at the early life stage prior to fertilization (gametophytes), we can accelerate breeding of heat-tolerant strains. We assessed sugar kelp (Saccharina latissima) gametophyte physiological stress under heat to generate predictions of heat-tolerant strains and then tested these predictions with juvenile sporophytes. Gametophyte heat tolerance was assessed for 93 genotypes by exposing them to seawater temperatures representing current (12oC) and future high (24oC) temperatures in the Gulf of Maine, U.S.A., and measuring photosynthetic performance (as chlorophyll a fluorescence) before and after heat stress. Based on these results, we created 3 predicted tolerant and 4 predicted intolerant crosses of male and female gametophytes, and monitored the growth of the resulting juvenile sporophytes when cultivated in control (12oC) and warm (up to 22oC) seawater temperatures. Our results indicate that we can identify heat-tolerant gametophytes that, when crossed, yield juvenile sporophytes that grow better under heat stress than sporophyte progeny of predicted intolerant gametophytes. This work demonstrates the potential for breeding heat-tolerant sporophytes by knowing only the gametophyte performance under heat stress.

Bio:

Sara Gonzalez is a marine ecologist and evolutionary biologist with a passion for seaweeds. Her research on seaweed ecology, physiology, and chemistry has applications toward sustainable seaweed aquaculture development for emerging global markets and climate mitigation solutions. As a postdoctoral scholar at Woods Hole Oceanographic Institution, her current research focuses on identifying heat-tolerant strains of sugar kelp that can thrive in our warming oceans, and using satellite remote sensing data to determine aspects of the health and ecology of kelp forests. After receiving a B.S. in Biological Sciences from Cornell University, Gonzalez completed a U.S. Fulbright student scholarship in Chile, examining kelp forest ecology and artisanal kelp harvesting strategies. Gonzalez received a Ph.D. in Ecology and Evolutionary Biology from the University of California, Santa Cruz, where she studied giant kelp in California and Chile, and used genomic analyses and field experimentation to uncover distinct evolutionary histories of two forms of the species as well as developmental and chemical differences. Prior to her seaweed research, Gonzalez worked in a range of ecological systems from estuarine shrimp to riparian

insects to tropical birds. She values collaborations and has conducted research on both the east and west coasts of the U.S. as well as in Costa Rica, Chile, Norway, and South Africa.

Kevin Folta

Controlling E, Controlling G, New Crops for Controlled Environments

Abstract:

The promises of vertical indoor farming have attracted interest and investment, but as business plans fail and best intentions fall short, it brings an opportunity to re-consider the most complicated machine in the room—the plant itself. Any plant genetic improvement efforts must consider the environment where a selection will be grown. We have known for a long time that crops bred for Florida may not perform optimally in upstate New York, and vice versa. So why have so many companies attempted to grow crops bred for the field in closed controlled environments? Crop productivity is dictated by interactions between genetics and environment (GxE), with the E constraining the potential of G. We can now control E, so why are we not identifying G specifically selected to match any given E? The field priorities of disease and stress tolerance flip to in-box priorities of stature control, sustained production, and energy consumption. What clever strategies can we employ to select new genotypes that are suitable for commercial production under an electronic canopy?

Bio:

Kevin Folta is a professor in the Horticultural Sciences Department at the University of Florida. Dr. Folta is known for his unique approaches to questions in photomorphogenesis, controlled environment agriculture, the genetic basis of flavors in fruits, and control of flowering. He also is known for his efforts in science communication, notably his training of scientists and farmers in counterintuitive methods of public engagement. He has been recognized with the NSF CAREER Award, the CAST Borlaug Award in Agricultural Communication among others. He's hosted the weekly Talking Biotech Podcast since 2014 with 30,000 monthly downloads. He also helps his wife farm fruit, vegetables and heritage breed turkeys in rural Florida. Ph.D. in molecular biology from the University of Illinois at Chicago in 1998.

Frank Technow

Back to the Future: germplasm evolution within complex genetic systems

Abstract:

Plant breeding germplasm evolves in a complex system of interacting genetic and environmental features. Creating predictable and heritable genetic gains in complex biological space requires population structures and selection strategies that seem counterintuitive under the assumptions of the classical model of quantitative genetics based on stationary genetic effects. This talk explores an alternative rationale for the success of the decentralized population structure of a large breeding operation like Corteva. This is done using theoretical models of biological complexity reflecting the properties of interactive genetic networks. It is argued that the observed population stratification and reduction in effective population size enables rather than hinders the long-term evolvability and adaptability of germplasm in complex genetic and environmental systems. These results introduce new insights into why the historically grown structure of hybrid breeding programs was successful in improving the yield potential of hybrid crops over the last century.

Bio:

Frank is a Senior Research Scientist for breeding strategies with Corteva Agriscience. In this role he creates and optimizes innovative breeding strategies through data analysis, theoretical simulation and quantitative genetics. He started his scientific career in his home country of Germany, where he obtained a PhD in plant breeding and genetics from the University of Hohenheim. His journey with Corteva started in 2014, when he joined DuPont Pioneer as Postdoc in the Breeding Technologies group. In 2015 he became a Research Scientist within the Plant Breeding department in Canada. In this role he was responsible for key innovations in breeding methods that challenged decades old paradigms and changed how the company breeds globally. Currently his scientific work focuses on the theoretical foundations of germplasm evolution and its role in the engineering of holistic agricultural production systems.

Nolan Bornowski

Out of the darkness: Historical challenges and modern solutions in button mushroom breeding

Abstract:

People have used mushrooms for their culinary, cultural, medicinal, and psychoactive properties for thousands of years. However, deliberate, human-directed modification of mushrooms as a food crop is a much more recent endeavor compared to domestication of other plant and animal species. The white button mushroom (Agaricus bisporus) is one of the most commercially relevant mushroom species and can be found growing in both natural and commercial environments around the world. Despite its prevalence, large-scale production of the white button mushroom is only a few hundred years old, and dedicated breeding efforts have only begun within the last century. Both biological and systemic challenges have contributed to the lack of breeding progress. Fortunately, modern advances in sequencing and bioinformatics permit a deeper investigation into the fundamental (and frequently enigmatic) aspects of mushroom biology and cultivation. The knowledge gained from such insight can then be applied toward not only developing new mushroom strains, but also transforming the industry to welcome new production methods and commercial end-products.

Bio:

Dr. Bornowski earned his bachelor's degree in Horticulture from the University of Wisconsin-Madison before traveling across Lake Michigan to attend graduate school at Michigan State University. There, he earned a master's degree in the dry bean breeding and genetics program where he studied quantitative genetics of black bean canning quality. He was profoundly impacted by a course on plant genomics that led to him pursuing a doctorate degree in that realm. His doctoral research projects involved developing genomic resources for breeders and researchers across a spectrum of crops, including various mint species, maize stiff-stalk inbreds, and tepary beans. In his current role as a research scientist at the mushroom spawn company, Amycel Spawn Mate, Dr. Bornowski focuses on improving the white button mushroom (Agaricus bisporus) through genomics and bioinformatics approaches. He is particularly interested in characterizing phenotypic and genotypic diversity in button mushrooms and then utilizing that diversity to develop better mushroom strains for commercialization. Outside of work, he enjoys trying new foods, playing drums, and breeding beans with unique seed coat characteristics.

Taqdeer Gill

Eye in the Sky: Hyperspectral Imaging for Sustainable Nitrogen Management in Vegetables

Abstract:

Snap beans and kidney beans are poor nitrogen fixers and need nitrogen fertilizer. However, excessive application of N leads to groundwater contamination. The traditional way of measuring crop nitrogen status is destructive and time-consuming. The objective of this study was to develop a tool that accurately predict the real-time crop nitrogen status and the end-of season yield for optimizing fertilizer management.

The field trial was conducted in 2022 and 2023. Eight nitrogen treatments were applied at 22 kg ha-1, 56 kg ha-1, 84 kg ha-1, 112 kg ha-1, 140 kg ha-1, 168 kg ha-1, 196 kg ha-1, 224 kg ha-1 to three kidney beans cultivars. Six nitrogen treatments were applied at 22 kg ha-1, 56 kg ha-1, 84 kg ha-1, 112 kg ha-1, 140 kg ha-1, 168 kg ha-1 to two snap beans cultivars. Hyperspectral images (400 nm to 2500 nm) were collected on a weekly basis. Top twenty bands along with genotype (G), environmental factors (E), management factors (M) were used to train different machine learning algorithms for predicting the nitrogen status and the final yield.

Our results indicated that top twenty bands along with GxExM performed the best for predicting final yield (R2 = 0.82). Our study demonstrated the potential capacity of hyperspectral imaging to estimate crop yield and nitrogen status.

Bio:

Taqdeer Gill is a PhD student in the Department of Plant and Agroecosystem Sciences at the University of Wisconsin-Madison under the mentorship of Dr. Yi Wang. Her research project focuses on development of remote sensing-based decision support models for nitrogen management of vegetable crops such as dark kidney beans and snap beans. The long-term goal of the project is to develop open-source tools that could help vegetable growers optimize nitrogen fertilizer application. She pursued M.S in Plant Science under the mentorship of Dr. Jason de Koff at Tennessee State University, Nashville and earned B.S in Agriculture (Hons) majoring in Horticulture at the Punjab Agricultural University (India).

Lucas Roberts

Adapting African Leafy Vegetables to Minnesota through Participatory Plant Breeding

Abstract:

Minneapolis-St. Paul is home to many African diaspora communities and recent emigrants have difficulty finding their traditional crops which are not offered by major seed suppliers. There are

a few producers of African leafy greens in the greater Twin Cities area, but due to a poor ability to ship, many customers from across the state must drive long distances to purchase familiar vegetables. Most of these tropical leafy vegetables are adapted to long warm growing seasons and struggle to produce seeds in a timely manner when grown in Minnesota. The Community Plant Breeding Team, a group of graduate student and postdoctoral volunteers, have identified four annual species to focus on adapting to a Minnesota growing season; these include spiderwisp, jute mallow, Ethiopian cabbage, and green amaranth. The group, with support from the University of Minnesota's Plant Breeding Center, started a participatory plant breeding project in 2021 with the goal to develop new varieties ideal for a home gardener. We quickly realized the importance of building relationships and being intentional with what language we use. For example, some common names of crops originated from colonizers and demote human vegetables to nothing more than livestock feed. One of the challenges we face is quantifying taste without applying a Western sense of flavor to our selections. Through working with and not for our stakeholders we have made great progress, our experiments inform best management practices, the giving garden donates fresh produce every week, and we are close to our first variety release.

Bio:

Lucas Roberts is a fourth year PhD candidate in the Applied Plant Sciences program at the University of Minnesota. He grew up on his family's diversified crop farm in central Illinois. Lucas majored in Agronomy and Genetics at Iowa State University while working in Matthew Hufford's evolutionary genomics lab. In 2017 he started a MS in Crop Sciences at the University of Illinois under Anthony Studer studying the genetics and physiology of water-use efficiency in maize. During this time, he spent six months as a visiting student at the International Maize and Wheat Improvement Center in Mexico. After seven years of maize research, Lucas joined the University of Minnesota's soybean breeding lab in 2020 under Aaron Lorenz. His project looks at developing new soybean varieties for sustainable cropping systems, specifically relay-cropping with pennycress. In 2023 he was named a National Association of Plant Breeders Borlaug Scholar. In his free time, he maintains a backyard breeding program of dahlia and iris. Currently Lucas volunteers as the field coordinator for the UMN Community Plant Breeding Team under the guidance of Rex Bernardo where he works with Twin Cities communities to adapt traditional African vegetables to Minnesota.