VacCAP

Improving Fruit Quality

Issue 1 | August 2020

VacCAP Objectives

The Vaccinium Coordinated Agricultural Project (VacCAP) aims at leveraging genetic and genomic resources to enable development of blueberry and cranberry cultivars with improved fruit quality attributes.

1. Establish genomic resources to enable effective association mapping studies in blueberry and cranberry.
2. Discover DNA markers and fruit characteristics that maximize industry profitability and match consumer preferences in blueberry and cranberry.
3. Deliver molecular and genetic resources to improve blueberry and cranberry fruit quality traits that maximize industry profitability and match consumer preferences.
4. Assess the potential socio-economic impact of blueberry and cranberry fruit quality improvements on market demand.
5. Engage U.S. *Vaccinium* breeders and stakeholder groups to transfer advanced phenomics and genomics tools to build a more coordinated and efficient cultivar development system.

Welcome to VacCAP!

Soon after I joined the small fruit scientific community in 2015, I realized that the ingredients needed to establish a community-based project to support advances in molecular breeding for blueberry and cranberry were already in place.

Dr. Massimo Iorizzo | Project Director
North Carolina State University

- Blueberries and cranberries are two crops that—bedsides being morphologically different—belong the same genus, *Vaccinium*, and share a lot of genetic information.
- New breeders with expertise in quantitative genetics and genomics had recently been hired, complementing the skills of a group of highly productive and respected traditional breeders in the small fruit breeding community.
- There was strong financial and strategic support for small fruit breeding programs from an industry community encompassing global leaders in blueberry and cranberry breeding, production, processing, and distribution.
- National and international scientists—with expertise in plant pathology, post-harvest physiology, horticulture, food science, socio-economics, engineering, molecular genetics, bioinformatics, and extension—were already supporting breeding programs, establishing a strong transdisciplinary team.

I trust that you would agree with me, that it was worth the efforts to put all these ingredients together in the form of The Vaccinium Coordinated Agricultural Project (VacCAP). Last and most importantly, this community is made of very dedicated and trustworthy professionals, and that is why we can bring this first edition of the VacCAP newsletter to you.

We welcome VacCAP collaborators and industry partners' inputs and we look forward to communicating and sharing our research with you.

What is VacCAP?

By Josie Russo, *University of Wisconsin-Madison*

The Vaccinium Coordinated Agricultural Project (VacCAP) is a massive undertaking, involving researchers from multiple U.S. academic institutions, USDA research centers, and international research partners. But what exactly is VacCAP, and how do we plan to assist the U.S. Vaccinium industry through our research?

VacCAP is a nationwide project aimed at developing new genetic tools to improve the fruit quality of cranberries and blueberries. Beginning with the *Vaccinium* Planning grant, the VacCAP mission and objectives have evolved through a process of active engagement among stakeholders and researchers.

In response to a breeding traits survey, stakeholders identified breeding cultivars with improved fruit quality as high priority, especially for fruit texture (firmness), sensory profile (flavor), shelf life, and appearance (color, size, free of disease damage).

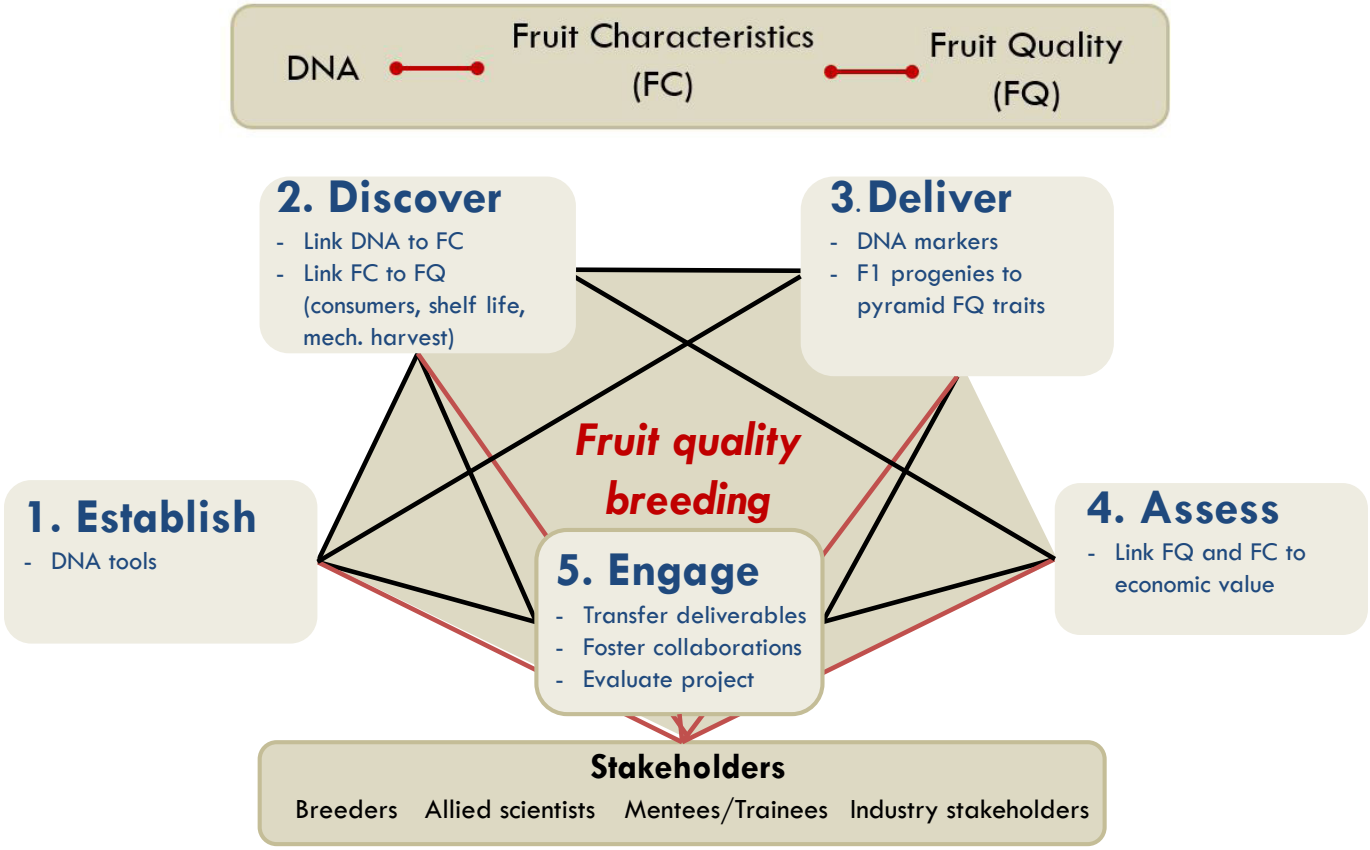
+$2 BILLION national *Vaccinium* industry's domestic wholesale value

The identification of fruit quality as a top priority by stakeholders was the major catalyst behind VacCAP's conception. Cranberries—once relegated to the juice aisle and yearly appearance on Thanksgiving tables—are now popular as dried and sweetened additions to granola bars and cereals. But that pivot also meant a need for higher quality fruit, since sweet and dry cranberries have different processing requirements. Blueberries, meanwhile, struggle with inconsistent quality in fresh market fruit and reliance on hand harvesting—which makes up as much as 40 percent of production costs. More consistent quality and durable berries will be a huge improvement for the blueberry community.

Currently, U.S. *Vaccinium* breeders have little empirical data to assign more or less importance to fruit characteristics (FCs) and few tools to select for high fruit quality. Breeders needs access to molecular and genetic resources, like marker assisted selection, to help improve fruit quality traits.

Our research looks at identifying FCs (appearance, texture, chemical composition) that contribute to higher fruit quality (shelf life, consumer preferences) and identifying DNA markers that are associated with them. *Vaccinium* breeders will then be able to effectively select new cultivars with FCs that positively contribute to fruit quality and increase market value.

Long term, the resources developed during the project will increase production of high quality fruit that will benefit growers, processors, distributors, and consumers through improved production, harvesting and processing efficiency, and a more consistent consumer eating experience.



Get to Know the VacCAP Teams

Our VacCAP team is listed below and organized by project objective. However, nine project teams manage the project and work collaboratively across project objectives and with our advisory panel

Eastablish (Comparative Genomics and Genotyping Teams)

- Nahla Bassil, Co-PD, USDA-ARS and NCGR
- David Chagné, Co-PI, Plant and Food Research Ltd
- Patrick Edger, Co-PD, Michigan State University
- Richard Espley, Co-PI, Plant and Food Research Ltd

Deliver (Breeding and Statistical Genetics Teams)

- Massimo Iorizzo, Project Director, North Carolina State University
- Patricio Munoz, Co-PD, University of Florida
- James Polashock, Co-PI, USDA-ARS and GIFVL
- Nicholi Vorsa, Co-PD, Rutgers University

Discover (Phenomics and Fruit Quality Teams)

- Lara Giongo, Co-PI, Fondazione Edmund Mach
- Massimo Iorizzo, Project Director, North Carolina State University
- Changying Li, Co-PI, University of Georgia
- Mary Ann Lila, Co-PD, North Carolina State University
- Patricio Munoz, Co-PD, University of Florida
- Penelope Perkins-Veazie, Co-PD, North Carolina State University
- Charles Sims, Co-PI, University of Florida
- Nicholi Vorsa, Co-PD, Rutgers University
- Juan Zalapa, Co-PD, University of Wisconsin-Madison

Assess (Socio-Economics Team)

- Elizabeth Canales, Co-PI, Mississippi State University
- Karina Gallardo, Co-PD, Washington State Univeristy

Engage (Extension and Data Management Teams)

- Amaya Atucha, Co-PD, Univeristy of Wisconsin-Madison
- Michael Coe, Key Personnel, Cedar Lake Research Group
- Lisa Wasko DeVetter, Co-PI, Washington State University
- Dorrie Main, Co-PD, Washington State University

Advisory Panels

Stakeholder Panel

- James Hancock, Berry Blue LLC
- Nicole Hansen, Cranberry Grower
- Matt Kramer, Fall Creek Farm and Nursery
- James Olmstead, Driscoll's, Inc.
- Rod Serres, Ocean Spray Cranberries, Inc.
- William Frantz, The Cranberry Institute

Scientific Panel

- Robin Buell, Michigan State University
- Jeffrey Endelman, University of Wisconsin-Madison
- Mario Ferruzzi, North Carolina State University
- Kim Hummer, USDA-NCGR (OR)
- Amy Iezzoni, Michigan State University
- Brandon McFadden, University of Delaware
- Anne Plotto, USDA-ARS (FL)
- Moira Sheehan, Cornell University
- Cindy Tong, University of Minnesota

Extension Panel

- Rodney Cook, Ag-View Consulting, Inc.
- David Eddy, Master Media Worldwide
- Tim Martinson, Cornell University
- Tom Peerbolt, The Northwest Berry Foundation
- Christopher Watkins, Cornell University

Supporting Industry Partners

- British Columbia Blueberries
- Berry Blue, LLC
- California Blueberry Commission
- Cape Cod Cranberry Growers' Association
- The Cranberry Institute
- The Dole Food Company
- Driscoll's, Inc,
- Fall Creek Farm and Nursery, Inc.
- Florida Blueberry Grower's Association
- Gerogia Blueberry Commission
- Kentucky Blueberry Growers Association
- Mariani Premium Dried Fruit
- New Jersey Blueberry Cranberry Research Council
- North American Blueberry Council
- North Carolina Blueberry Council, Inc.
- Ocean Spray Cranberries, Inc.
- Oregon Blueberry Commission
- Oregon Blueberry Farms and Nursery
- Oregon Cranberry Grower Association
- U.S. Highbush Blueberry Council
- Valley Corporation
- Washington Blueberry Comission
- Wayne County Blueberry Growers Association
- Wisconsin State Cranberry Growers Association

Team: 21 PIs, >70 partners, 25 institutions (US, Canada, New Zealand, Italy, Scotland)

National and International Partners

Over 70 national and international partners representing the blueberry and cranberry industry, breeders, allied scientists and extension specialists supported the project and will be engaged during the project in activities that aim to: a) transfer project deliverables; b) foster collaborations; c) inform about project outcomes; d) continue planning research needs around blueberry and cranberry problems not directly or immediately addressed in this project.

Breeding and Molecular Geneticist Partners

- Hamid Ashrafi, Assistant Professor, North Carolina State University
- Mark K. Ehlenfeldt, Research Geneticist, USDA-ARS
- Stephen Stringer, Research Geneticist, USDA-ARS
- Lisa J. Rowland, Research Geneticist, USDA-ARS
- Kalpalatha Melmaiee, Assistant Professor, Delaware State University
- Ebrahiem Babiker, Research Geneticist, USDA-ARS
- Moira Sheehan, Director of Breeding Insights, Cornell University
- Jim Hancock, Breeders, Berry Blue, LLC
- Jim Olmstead, Global Breeding Director-Blueberry, Driscoll's, Inc.
- Mathew Kramer, Director of Product Development & Commercialization, Fall Creek Farm & Nursery, Inc.
- Bob Gabriel, President, Oregon Blueberry Farm and Nursery
- Edward Grygleski, Cranberry Breeder and Producer, Valley Corp.
- Rachel Itle, Assistant Research Scientist, University of Georgia

Fruit Quality Partners

- Anne Plotto, Research Plant Physiologist, USDA ARS
- Randy Beaudry, Professor, Michigan State University
- Steve Sargent, Professor and Associate Chair, University of Florida
- Rod Serres, Manager Agricultural Science, Ocean Spray
- Andy Reitz, Director of Grower Relations, Mariani Co., Inc.
- Mike Mainland, Professor Emeritus, North Carolina State University

Bioinformatics and Biotechnology Partners

- Robert Reid, Assistant Professor Bioinformatics, University of North Carolina-Charlotte
- Margaret Staton, Assistant Professor of Bioinformatics, University of Tennessee
- Guo-Qing Song, Associate Director Plant Biotechnology Resource & Outreach Center, Michigan State University

Extension Network

- Ali Sarkhosh, Assistant Professor, University of Florida
- Cassie Bouska, Assistant Professor, Oregon State University
- Carlos Garcia-Salazar, Extension Educator, Michigan State University
- Kim Patten, Director Pacific Co. and Extension Professor, Washington State University
- Cesar Rodriguez-Saona, Extension Specialist, Rutgers
- Renee Allen, Extension Specialist, University of Georgia
- William O. Cline, Research and Extension Specialist, North Carolina State University
- Kathleen Demchak, Senior Extension Associate, Penn State University
- Ben Faber, Advisor, Cooperative Extension Ventura County
- Mary Rogers, Associate Professor, University of Minnesota
- Hilary A. Sandler, Director of UMass Cranberry Station and Extension Associate Professor, University of Massachusetts-Amherst
- Erick D. Smith, Assistant Professor, Univeristy of Georgia
- Eric Thomas Stafne, Extension/Research Professor, Mississippi State University
- Wei Qiang Yang, Associate Professor and District Berry Extension Agent, Oregon State University
- Mike Mainland, Professor Emeritus, North Carolina State University

Other Abiotic and Biotic Stresses Partners

- Christelle Guédot, Associate Professor, University of Wisconsin
- Jonathan Oliver, Assistant Professor-Fruit Pathologist, University of Georgia
- David Bryla, Research Horticulturist, USDA-ARS HCRU
- Scott Lukas, Assistant Professor, Oregon State University Hermiston Agricultural Research and Extension Center

International Partners

- Michael Dossett, Research Scientist at BC Berry Cultivar Development Inc., British Columbia
- Susan McCallum, Blueberry Researcher at James Hutton Institute, Scotland
- Luis Diaz Garcia, Instituto Nacional de Investigaciones Forestales y Agrícolas y Pecuarias, Aguascalientes, Mexico
- Paul Sandefur, Manager of Breeding Operations at Fall Creek Farm & Nursery Inc., Oregon, USA
- Simon Bonin, Director of Grower Relations and Agronomy at Fruit d'Or, Quebec, Canada
- Susan Thomson, Bioinformatician at Plant and Food Research Ltd, New Zealand
- Toshi Foster, Senior Scientist, Plant and Food Research Ltd, New Zealand

Breeding for a Machine Harvestable Berry

By Josie Russo, *University of Wisconsin-Madison*

Blueberry harvesting is complicated—a balancing act between a tight, expensive labor market and soft, finnicky fruits.

Increased labor costs over the past few years have more growers looking to turn from hand-harvesting to machine harvesters. But traditional machine harvesters cater to the processing market where fruit durability and bruising are not a concern.

Many blueberries can get damaged during the traditional machine harvesting process—up to 60 percent, in fact. While this damage doesn't impact the domestic fresh-markets with short shelf lives as much, it is not conducive for important export markets and storage over a longer period of time. Damaged berries are lower in quality and will have a shorter shelf life, which can result in another financial hit for growers.

So, how can we make blueberry harvesting less complicated and more cost effective? There is no one, simple solution. It is a perfect storm of tweaking and refining different factors, from adapting the harvesting equipment all the way down to improving the fruit's genetics.

Researchers are trying to find out if there is a way to combine the cost efficiency of new machine harvesting technologies with the quality of hand-picked blueberries. Dr. Lisa Wasko DeVetter, a VacCAP Co-PI and Associate Professor at Washington State University, is working on another project that aims at implementing "soft-catch" technology onto machine harvesters, using softer materials on high impact sites to reduce damage to the berries. But the machines are only as good as the fruit they have to work with. Different cultivars have different reactions, but overall, new cultivars that do not bruise as easily are desirable. That's where the genetics comes in.

Dr. Patricio Munoz, a VacCAP Co-PD and Assistant Professor at the University of Florida, is tackling the challenge by developing improved blueberry cultivars with a focus on firmness.

"Plants need several characteristics to be considered a good machine harvestable. By far, fruit firmness is the most important. If you don't have firm fruit, nothing else matters. You'll just get jam if it's not firm." Munoz said.

And it sounds like they're making good progress in that aspect.

"We did a review of fruit firmness from all the blueberry cultivars that have been released since the beginning of the domestication of the species and had data in the literature," Munoz said. "It showed a linear trend in firmness improvement for all low-chill varieties. Almost all varieties—over 30— can

be machine harvested, as conformed by growers and machine harvest service providers, with the exception of two cultivars, and those two cultivars are known to have soft fruit."

While advances in fruit firmness among new cultivars is progressing, Munoz says the next issue is going to be how to reduce fruit loss to the ground during harvesting operations. Other relevant traits needing to be addressed include how easily the fruit releases from the plant and bush architecture.

"Almost all blueberries do not produce a single trunk; they have lots of canes. It would be easier to machine harvest with a single trunk," Munoz said. "With multiple, spread-out canes, this creates spaces for fruit to fall to the ground when using most current machine harvesters."

There is a lot more variability in the architecture of blueberry plants to work with to help address this, though. Munoz noted the extreme differences in the more tree-like Meadowlark cultivar compared to the very bushy cultivars that many associate with blueberries.

Growers can modify plant architecture to better suit machine harvesting by pruning, using cartons or zip ties to narrow the crown after planting, and/or using a trellis system. However, this requires additional labor and costs. Having an optimal plant architecture through genetics would be more cost-effective for growers who are already dealing with thin margins.

At the end of the day, the key goal is to improve cultivars as a way to keep blueberry harvesting successful and cost-efficient for growers.

"In 2017, we released a cultivar specifically for machine harvest for fresh market (cv. Optimus). This trait has become a standard practice to check for in new cultivars, such as in 'Colossus'. We hope to keep developing cultivars that can be machine harvested," Munoz said. "That's the objective of the program and the main goal is make producers be more profitable and stay in the game."

Northern highbush blueberry ('Duke' and 'Draper') being harvested using a modified machine harvester for the fresh market in northwest Washington. All photos by Dr. Lisa Wasko DeVetter.

Dr. Chad Finn – Forever Inspiring the Berry Breeding Community

By Dr. Lisa Wasko DeVetter, *Washington State University*

Dr. Chad Finn was a well-regarded research geneticist and berry breeder that worked for the United States Department of Agriculture-Agricultural Research Services (USDA-ARS) in Corvallis, Oregon, USA. He also had an infectious laugh you could hear across a room and a hug that could break you (literally—he has accidentally broken ribs!), but overwhelmingly gave you a sense of enduring friendship. Chad's passion for plants, plant breeding, and small fruit improvement was also well-known and respected in the berry production and plant breeding community.

Sadly, the berry community lost this productive and influential member of their community on December 17, 2019, due to an accident sustained while Chad was on vacation in Hawaii. Hundreds of us also lost a dear friend. Chad was only 57 years old at the time of his passing, but he had an impactful career worthy of recognizing and celebrating.

Chad's expertise was berry breeding, germplasm, and cultivar performance, but he also commanded expertise in berry production and processing. As a USDA breeder, he spent 26 years of his professional career developing not just blueberry, but also raspberry, blackberry, and strawberry cultivars. He was prolific in his work and released or co-released 51 berry cultivars that are grown all over the world. This figure includes 21 blackberry, 11 red raspberry, 12 strawberry, and 7 blueberry releases. He was also an instrumental partner in the only government-university cooperative breeding program with Dr. Bernadine Strik at Oregon State University, which has led to many breeding and horticultural successes. His work and collaborative spirit is a model to many.

Beyond breeding, Chad made many important literary contributions by authoring or co-authoring 475 publications, including 217 peer-reviewed papers, 16 patents/patent applications, 34 book chapters, 38 extension publications, 85 proceeding articles, and over 137 abstracts. He was well known around the world and exchanged germplasm with more than 25 breeding programs internationally. Furthermore, he gave over 273 invited presentations (17 as keynote speaker). Chad was always busy, but his high spirits and energy seemed unbounded.

The innovativeness and impact of Chad's research program have been recognized by the scientific community and small fruit industry and is demonstrated by his receipt of the following awards: USDA-ARS Technology Transfer award, American Pomological Society's Wilder Medal for outstanding service to horticulture in the broad area of pomology, American Society for Horticultural Science's Outstanding Fruit Cultivar Award for 'Black Diamond' blackberry, and the Federal Laboratory Consortium's Far West Regional Award

Chad Finn with his friend and collaborator in the only government-university cooperative breeding program, Dr. Bernadine Strik (top left), Chad showcasing blackberry selections (top right), Chad sharing some of his strawberry selections at a field day along with his technical support staff, Ted Mackey and Pat Jones (lower left), and Chad in his strawberry field (lower right).

for "Development of New Berry Varieties" in the category of Outstanding Commercialization Success. In addition, Chad was elected a Fellow of the American Society for Horticultural Science and honored as a Distinguished Alumnus by Purdue University's Department of Horticulture. He has also received numerous international and domestic requests for information, invitations to discuss his research program, successful grant proposals, and requests to assist in the development and evaluation of plant material from other breeding programs around the world. He was an extraordinary man and scientist.

Beyond the man and scientist, Chad was a dear friend, husband, and father. He is survived by his wife, Barb, two sons Elliott and Ian, sister Beth, and brothers Bart, Dan and Mark. He also leaves behind hundreds of friends that will cherish their memories of Chad. The friendships he forged span the world and hundreds considered Chad a dear friend and acquaintance, which was exemplified at his celebration of life where there was standing room only.

For the VacCAP community, Chad Finn was an instrumental figure that played a key role in the visioning that led to this successful proposal. Now that Chad is gone, his role has changed from one of collaboration to inspiration, as we are all inspired by Chad to do our very best on this project proposal and make a positive, lasting impact to *Vaccinium* crop improvement.

In Memory of Dr. Chad Finn

Chad was an extraordinary berry crop breeder. His cultivars are widely planted and have such a positive impact on our industry. As I've walked our cooperative breeding plots this season, helping to evaluate his advanced selections, I've been reminded of how talented he was.

We will continue to release new cultivars in his honor. Chad was an amazing colleague and a generous, kind man. His booming laugh and huge hugs were legendary. I cannot fully express how much I miss him.

– Dr. Bernadine Strik, Professor, Oregon State University.

Dr. Chad Finn with Dr. Bernadine Strik

Chad was a larger-than-life person, and upon meeting him, I liked him instantly. The knowledge he had for his craft, from cross to release and from product to market, was unparalleled. To do that for one species takes most people a lifetime, and he did it for five different species.

The small fruit breeding community saw him as a pillar of practical know-how and as a pioneer of new technologies and forward thinking. I saw him like a sage, doling out nuggets of information with every question posed to him. Chad was generous with his time, his humor, and his knowledge, and will be sorely missed.

– Dr. Moira Sheehan, Breeding Insight Director, Cornell University

I miss Chad like he lived his life: FULLY, GENUINELY, ALL THE WAY. He was the best partner that I have ever had or will ever have. I am blessed to have crossed his path and been his work partner and friend. Many will drink from the wells he dug and the fires he built.

– Dr. Nahla Bassil
USDA-ARS, NCGR

Dr. Chad Finn with Dr. Nahla Bassil

Chad Finn, a person who would bring a positive and productive experience any time he was engaged, who you would wish to have in your team, who would be always available, provide critical inputs and make critical decisions with a positive perspective and a smile, who you would look for to entertain by a beer or glass of wine.

A person that not only had a tremendous impact on his field of work, but that inspired everyone around him. That is a true leader. Thank you, Chad, for sharing all these with me.

– Dr. Massimo Iorizzo, Associate Professor, NC State University

I am so grateful to Chad for having shared a part of his very large life with me. No one better have I known. He was a great friend to us all and was beloved for his wit, booming laugh and willingness to research on all things small fruit.

He was a dream collaborator, who repeatedly came up with great ideas, made everyone feel at ease and exuded great fun. He was a prodigious plant breeder who maintained the most diverse berry breeding program in the world and created varieties that really made a difference.

Chad, you were my dearest friend and you will be sorely missed by everyone who knew you.

– Dr. James Hancock, Professor Emeritus, Michigan State University

Chad was brusque, rough around the edges, and unfailingly honest and upfront. You always knew exactly where you stood with him.

– Dr. Mary Ann Lia, Director, Plants for Human Health Institute

Building a Better Berry: A Cranberry Q&A With Dr. Juan Zalapa

By Dr. Amaya Atucha and Josie Russo, *University of Wisconsin-Madison*

Dr. Amaya Atucha sat down with Dr. Juan Zalapa to discuss his research on improving cranberry fruit quality traits, and what a more efficient cranberry means for the Vaccinium industry.

What is the main focus of your research program?

One main focus of my lab—the USDA Cranberry Genetics Lab—is to understand traits that help growers be more efficient at producing cranberries, with the ultimate goal of breeding cultivars that allow them to reduce inputs and maximize economic return. We have focused over the years on yield-related traits, mostly total yield and the size of the berries. In the last five to 10 years, there has been a shift from focusing on higher yield to an interest in producing high quality fruit. This has been mainly driven by the need to produce berries with improved fruit quality traits, such as color and firmness, to produce sweet and dry cranberries (SDC).

My lab has been working on developing tools to measure fruit quality, and it has been quite an interesting exercise to find out what fruit quality means for different people. We did a survey during the planning grant we got before VacCAP that allowed us to look at what traits the industry was interested in, and it was very clear fruit quality was an important trait, especially fruit firmness and fruit size—which my research group was already working on at that time.

Based on the information we gathered from this survey, my lab refocused on prioritizing fruit quality traits. However, to be able to make significant contributions in this area, we had to develop methods and techniques to be able to measure some of these traits, which is what we have been doing for a number of years now.

For example, firmness is a difficult trait to measure, because there are different ways of measuring firmness. We've done a lot of work to try to understand firmness and how that can be measured, and ultimately, how that can be used to produce a better SDC.

Now that we actually have an understanding of some of these traits and developed techniques to measure them, we are now in the process of developing cultivars and understanding the genetics behind how these traits are transmitted from parent to offspring.

The cranberry industry has really changed. About 15 or 20 years ago, priority was to increase yield and fruit color. But now with the development of new products such as the popular SDC used in cereal and granola bars, the industry realized that fruit quality traits, such as firmness, are key to produce SDCs. But why is fruit firmness important in terms of cranberries?

Cranberries are processed in very unique way. Once the fruit is harvested, it goes in a freezer and is kept frozen until processing. Afterwards, the berries are thawed and sliced to make the SDCs. This process of freezing and thawing the berries makes them very soft, which ultimately makes the slicing process difficult because the skin separates from the pulp, meaning they basically fall apart.

Cranberries seem firm compared to other fruits, so why is their focus on firmness?

What we call firmness in cranberry is not really just the firmness to the touch, but we have discovered it is related to the thickness of the flesh. Cranberries are a very unique fruit because they have air pockets inside, which makes them hollow and this in part is the reason they float on water. The size of these internal cavities in combination with the thickness of the surrounding flesh affect fruit firmness. So, when we talk about firmness in cranberries, it is very different to firmness in other fruit crops such as apples or peaches where firmness is related to the density of the flesh and how it softens as the fruit ripens.

Where does VacCAP fit in all this? What outcomes do you hope for—in the short and long term?

The great thing about VacCAP is that it allows us to work with the blueberry team. They are also interested in many of the same fruit quality traits, and just like us they are developing ways to evaluate these traits. This is great because we can learn from each other and share methodologies and techniques.

We are also working on linking these traits to genetic components and finding out what genes control traits that matter for SDC production. Part of the project for VacCAP is to incorporate wild plant material, which is very unique. No one has used this approach before in *Vaccinium* to understand how these plants may contribute genes to traits that matter, like fruit quality. Overall, we are working on how to incorporate genetic diversity in our breeding program to improve fruit quality.

The final aspect is how to design strategies to bring those genes together. Once we know how those traits are measured, where they're located in the chromosome, how they may be present or represented in different diverse plants all over the growing areas, then I can figure out how we can use all that information to bring genes together.

How does this all integrate in *Vaccinium*?

Blueberries and cranberries are closely related species,

Dr. Juan Zalapa completing some maintenance in a high density cranberry nursery at Saddle Mound Cranberries (top image). Workers setting up cranberry research and breeding plots at the Wisconsin Cranberry Research Station in Black River Falls, WI (bottom right).

which means they have a lot of these genes in common. So how can all these genes be useable for all of us as *Vaccinium* breeders, and researchers and geneticists? This is the most exciting part: to see what we have in common and what we don't, and then see how we can bring things together. In order to discover new things, what's important is the populations you use, the plants you use, and the different techniques you can implement in your crop. So, we may have different techniques we can implement or different plants to bring in.

We're getting almost two studies out of one. Anything that blueberry breeders and researchers find could be very useful to me, and the other way around. We are making sure we have all the elements to make sure everything is synched and we are able to use the information the other produces.

And that work can be extended. *Vaccinium* has hundreds of species. We're only talking about five or six species we're working on between blueberries and cranberries. But the work can be expanded to include species we don't even know about that could bring in really interesting traits and so on. I think this is where the power of getting together with the *Vaccinium* community is really going to pay off.

VacCAP Team and Other Related Publications

- Cappai F, Amadeu RR, Benevenuto J, Cullen R, Garcia A, Grossman A, Ferrão LFV and Munoz P (2020) High-Resolution Linkage Map and QTL Analyses for Machine Harvest Traits in Autotetraploid Blueberry. *bioRxiv*. doi: 10.1101/2020.05.13.093633

- Farneti B, Emanuelli F, Giongo L, Toivonen P, Iorizzo M, Folta K and Finn CE. (2020) Editorial: Interdisciplinary Approaches to Improve Quality of Soft Fruit Berries. *Front. Plant Sci.* doi: 10.3389/fpls.2020.592222

- Farneti B, Emanuelli F, Khomenko I, Ajelli M, Biasioli F and Giongo L (2020) Development of a Novel Phenotypic Roadmap to Improve Blueberry Quality and Storability. *Front. Plant Sci.* 11:1140. doi: 10.3389/fpls.2020.01140

- Ferrão LFV, Johnson TS, Benevenuto J, Edger PP, Colquhoun TA and Munoz PR (2020) Genome-Wide Association of Volatiles Reveals Candidate Loci for Blueberry Flavor. *New Phytol*. 226:1725. doi:10.1111/nph.16459

- Fong SK, Kawash J, Wang Y, Johnson-Cicalese J, Polashock J and Vorsa N (2020) A Low Citric Acid Trait in Cranberry: Genetics and Molecular Mapping of a Locus Impacting Fruit Acidity. *Tree Genetics & Genomes*. 16:42. doi: 0.1007/s11295-020-01432-4

- Günther CS, Dare AP, McGhie TK, Deng C, Lafferty DJ, Plunkett BJ, Grierson ERP, Turner JL, Jaakola L, Albert NW and Espley RV (2020) Spatiotemporal Modulation of Flavonoid Metabolism in Blueberries. *Front. Plant Sci.* 11:545. doi: 10.3389/fpls.2020.00545

- Mengist MF, Grace MH, Xiong J, Kay CD, Bassil N, Hummer K, Ferruzzi MG, Lila MA and Iorizzo M (2020) Diversity in Metabolites and Fruit Quality Traits in Blueberry Enables Ploidy and Species Differentiation and Establishes a Strategy for Future Genetic Studies. *Front. Plant Sci*. 11:370. doi: 10.3389/fpls.2020.00370

- Rowland LJ, Ogden EL and Vinyard BT (2020) Phenotypic Evaluation of a Hybrid Diploid Blueberry Population for Plant Development and Fruit Quality Traits. *Agronomy*. 10:1067. doi: 10.3390/agronomy10081067

- Sater HM, Bizzio LN, Tieman DM and Muñoz PD (2020) A Review of the Fruit Volatiles Found in Blueberry and Other Vaccinium Species. *Journal of Agricultural and Food Chemistry*. 68:5777. doi: 10.1021/acs.jafc.0c01445

Events

On August 26, we presented a webinar titled "An Introduction to the Breeding Information Management System (BIMS) and the Field Book App". The recording can be found on our VacCAP Project YouTube channel.

BIMS is a secure and comprehensive online breeding data management system available at www.vaccinium.org that allows individual breeders to store, manage, archive and analyze their private breeding program data. Field Book is an android App for data collection which allows breeders to replace hard-copy field books, thus alleviating the possibility of transcription errors while providing faster access to the collected data.

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- Get the latest articles and resources
- Find webinar announcements and registration links
- Check out photos from the field
- And so much more!

Also check out our new website www.vacciniumcap.org and YouTube channel to see articles and videos as they go live.

Partners: Do You Want to Contribute to the VacCAP Newsletter?

If you are interested in contributing or have announcements for events, publications, or another other initiative that you want to share, contact Josie Russo at jrusso2@wisc.edu with the subject line "VacCAP Newsletter Contribution"

VacCAP
IMPROVING FRUIT QUALITY

USDA
United States Department of Agriculture
National Institue of Food and Agriculture
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