VacCAP

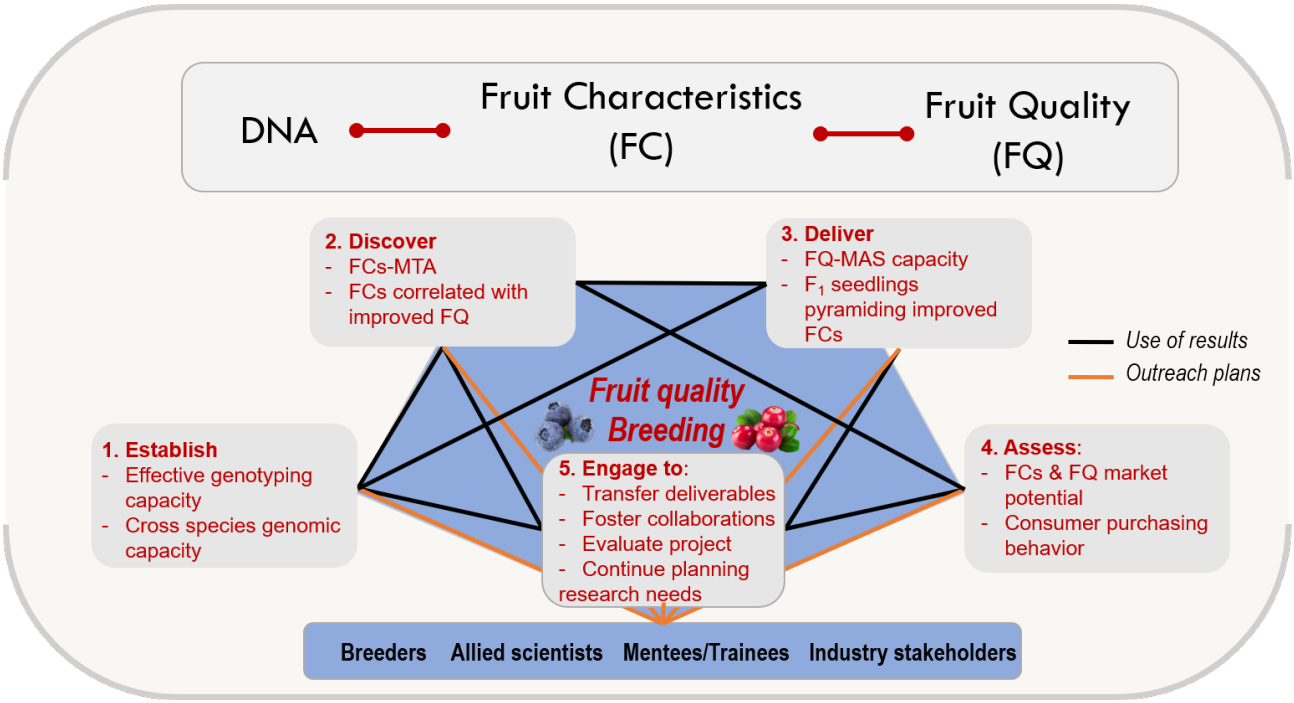
Improving Fruit Quality

Annual Project Report and Plan

Annual Meeting II | November 12-13, 2020 | Online

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.



USDA
United States Department of Agriculture
National Institue of Food and Agriculture
Award #: 2019-51181-30015

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Agenda Day 1

Advisory Board Meeting | Thursday, November 12, 2020 | Online

Zoom link: ***https://ncsu.zoom.us/j/95187243125?pwd=R2ZMN2FlbFdXc1VZaVlQbW50OUhSZz09***

Time	Section 1 Plan
12:00-12:05	Introduction with Iorizzo
12:05-12:30	Objective 1 • Edger - Developing the Vaccinium PanGenome • Bassil - Developing the Vaccinium Genotyping platform
12:30-1:10	Objective 2 • Iorizzo - Blueberry - Discover DNA markers associated to fruit characteristics • Zalapa - Cranberry- Discover DNA markers associated to fruit characteristics • Giongo/Perkins - Blueberry - Identify fruit characteristics that contribute to fruit quality
1:10-1:30	Objective 3 • Munoz - Develop and validate cost effective DNA assays for Vaccinium breeding • Vorsa - Breeding for FRR
1:30-1:40	Break
	Section 2 Plan
1:40-1:50	Objective 4 • Gallardo - Assess the potential socio-economic impact of blueberry and cranberry fruit quality improvements on market demand
1:50-2:20	Objective 5 • Main – GDV updates and VacCAP development • Atucha – VacCAP update, meetings, newsletter & social media, workshops/webinars
2:20-2:30	International Collaborators (NZ team activities and alignment with VacCAP) • Tim Millar • Catrin Guenther
2:30-3:30	Discussion

November 12 time zone conversion table

	Session	I	Break	I	Discussion
Time zone					
PT (-3)	9	10:30	10:40	11:30	12:30
CT (-1)	11	12:30	12:40	13:30	14:30
ET	12	13:30	13:40	14:30	3:30
IT (+6)	18	19:30	19:40	20:30	21:30
NZ (+17)	5	6:30	6:40	7:30	8:30

Agenda Day 2

Working Group Meeting | Friday, November 13, 2020 | Online

Zoom Link: https://ncsu.zoom.us/j/91064990675?pwd=Zncrd3VYRGp1NVp6a3M4NFZNcFFP

9:30 AM Session 1. Objective 2a-b cranberry.

- Objective: discuss Y1 activities and plan Year 2 activities
- Expected participants: Iorizzo, Vorsa, Zalapa, Polashock, Pottorff, Bassil
- Coordinator: Zalapa

10:30 AM Session 2. Objective 2a-c blueberry.

- Objective: discuss Y1 activities and plan Year 2 activities
- Expected participants: Perkins-Veazie, Lila, Giongo, Munoz, Iorizzo, Pottorff, Mackey, Sims, Li, Gallardo, Canales
- Coordinator Obj 2a-b: Iorizzo (45 min)
- Coordinator Obj 2c: Perkins-Veazie (45 min)

12 PM Session 3. Objective 3 Cranberry and blueberry.

- Objective: Plan Y2 activities
- Expected participants: Munoz, Vorsa, Polashock, Zalapa, Iorizzo, Pottorff
- Coordinator blueberry team: Munoz (30 min)
- Coordinator cranberry team: Vorsa (30 min)

1:00 PM Session 4. Objective 5 Extension.

- Objective: discuss Y1 activities and plan Year 2 activities
- Expected participants: Atucha, De Vetter, Main, Zalapa, Perkins-Veazie, Munoz, Coe, Iorizzo, Pottorff, Bassil
- Coordinator Data Management Team: Main (40 min)
- Coordinator Extension Team: Atucha (50 min)

2:30 PM Session 5. Objecvtive 4. Socio Economics

- Objective: discuss Y1 activities and plan Year 2 activities
- Expected participants: Gallardo, Canales, Perkins, Iorizzo, Pottorff, Munoz, Bassil, Mackey
- Coordinator Extension Team: Gallardo

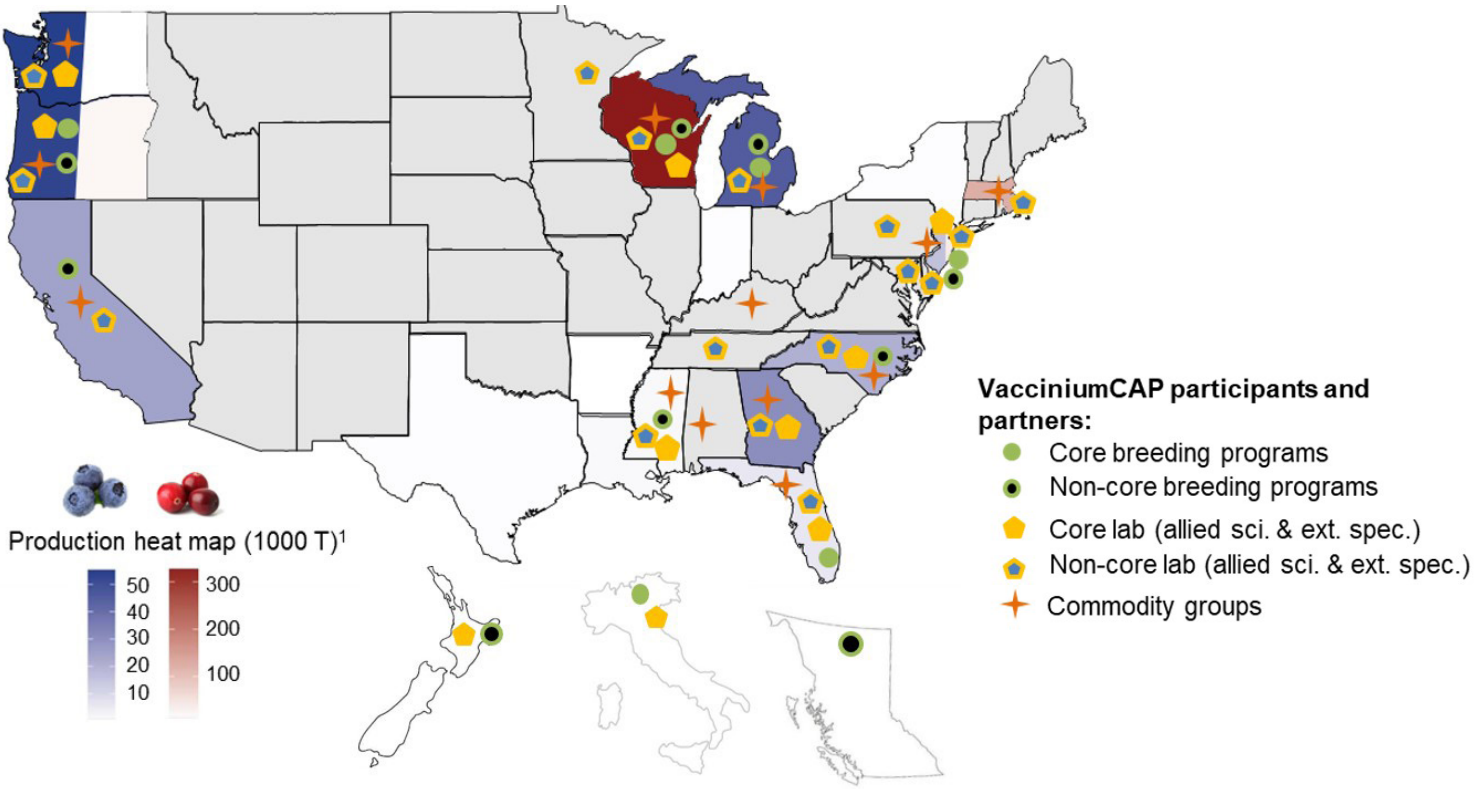
3:30 - 5:00 PM Session 6. Objective 1

- Objective: discuss Y1 activities and plan Year 2 activities
- Expected participants: Edger, Bassil, Chagne, Espley, Iorizzo, Munoz, Pottorff, Zalapa, Polashock, Vorsa
- Coordinator Obj 1a: Edger (40 min)
- Coordinator Obj 1b-c: Bassil (50 min)

November 13 time zone conversion table

Session	I		II	III	IV	V	VI
Time zone							
PT (-3)	6:30	7:30	9	10	11:30	12:30	14
CT (-1)	8:30	9:30	11	12	13:30	14:30	16
ET	9:30	10:30	12	13	14:30	15:30	17
IT (+6)	15:30	16:30	18	19	20:30	21:30	23
NZ (+17)	2:30	3:30	5	6	7:30	8:30	10

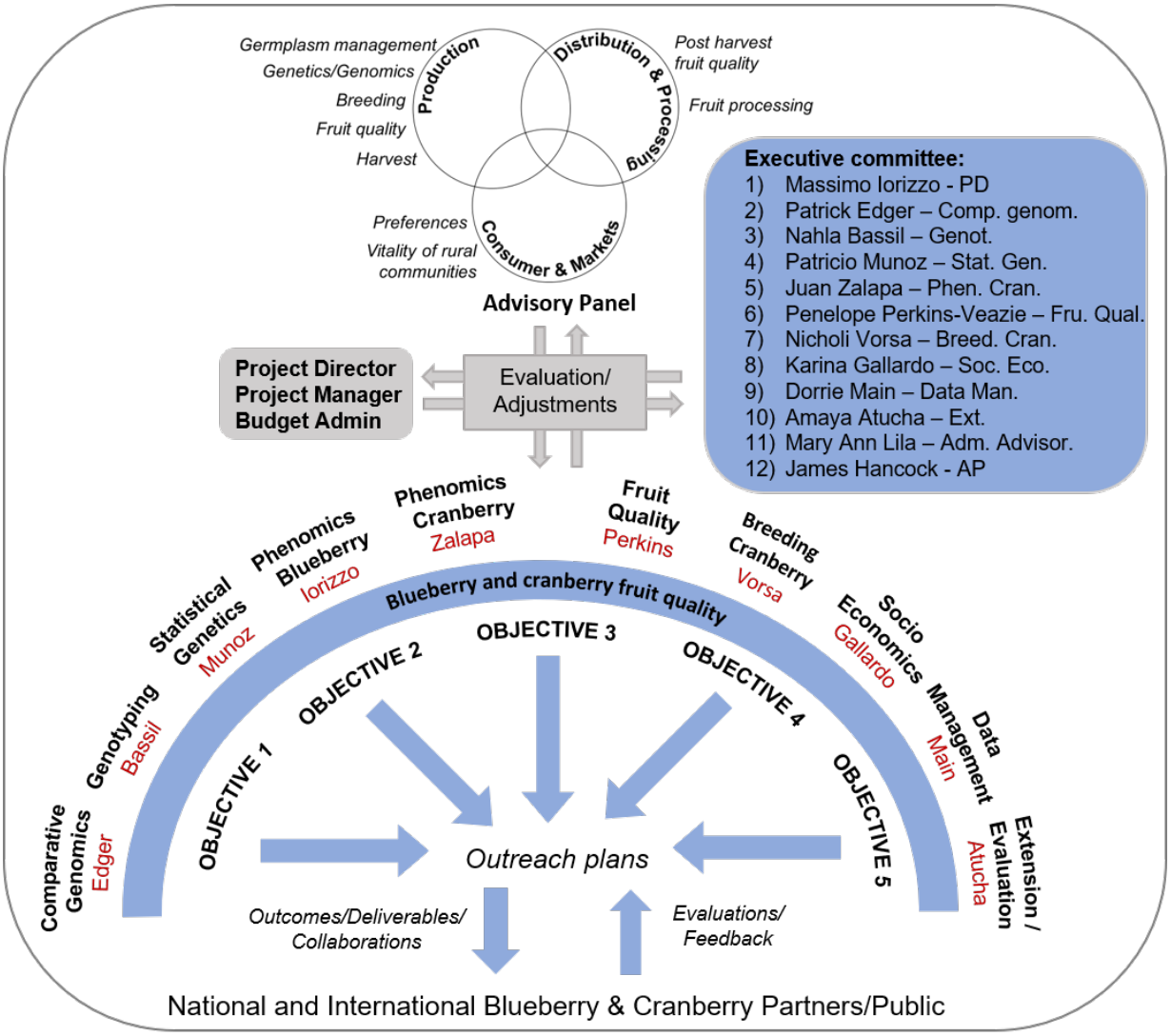
VacCAP PIs and Partners



- Massimo Iorizzo, Project Director, North Carolina State University
- Amaya Atucha, Co-PD, University of Wisconsin-Madison
- Nahla Bassil, Co-PD, USDA-ARS and NCGR
- Patrick Edger, Co-PD, Michigan State University
- Karina Gallardo, Co-PD, Washington State University
- Mary Ann Lila, Co-PD, North Carolina State University
- Dorrie Main, Co-PD, Washington State University
- Patricio Munoz, Co-PD, University of Florida
- Penelope Perkins-Veazie, Co-PD, North Carolina State University
- Nicholi Vorsa, Co-PD, Rutgers University
- Juan Zalapa, Co-PD, University of Wisconsin-Madison
- Elizabeth Canales, Co-PI, Mississippi State University
- David Chagné, Co-PI, Plant and Food Research Ltd
- Lisa Wasko DeVetter, Co-PI, Washington State University
- Richard Espley, Co-PI, Plant and Food Research Ltd
- Lara Giongo, Co-PI, Fondazione Edmund Mach
- Changying Li, Co-PI, University of Georgia
- James Polashock, Co-PI, USDA-ARS and GIFVL
- Charles Sims, Co-PI, University of Florida
- Michael Coe, Key Personnel, Cedar Lake Research Group

How VacCAP Is Managed

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.



Breeding Teams

- Team Leaders: TBD (Blueberry), N. Vorsa (Cranberry)
- Team members: P. Munoz, P. Edger, N. Vorsa, L. Giongo, J. Zalapa, M. Iorizzo
- Tasks: finalize the list and maintain the material to use in this project. Collect and distribute blueberry and cranberry materials to be used in this project. Develop blueberry/ cranberry F1 progenies to pyramid multiple superior fruit quality traits (Obj.3). Coordinate the implementation of standardized phenotyping protocols for on-site fruit quality assessment in collaboration with the blueberry/cranberry Phenomic Teams (Obj. 2-3). Serve as a training group to use the data collection software (e.g. Field book) and BIMS system in collaboration with the Data Management Team. Act as liaison between the Extension Team, the PD, and blueberry and cranberry industry organizations.

Comparative Genomics Team

- Team Leader: P. Edger
- Team members: N. Bassil, P. Munoz, J. Zalapa, N. Vorsa, J. Polashock, D. Chagné. R. Espley.
- Tasks: coordinate the activities required to develop and characterize the *Vaccinium* pangenome (Obj.1a) that will be used to develop the SNP catalog. Collaborate with Genotyping Team to establish the SNP catalog (Obj.1b) and provide bioinformatic analysis needed to select the final set of SNPs used to validate the *Vaccinium* Genotyping Platform (Obj. 1c). Liaise with Breeding and Statistical Genetic Teams to finalize the list of blueberry and cranberry material needed for the comparative genomic analysis. Liaise with Data Management and Extension Teams to deliver genomic resources through the Genome Database for *Vaccinium* (GDV) and to provide content about the comparative genomic outcomes (Obj. 1a).

How VacCAP Is Managed

Genotyping Team

- Team Leader: N. Bassil
- Team members: P. Edger, P. Munoz, J. Zalapa, N. Vorsa, L. Giongo, D. Main, M. Iorizzo, J. Polashock, D. Chagné
- Tasks: coordinate activities to develop the SNP catalog, validate the SNP set, organize the *Vaccinium* Genotyping forum, and finalize selection and validation of the *Vaccinium* Genotyping Platform (Obj. 1b-c). Collaborate with the Breeding and Statistical Genetics Teams to finalize the list of blueberry and cranberry germplasm needed for the genotyping platform validation. Extract DNA and genotype the blueberry and cranberry samples for the genetic and validation studies (Obj. 2b, 3b). Will provide content for Extension efforts on outcomes.

Statistical Genetics Team

- Team Leader: P. Munoz
- Team members: J. Zalapa, M. Iorizzo, N. Vorsa, L. Giongo, N. Bassil, P. Edger, J. Polashock
- Tasks: coordinate activities required to perform marker-trait association analysis and QTL/marker validation (Obj. 2b, 3b). Will collaborate with Breeding Team to finalize the list of germplasm to be used in the project. Provide support for statistical analysis needs. Liaise with the Data Management Team to use the computational infrastructure to store and deliver markers/QTL data through the GDV (public and private partitions). Liaise with the Extension Team to provide content about the marker-trait association analysis and QTL/ marker validation outcomes (Obj. 2b, 3b).

Phenomic Teams

- Team Leaders: M Iorizzo/L. Giongo (blueberry), J. Zalapa (cranberry)
- Team members: P. Munoz, P. Perkins-Veazie, M.A. Lila, D. Main, J. Polashock, N. Vorsa
- Tasks: coordinate activities required to implement phenotyping methods (Obj. 2a, 3a). Collaborate with the Statistical Genetics Team on marker trait association analysis (Obj. 2a) and QTL/ marker validation (Obj. 3b). Collaborate with the Fruit Quality and Socio-Economic (Blueberry) Teams to correlate fruit characteristics and their performance for shelf life, resistance to bruising, sensory panel (Obj. 2c) and potential economic value (willingness to pay) (Obj. 4a). Liaise with the Breeding and Statistical Genetics Teams to finalize the list of blueberry and cranberry germplasm needed for the phenotypic analysis (Obj. 2a-3a). Liaise with the Data Management Team to use the data management computational infrastructure to store and/or deliver phenotypic data through the GDV (public and private partitions). Liaise with the Extension Team to provide content about outcomes delivered through the phenotypic analysis (Obj. 5).

Fruit Quality Team

- Team Leader: P. Perkins-Veazie
- Team members: C. Li, C. Sims, M.A. Lila, L. Giongo, M. Iorizzo, P. Munoz
- Tasks: coordinate activities required for the blueberry fruit quality studies, which includes the evaluation of shelf-life, sensory panel and bruising damage (Obj. 2c) in collaboration with the Phenomic and Breeding Teams. Will collaborate with the Socio Economic Team to plan and conduct a joint consumer panel analysis. Will liaise with the Extension Team to provide content regarding the outcomes delivered through the fruit quality studies (Obj. 2c) and the Extension outreach plans.

Socio-Economics Team

- Team Leader: K.R. Gallardo
- Team members: E. Canales, C. Sims
- Tasks: coordinate activities required to perform the socio-economic studies (Obj. 4). Collaborate with the Breeding, Phenomic and Fruit Quality Teams to acquire blueberry plant material, phenotyping and sensory data. Work with Extension Team to provide content about the outcomes delivered through the socio-economic studies and to develop outreach activities planned by the Extension Team (Obj. 5).

Extension Team

- Team Leader: A. Atucha
- Team members: D. Main, L. De Vetter, M. Coe (External Evaluator)
- Tasks: coordinate activities and provide content for the extension and outreach activities/resources (Obj. 5). Will collaborate with the Data Management Team to develop and populate the VacCAP extension platform and work with External Evaluator to collect and evaluate feedback from Extension audiences.

National and International Partners

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 Insight, Cornell University
- Jim Hancock, Breeder, 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

Extension Network (Continued)

- 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, University 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

National and International Partners

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
- Georgia 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 Commission
- Wayne County Blueberry Growers Association
- Wisconsin State Cranberry Growers Association

Advisory Panels

Stakeholder Panel

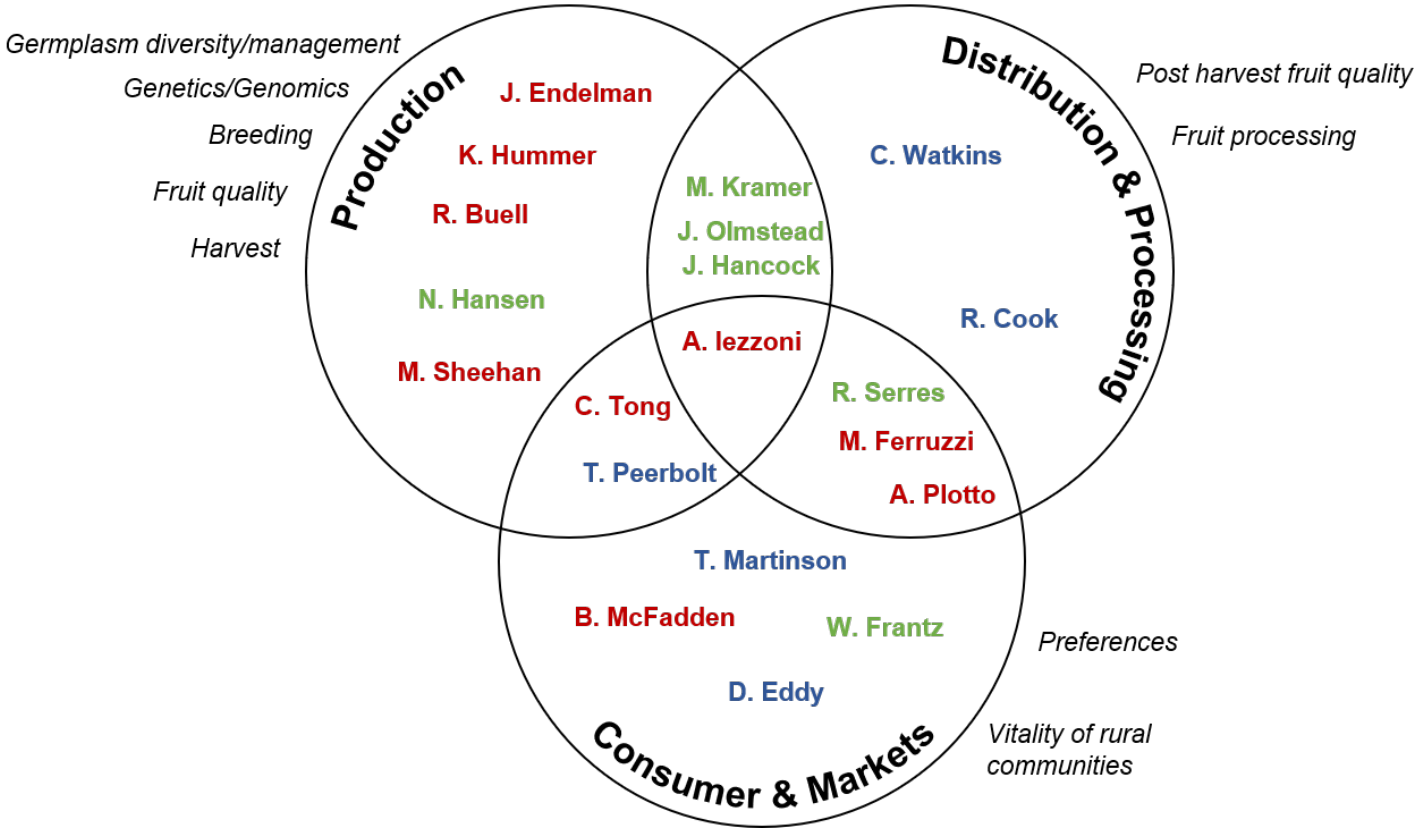
- James Hancock, Berry Blue LLC
- Nicole Hansen, Cranberry Grower
- Matt Kramer, Fall Creek Farm and Nursery
- James Olmstead, Driscoll's, Inc.
- Rod Serres, Ocean Spray Cranberries, Inc.
- William Frantz, The Cranberry Institute

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

Scientific Panel

- Robin Buell, Michigan State University
- Jeffrey Endelman, University of Wisconsin-Madison
- Mario Ferruzzi, North Carolina State University
- Kim Hummer, USDA-ARS-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



US and Global Cordinated Efforts for Improving Cranberry and Blueberry

Misson

Address major bottlenecks for growth of U.S. *Vaccinium* industry, by creating a nationwide coordinated transdisciplinary research approach to develop and implement marker assisted selection (MAS) capacity in *Vaccinium* breeding programs, to enable breeders to select and pyramid fruit characteristics (FCs) that positively contribute to fruit quality and market value. In the long term, this mission will increase production of fruit with improved characteristics that meet the ever-changing industry, market, and consumer preferences.

What Success Would Look Like

Discovery. VacCAP project outputs will increase the knowledge of:

- Cranberry and blueberry genome structure and evolution
- Genetic mechanisms and genes controlling economically important traits including fruit characteristics
- The relationships between fruit characteristics and fruit quality (shelf life, texture, bruising and sensory traits)
- Consumer behavior and interests regarding blueberry fruit quality and cranberry products
- New *Vaccinium* stakeholder priorities for the sustainability and profitability of the industry

Engagement. VacCAP deliverables and outcomes will be utilized by the *Vaccinium* community for the following goals:

- VacCAP DNA tools and phenotyping methods will be utilized by VacCAP PIs and the *Vaccinium* community worldwide to advance breeding and/or research programs
- VacCAP outcomes will be used by growers, processors and distributors to plan production and distribution strategies
- Funding of new off-shoot projects from VacCAP developed tools and deliverables with new collaborative alliances established

Education. The VacCAP team influences the next generation of breeders and scientists, increasing knowledge through collaborations:

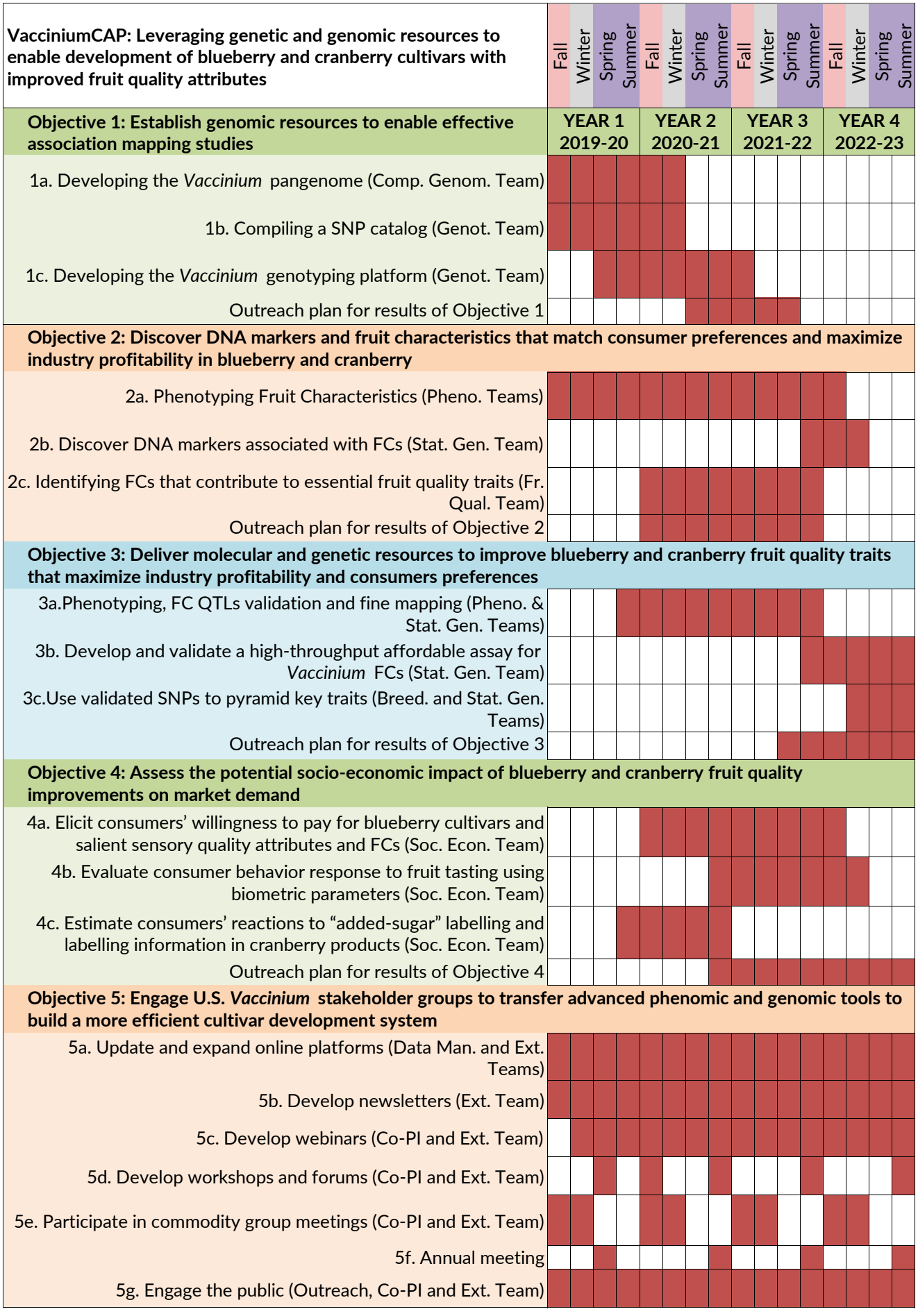
- MS/PhD students and post-docs are trained in plant breeding, genetics, fruit phenotyping, postharvest physiology, socio-economics, sensory analysis and extension practices, to become the next generation of breeders, scientists, and agriculture liaisons.

Long-Term Impact

- Increased ability of the *Vaccinium* growers, processors and distributors to market a higher percentage of premium fruit through the use of improved varieties without increased production costs
- Increased consumption of blueberry and cranberry products in the US and worldwide due to improved fruit quality
- Increased efficiency of *Vaccinium* breeding programs for selection and improvement of fruit quality traits important to the consumer and industry
- Increased profitability, competitiveness, and sustainability of *Vaccinium* industries

Timeline

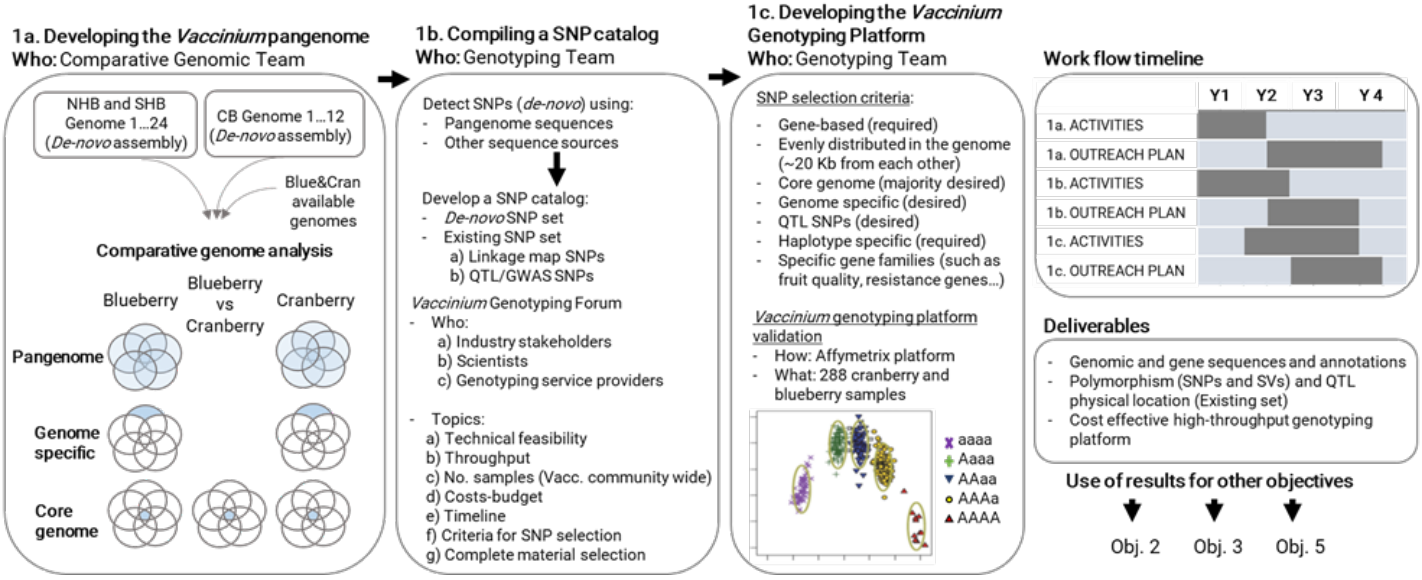
Cranberry Harvest Season Blueberry Harvest Season



Objective 1

Establish genomic resources to enable effective association mapping studies in blueberry and cranberry

The Comparative Genomic and Genotyping Teams will develop a cost effective high-density genotyping platform by mining the *Vaccinium* pangenome that represents the genetic diversity of blueberry and cranberry germplasm and their shared ancestry. In the mid and long term, this genotyping platform is expected to significantly expand our capacity to identify and validate DNA markers associated with economically important traits in blueberry and cranberry.



Method Overview

To achieve this objective, the Comparative Genomic and Genotyping Teams will:

- 1a. Develop a *Vaccinium* pangenome. A pangenome for Northern Highbush (NHB), Southern Highbush (SHB), and cranberry (CB) will be assembled. The aim is to identify the core and dispensable portions of the genome. For each species/group, 12 genotypes that are highly representative of the pedigree of NHB, SHB and CB cultivars and that capture the greatest amount of genetic diversity were selected. This approach will limit ascertainment bias in the SNP selection.
- 1b. Compile a SNP catalog. A SNP catalog will combine de-novo with existing SNP sets (within linkage maps or representing QTLs). The SNPs catalog will be annotated with SNP location within genes, core or dispensable genes, gene families, alleles and haplotypes. This approach will ensure the identification of highly informative SNPs.
- 1c. Develop the *Vaccinium* Genotyping Platform. DNA regions surrounding highly informative SNPs will be selected to design a genotyping platform. Criteria for SNP selection will aim to maximize the representation of genes, markers associated with QTLs, informative haplotype blocks and to be distributed approximately 20-30Kb apart. *Vaccinium* breeders and geneticist will be engaged to establish a genotyping consortium that will help to lower the genotyping costs per sample, while ensuring application of these new molecular resources.

P. Edger

N. Bassil

D. Chagné

R. Espley

Obj. 1 – VacCAP: Year 1 Progress Summary

Obj. 1. Establish genomic resources to enable effective association mapping studies in blueberry and cranberry	
1a. Developing the Vaccinium pangenome [Comparative Genomic Team]	**To whom***
Prepare material for sequencing (12 NHB, 12 SHB and 12 CB) : obtained plant material for DNA and RNA extractions for all 36 genotypes.	Genotyping and Statistical Genetic Teams, Breeder, Geneticist and Bioinformatic Partners
Whole genome sequencing : isolated DNA, constructed libraries and sequenced the genomes of 36 cultivars.	
Assembled genomes : completed the genome assembly for fifteen highbush blueberry cultivars.	
Finalize and acquire reference genomes from team members and partners and begin comparative analysis : completed three additional chromosome scale genome assemblies representing blueberry wild diploid species and one cranberry cultivar. Completed construction of three high density linkage maps that are used to anchor and improve the quality of the blueberry genome assemblies. Conducted genome-wide analyses to identify regions of the genome that contain introgression from related *Vaccinium* species used by various breeding programs.	
Expected impact. These genomic resources will: expand studies aimed at identifying candidate genes associated with fruit quality and other economically important traits; provide a solid framework to design a genotyping platform that best represents the blueberry and cranberry diversity; enable comparative studies within the Ericaceae and across other plant families	
1b. Compiling SNP catalog [Genotyping Team]	**To whom**
Compile existing SNP set from team members and partners : collected SNP marker information (47,025) from four blueberry and cranberry linkage maps and QTL studies.	Statistical Genetic Team, Breeder and Geneticist Partners
Compile existing set of blueberry and cranberry sequences from public database (GDV & NCBI) and unpublished data from team members and partners for de-novo SNP identification : downloaded public sequence data of *Vaccinium* (532) and obtained sequences from collaborators (135 DNA and transcriptome) and cleaned and stored them on local server.	
1c. Developing genotyping platform [Genotyping Team]	**To whom**
Collect DNA from 188 blueberry and 100 cranberry to genotype during Testing Phase: coordinated collection of blueberry and cranberry material from VacCAP breeders and partners. Leafe tissue from all 288 samples were collected and stored for DNA extraction.	Breeding, Statistical Genetic Teams, Breeder and Geneticist Partners
Evaluate genotyping platforms: distributed surveys and received replies from 18 core and non-core labs to assess the technical needs for a high-throughput genotyping platform for blueberry and cranberry. Organized multiple meetings with the Genotyping Team to discuss /evaluate needs and the available technologies.	
Expected impact 1b-c. A cost effective genotyping platform that is useful to the *Vaccinium* scientific community worldwide, and that will enable genetic studies to identify loci and markers associated with fruit qualiy and other important traits.	
Challenges & changes. Due to operational restrictions (total or partial lockdown) employed by funded institutions to prevent the spread of COVID-19 infections and delay of funding releasefrom the USDA-NIFA the following activities were not performed as planned: sequencing of the 36 blueberry and cranberry samples was delayed resulting in a delay in downstream analysis (Obj. 1b-c).	
Addressing challenges and recommendations. Activities that were delayed already restarted and will be completed in Year 2. Complementary activities included finalizing linkage maps and performing comparative analysis to improve the quality of the available genomes by the Comparative Genomics Team.	

* To whom results are transferred during the project

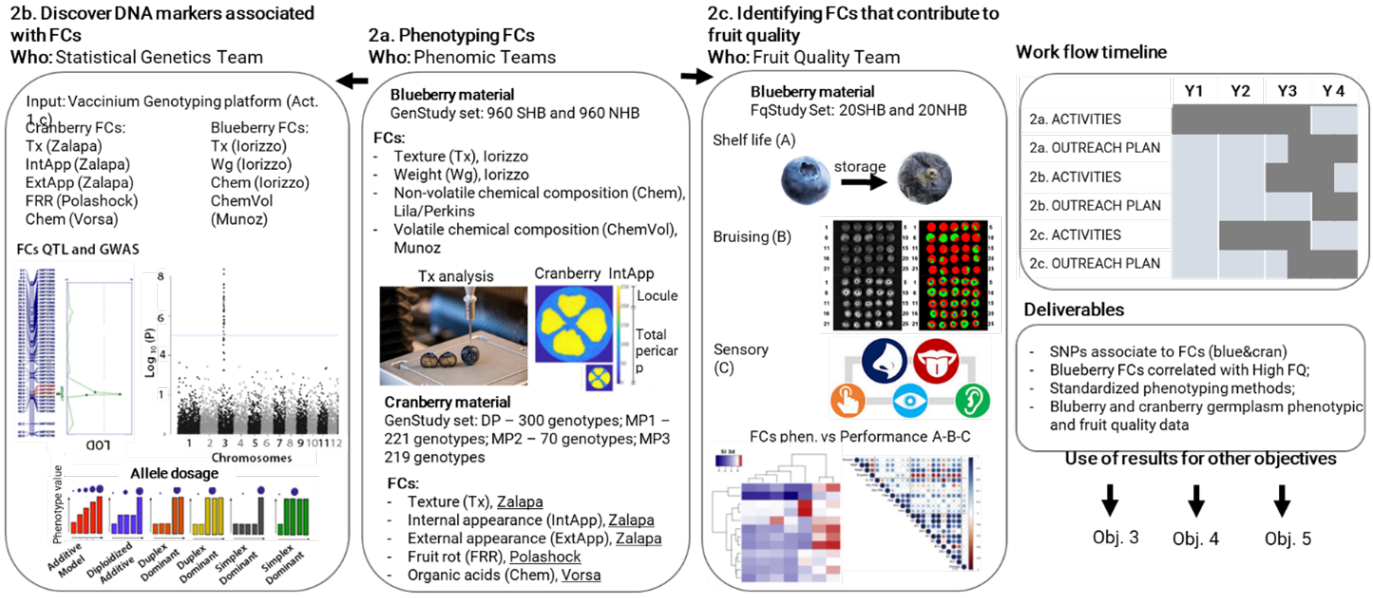
Obj. 1 - VacCAP Plan for Year 2

Obj. 1. Establish genomic resources to enable effective association mapping studies in blueberry and cranberry	
1a. Developing the *Vaccinium* pangenome [Comparative Genomic Team]	**To whom**
Finalize genome assembly and annotation for all 36 genotypes	Genotyping and Statistical Genetic Teams, Breeder, Geneticist and Bioinformatic Partners
Construct the pangenome (blueberry specific, cranberry specific, and pan-Vaccinium)	
Identify cultivar-specific genes associated with fruit quality	
Develop blueberry haplotype map	
1b. Compiling SNP catalog [Genotyping Team]	**To whom**
Finalize compilation of existing SNPs from team members and partners	Statistical Genetic Team, Breeder and Geneticist Partners
Identify location of existing SNPs in the pangenome and annotate them	
Finalize compilation of existing set of blueberry and cranberry sequences from public database (GDV) and unpublished data from team members and partners for de-novo SNP identification	
Identify and annotate de novo SNPs	
Phase de novo SNPs using haplotype map and Illumina data	
1c. Developing genotyping platform [Genotyping Team]	**To whom**
Extract DNA from 188 blueberry and 100 cranberry to genotype for the testing phase	Breeding, Statistical Genetic Teams, Breeders and Geneticist Partners
Finalize choice of genotyping platform	
Organize the Genotyping Forum	
Form Vaccinium Genotyping Consortium	
Possible challenges. Inability to receive all sequence or existing SNP data from partners; Need to organize the Genotyping Forum virtually due to COVID.	

Objective 2

Discover DNA markers and fruit characteristics that maximize industry profitability and match consumer preferences in blueberry and cranberry

The Phenomics, Statistical Genetics and Fruit Quality Teams will identify DNA markers associated with fruit characteristics (FCs) and subcomponents that reduce fruit bruising, contribute to an extension of fruit shelf life, and match consumer preferences. This outcome will establish a link between DNA markers associated with FCs, and fruit quality attributes.



Method Overview

To achieve this objective, the the Comparative Genomic and Genotyping Teams will:

- 2a. Phenotype FCs. A blueberry and cranberry Genetic Study set will be phenotyped for texture, weight, appearance and chemical composition (Table 1). The blueberry GenStudy set represents the two predominant cultivated genetic backgrounds, northern (NHB) and southern highbush blueberry (SHB), and includes 960 NHB (120 NHB families) and 960 SHB (120 SHB families) individuals. The cranberry GenStudy set includes three bi-parental mapping populations (MP1, 2 and 3) and a diversity panel (DP) set.
- 2b. Discover DNA markers associated with FCs. Individuals will be genotyped using the *Vaccinium* genotyping platform developed in Obj. 1c. Genotyping and phenotypic data from the cranberry DP and all blueberry genotypes in the GenStudy set will be used for GWAS. Genotypic and phenotypic data from cranberry MP 1, 2 and 3 will be used to construct genetic linkage maps and identify Quantitative Trait Loci (QTLs).
- 2c.Three independent experiments will be performed to evaluate which FCs (and sub-components) contribute to the three major indicators of blueberry fruit quality, improved shelf life, matching consumer preferences, and reduction of fruit damage from mechanical harvest (Table 2). These experiments will be performed using the FqStudy set (20 NHB and 20 SHB) which was selected for variation in firmness, shelf life and sensory data; thus, increasing the discriminatory statistical power for these analyses.


M. Iorizzo


J. Zalapa


M. Lila


C. Li


C. Sims


P. Munoz


P. Perkins-Veazie


L. Giongo


N. Vorsa

Table 1. Material, FC, parameters and method that will be used to evaluate the blueberry and cranberry GenStudy sets and ValStudy set.

Crop/Study sets	FCs/Traits	Parameters/sub-components	Method
Blueberry GenStudy set SHB (N=960); NHB (N=960) ValStudy set SHB and NHB (N=240)	Texture (Tx)	Max force, Min force, Final force, Area, Young's modulus, Deformation at max force, Deformation at min force, SI	TAXTplus puncture test
	Weight (Wg)	Weight, Size*	High Precision Scale
	Scar (ScD)	Scar (ScD) diameter	Digital caliber
	Non-Volatile chemical composition (Chem)	Titratable acidity (TA), pH, Soluble Solid Content (SSC)	Digital refractomers and pH meter
		Sugars (SSg): fructose, glucose, sucrose	NIR & HPLC
		Organic acids (Ac): malic, citric, quinic, shikimic	UPLC
	Volatile chemical composition (ChemVol)	Volatile organic composition (>60 volatile compounds)	GC-MS
	Storage Index (SI)	SI = log2(TiPH/TiH) TiH= Tx at harvest TiPH= TX post storage	TAXTplus puncture test
Cranberry GenStudy set MP1 (N=221), MP2 (N=67); MP3 (N=219); DP**(N=300) Cranberry ValStudy set (N=260)	Tx	Max force, Min force, Final force, Area, Young's modulus, Deformation at max force, Deformation at min force	TAXTplus Puncture, Double compression test, Kramer shear cell test
	Wg	Weight	High Precision Scale
	External Appearance (ExtApp)	Fruit width, length and ratio, area, perimeter, eccentricity, color and color variation	GiNA
	Internal Appearance (IntApp)	Total pericarp area, fruit diamenter, flesh to locule ratio, outer wall thickness, locule cavity size, fruit symmetry, Internal pericarp area	MATLAB
	Fruit rot resistance (FRR)	Sound and rotted % of rot for accession	Visual score
	Chem	Organic acids: quinic, citric, malic, and benzoic acids	HPLC

*Fruit weight will be used as a proxy to estimate fruit size. **Data for FRR are already available to Co-PD Polashock.

Table 2. Material, FCs, Shelf life and bruising parameters and method that will be used to evaluate the blueberry and cranberry FqStudy sets.

FCs	Parameters/sub-components	Method
Tx: Puncture, Double compression test	Max force, Min force, Final force, Area, Young's modulus, Deformation at max force, Deformation at min force, SI	TAXTplus
Wg	Weight, Size*	High Precision Scale
ScD	Scar (ScD) diameter	Digital caliber
Chem	Titratable acidity (TA), pH, Soluble Solid Content (SSC),	Digital refractomers and pH meter
	Sugars (SSg)	NIR & HPLC
	Moisture content (Mc)	
	Organic acids (Ac)	UPLC
	Cell wall composition	Spectrophotometer
ChemVol	Volatile organic composition	GC-MS
Shelf life indicators Weight loss (WgLo) Decay (Dec) Leakage (Lk) Shrivel (Shr) Water loss (WaLo)		Visual score or imaging analysis
Moisture content (Mc)		SMART6 moisture analyzer
Storage Index (SI)		TAXTplus puncture test
Sensory panel (Sims) Overall Liking Texture Liking Flavor Liking Sweetness Intensity Sourness Intensity Flavor Intensity	Intensity according to Global Hedonic Intensity Scale (GHIS) Intensity Global Sensory Intensity Scale (GSIS)	Sensory Panel
Internal Bruising Bruising Index	Ratio of bruised to whole fruit area or volume	Imaging analysis systems: Short wave near infrared (SWIR) and structured light and hyperspectral images

Obj. 2 – VacCAP: Year 1 Progress Summary

Obj. 2. Discover DNA markers and fruit characteristics that maximize industry profitability and match consumer preferences in blueberry and cranberry.	
2a. Phenotyping fruit characteristics (FCs) [Phenomic Teams]	**To whom***
Finalize phenotyping protocols, equipment needs and settings. **Blueberry:** developed a new protocol to simultaneously evaluate blueberry texture (Tx), stem scar diameter (ScD), scar tear (ScT), fruit weight (Wg) and shelf life indicators such as wrinkle/shrivel (Wr/Shr), mold, leakage (Lk). Coordinated with core labs (Munoz and Finn) purchasing of equipments needed to implement this new protocol. The method was implemented at one core lab (Oregon-Finn-Bassil) where staff and students were trained. Developed a new method to identify and quantify organic acids. To begin efforts to compare multiple texture analyses methods, we also started to test a new subset of parameters and indices coming from texture analyses conducted via penetration, compression and through needle. **Cranberry:** Developed a new method to evaluate texture (firmness).	Fruit Quality, Breeding, Statistical Genetic and Breeding Teams and Partners
Phenotype FCs. Blueberry : Evaluated FCs and shelf life indicators on the NHB GenStudy set (N=960) and one additional mapping population (DxJ, N=186). FCs were evaluated at the harvest time and six weeks post-harvest (stored at 4℃). Preliminary analysis indicated a wide range of variation for most of the traits and parameters. Fruits for non-volatile chemistry analysis were frozen and shipped to Co-PIs Perkins-Veazie and Lila. ***Cranberry:*** Evaluated texture (Tx), external appearance (ExtApp), internal appearance (IntApp), non-volatile chemical composition (Chem) on 3 mapping populations (MP1, N= 171, MP2, N=71, MP3, N=211). Evaluated % fruit rot in MP3. Preliminary analysis indicated a wide range of variation for most of the traits and parameters.	Statistical Genetic and Breeding Teams
Expected Impact. The newly developed texture analysis methods measure multiple mechanical parameters that contribute to texture and overcome the limitation of the most commonly used blueberry and cranberry firmness analysis method that only evaluate external firmness. This will allow to better understand which texture parameter and/or other FCs contribute to fruit firmness, and if it is genetically inherited. Phenotypic data will provide information to Oregon Breeding Program about parents to use in new crosses to develop cultivars with improved fruit characteristics and shelf life. Development of new methods for evaluate texture and chem composition can contribute to increasing the number of the potential users of the technique used to phenotype these FCs in blueberry.	
2b. Discover DNA markers associated with FCs [Statistical Genetics Team]	**To whom**
Collect material, extract DNA from GenStudy set: identified, labeled plants in the field and initiated collection of leaves from blueberry and cranberry GenStudy sets.	Breeding and Genotyping Teams, Breeders and geneticist partners
Expected impact. We expect that FCs-DNA marker associations will be identified. This outcome will provide the fundamental knowledge to understand the position, number of QTLs (as proxy for genes) involved in controlling FCs, and validation of some key FC-QTLs.	
2c. Identifying FCs that contribute to essential fruit quality traits [Fruit Quality Team]	**To whom**
Finalize phenotyping protocols, equipment needs and settings : FQ team implemented the new texture analysis protocol/method to evaluate blueberry plant material in NC. Evaluated multiple settings for storage conditions. Genetic variability within the original NHB GenStudy set at harvest and during post-harvest conditions was implemented also with new parameters developed (I) and proofed through obj 2a, and extended also to some additional top quality cultivars present on the European markets. This subset of varieties was chosen to validate the correlation and robustness of the parameters using two different equipments and a handy tool nowadays used in cherry by growers.	Socio Economic and Statistical Genetic Teams, Breeding, Fruit Quality and Other industry partners
Perform FQ analysis : Evaluated FCs (Tx, Wg, ScD, ScT) and shelf life indicators (Shr/Wr, mold, Lk) on 62 blueberry cultivars from NC. Fruit were evaluated at harvest, and one, two, three and four weeks after harvest (stored at 4℃). Effects of the genotype and time-points (harvest and post-harvest) on the genetic variability was studied. Preliminary analysis indicated extensive variation and indicated that a longer storage period will be needed to observe clearer symptoms of shelf life decay.	

Expected impact. We expect to identify FCs subcomponents that positively correlate with extended shelf life, consumer preferences and reduced internal bruising, contributing to improved fruit quality. This outcome will enable us to establish a link between DNA markers associated with FCs, and high priority fruit quality attributes. Overall, the outcomes of this objective will enable blueberry and cranberry breeders and allied scientists to plan development of DNA marker assays to facilitate breeding for FCs and quality attributes that can lead to increased industry profitability in the long term. Phenotypic data will also provide information to breeding programs about parents to use in new crosses to develop cultivars with improved fruit quality.
Challenges & Changes. Due to operational restrictions (total or partial lockdown) employed by funded institutions to prevent the spread of COVID-19 infections and delay of funding release from the USDA-NIFA the following activities were not performed as planned: Southern Highbush GenStudy set was not harvested and phenotyped; cranberry diversity panel could not be transplanted in the field.
Addressing challenges and recommendations: to finalize setting protocols for the Obj.2c, FQ analysis - shelf life - was started in Year 1 (instead of year 2). Preliminary results indicated that next year a longer storage period (7-8 weeks) will be needed to observe more clear signs of shelf life decay. During our first annual meeting members of the Advisory Board indicated that it is important to identify methods that can be easily used in a breeding program for evaluating texture. To address this comment, we started to test a new subset of parameters and indices of fruit quality coming from texture analyses conducted via penetration, compression and through needle.

* To whom results are transferred during the project

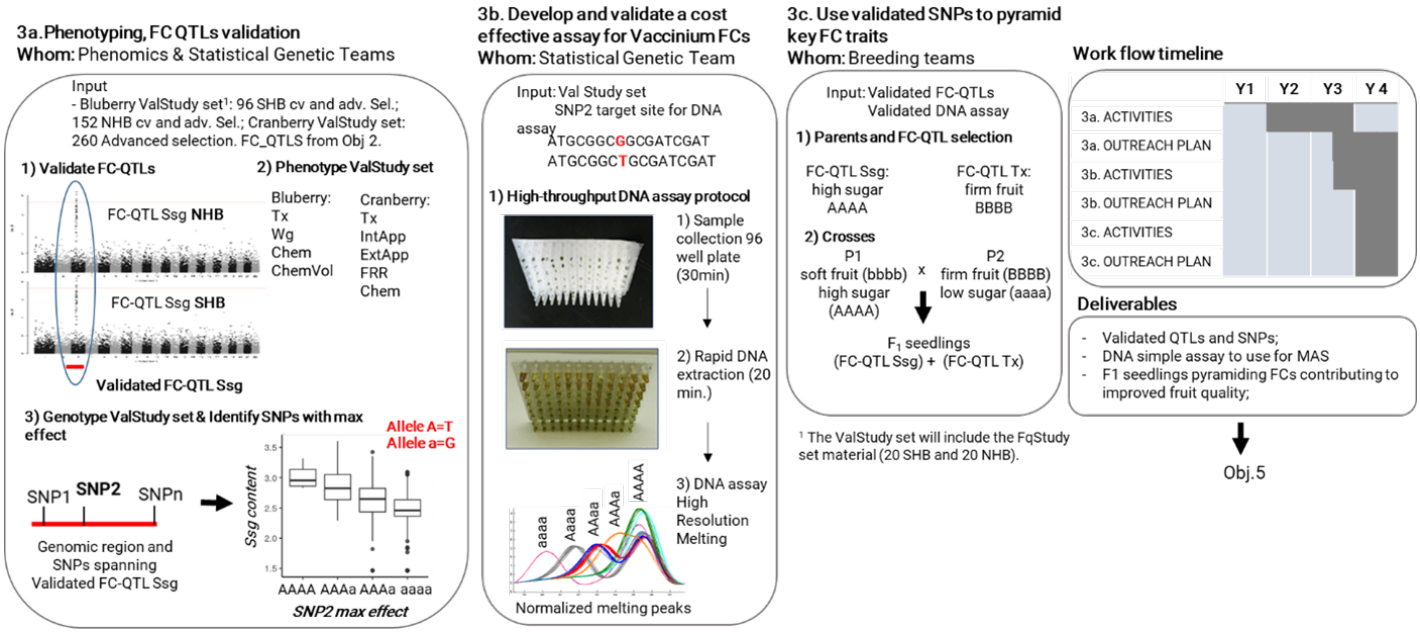
Obj. 2 – VacCAP: Plan for Year 2

Obj. 2. Discover DNA markers and fruit characteristics that maximize industry profitability and match consumer preferences in blueberry and cranberry.	
2a. Phenotyping fruit characteristics [Phenomics Team]	**To whom**
Finalize phenotyping protocols, equipment needs and setting	Fruit Quality, Breeding, Statistical Genetic and Breeding Teams and Partners
Harvest and distribute fruit material from the GenStudy set	
Phenotype FCs and shelf-life indicators	
Complete analysis of year 1 data	
2b. Discover DNA markers associated with FCs [Statistical Genetic Team]	**To whom**
Finalize material collection, extract DNA from GenStudy sets	Breeding and Genotyping Teams, Breeders and geneticist partners
Begin genotyping GenStudy set	
2c. Identifying FCs that contribute to essential fruit quality traits [Fruit Quality Team, Penelope Perkins Lead]	**To whom**
Collect and distribute fruit	Socio Economic and Statistical Genetic Teams, Breeding, Fruit Quality and Other industry partners
Perform FQ analysis sensory, shelf-life, bruising	
Excepted challenges. New operational restrictions to prevent the spread of COVID-19 infections could affect the following activities: - harvesting and phenotyping of blueberry and cranberry year 2 materials; delay laboratory work (volatile and non volatile analysis).	

Objective 3

Deliver molecular and genetic resources to improve blueberry and cranberry fruit quality traits that maximize industry profitability and match consumer preferences

The Breeding and Statistical Genetic Teams will validate fruit characteristics (FCs) QTLs in blueberry and cranberry and develop cost effective DNA assays to select parents with FCs that positively contribute to fruit quality and market value. Phenotypic data from Obj 2a-2c, 3a, 4a-b will also be used to select breeding lines with desirable FCs to establish new crosses. These outcomes will provide breeders empirical data to assign a level of importance to FCs relative to consumer preferences, decay during production, processing and distribution, and provide new tools to select for high fruit quality.



Method Overview

To achieve this objective, the Breeding and Statistical Genetic Teams will:

- 3a. Phenotype and validate FC-QTLs. A validation study set (ValStudy set) that will include cultivars used in breeding programs for both blueberry and cranberry, will be phenotyped for all of the FCs evaluated in Obj. 2a and genotyped using the *Vaccinium* genotyping platform. FC-QTLs and existing FC-QTLs from Obj 1b and 2b will be validated in the Validation Set. FC-QTLs will be considered validated when markers show predictive ability for the targeted trait in the ValStudy set. SNPs confirming the genetic association and with max effect will be used as targets to design high-throughput DNA assays.
- 3b. Develop and validate high-throughput cost effective assayjkk for *Vaccinium* FCs. The aim of this activity will be to develop a high-throughput protocol that is fast, cheap and enables the rapid sampling of plant tissue, DNA extraction and precise genotyping. A plate based DNA assay using the validated FC-SNPs from Obj.3a will be used for targeted genotyping (such as High Resolution Melting, KASP or rhAMP). Markers developed from this objective will be evaluated for consistency to confirm marker-trait associations to be used for marker-assisted selection (MAS) of elite breeding materials.
- 3c. Pyramid key traits using validated SNPs and phenotypic data. Progenies with the desired FC markers or desired FC phenotypic profile evaluated in Obj 2a-b and 3a will be crossed to 'pyramid' multiple positively associated markers into superior genotypes. Breeding priority will be given to genotypes that inherit the highest number of superior FCs, determined by SNP-genotyping and phenotypic data.


P. Munoz


N. Vorsa


M. Iorizzo


J. Zalapa


J. Polashock

Obj. 3 – VacCAP: Year 1 Progress Summary

Obj. 3. Deliver molecular and genetic resources to improve blueberry and cranberry fruit quality traits that maximize industry profitability and match consumers preferences	
3a. Phenotyping, FC QTLs validation and fine mapping [Phenomic and Statistical Genetic Teams]	**To whom***
Phenotype ValStudy Set: evaluated FCs and shelf life indicators on 157 tetraploid genotypes from the National Clonal Germplasm Repository that include mainly NHB cultivars and accessions and few SHB cultivars. FCs were evaluated at the harvest time and six weeks post-harvest (stored at 4°C). Preliminary analysis indicated a wide range of variation for most of the traits and parameters. Fruits for non-volatile chemistry analysis were frozen and shipped to Co-PIs Perkins-Veazie and Lila.	Genotyping and Breeding teams, Breeder, and Geneticist Partners
Collect material, extract DNA from ValStudy set: identified, labeled plants in the field, and initiated collection of leaves from blueberry ValStudy sets from the NCGR (OR).	
Develop list of target existing FC-QTLs: based on complementary projects NBS-LLR resistance genes and genes involved in the synthesis of volatile (VOC) metabolites were identified in the cranberry and blueberry genomes, respectively. Completed a genetic study for citric and malic acids (CITA), in cranberry. QTL (GBS and SSR) analysis identified a multi-allelic Mendelian locus CITA with hierarchy of codominant alleles which are carries by parents of MP-1, 2 and 3 at the CITA locus.The genomic location of existing fruit rot (FRR), CITA and VOC QTLs are integrated and are used to identify their overlap with candidate resistance genes. This information establishes a foundation to validate FRR, CITA and VOC QTLs, study candidate genes and SNPs to target for DNA assay.	
3b. Develop and validate a high-throughput affordable assay for Vaccinium FCs [Statistical Genetic Team]	**To whom**
Finalize selection and protocol for simple DNA assay: initiated the development of the evaluation of DNA extraction and genotyping high-throughput assays for blueberry.	Genotyping and Breeding teams, Breeder, and Geneticist Partners
3c. Pyramid key traits using validated SNPs and phenotypic data [Breeding Teams]	**To whom**
Will start in Year 2	Statistical Genetic Team, Breeder and Geneticist Partners
Expected impact 3a-c. Validated QTLs will provide opportunity to perform functional characterization of candidate genes and plan future ad-hoc experiments to evaluate genotype × environment effects for FCs targeted by validated DNA assays. DNA assays for FCs, and new crosses made based on molecular and phenotypic data will provide a foundational work to accelerate breeding for fruit quality in blueberry and cranberry breeding programs.	
Challenges & changes. None to report	

* To whom results are transferred during the project

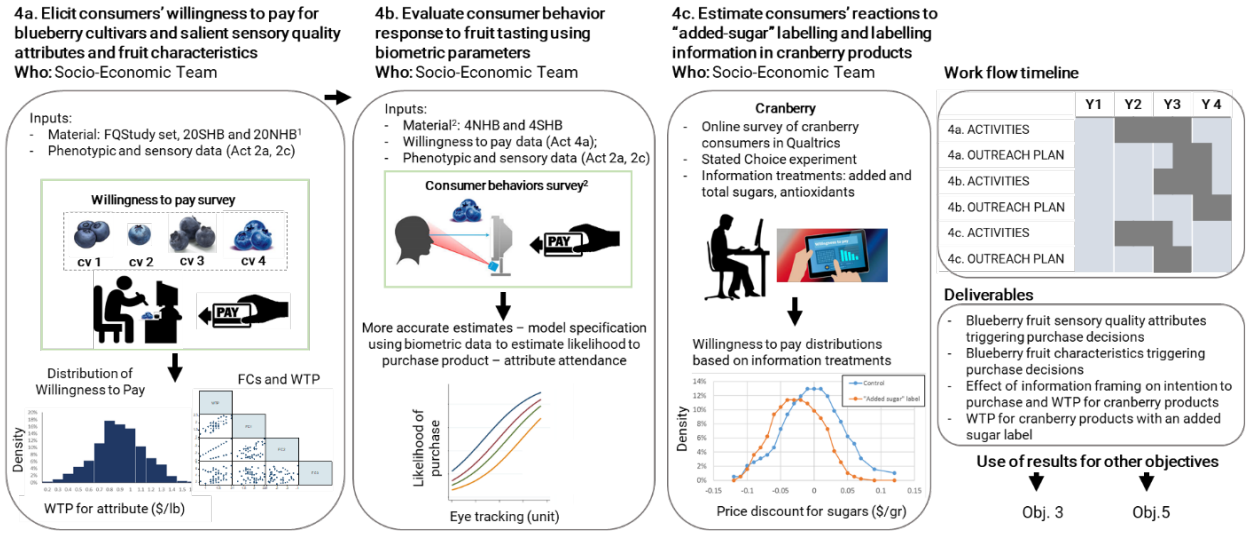
Obj. 3 – VacCAP: Plan for Year 2

Obj. 3. Deliver molecular and genetic resources to improve blueberry and cranberry fruit quality traits that maximize industry profitability and match consumers preferences	
3a. Phenotyping, FC QTLs validation and fine mapping [Phenomic and Statistical Genetic Teams]	**To whom**
Phenotype ValStudy Set	Genotyping and Breeding teams, Breeder, and Geneticist Partners
Collect material, extract DNA from ValStudy set	
Plan genotyping needs for ValStudy set	
3b. Develop and validate a high-throughput affordable assay for Vaccinium FCs [Statistical Genetic Team]	**To whom**
Finalize selection and protocol for the fast and simple DNA assay	Genotyping and Breeding teams, Breeder, and Geneticist Partners
Test protocol for simple DNA assay on a set of existing FC-QTLs (VOC)	
3c. Pyramid key traits using validated SNPs and phenotypic data [Breeding Teams]	**To whom**
Develop a list of genotypes harboring superior FCs based on phenotypic year 1 data	Statistical Genetic Team, Breeder and Geneticist Partners
Make crosses and store seeds	
Possible challenges. New operational restrictions to prevent the spread of COVID-19 infections could affect the following activities: - harvesting and phenotyping of blueberry and cranberry year 2 materials; delay laboratory work (volatile and non-volatile analysis); breeding activities.	

Objective 4

Assess the potential socio-economic impact of blueberry and cranberry fruit quality improvements on market demand

The Socio-Economic team will evaluate the willingness to pay (WTP) for specific sensory quality characteristics and fruit quality attributes associated with consumer preferences for fresh blueberry and processed cranberry products. Estimates of WTP surveys will inform breeding programs to target the traits of maximum value to consumers. Insights from WTP estimates for cranberry products will inform breeding efforts, specifically to sugar content and acidity in cranberries. Outcomes from this study will provide marketers and stakeholders with insights on new messaging strategies to market blueberry cultivars with improved fruit qualities and cranberry products with nutrition facts.



[1] The willingness to pay survey will be carried in conjunction with sensory panel survey.
[2] For the consumer behaviors study 4 SHB and 4 NHB were selected form the set of cultivars used for the FQStudy set (used in Act 2c and 4a).

Method Overview

To achieve this objective, the Socio-Economic team will:

- 4a. Elicit consumers' willingness to pay for blueberry cultivars and salient sensory quality attributes and fruit characteristics. Sensory tasting and willingness to pay elicitation will be combined via the use of sensory taste tests and choice experiments. The study will use 20 NHB and 20 SHB blueberry cultivars, complementing the activities conducted in Act. 2c (fruit quality studies). The selection of these cultivars is based on differences in fruit firmness and sensory profiles that will enable a statistical correlation of sensory characteristics, consumers' preferences and willingness to pay.

- 4b. Evaluate consumer behavior response to fruit tasting using biometric parameters. A subset of four SHB and four NHB cultivars representing a subset of the material used in Obj. 4a, will be used to measure consumers' behavioral reactions to the blueberry sensory quality profile via the collection of biometric data. Respondents will be asked to complete a sensory evaluation questionnaire and their WTP. Data from Obj. 2c, 4a, 4b will be integrated to identify possible FCs that contribute to consumer preferences and WTP.

- 4c. Estimate consumers' reactions to "added-sugar" labeling and labeling information in cranberry products. In this objective an online survey and a choice experiment with a representative sample of U.S. consumers will be conducted to, (a) quantify consumers discount for cranberry products with an "added-sugar" line on the nutrition facts panel label, (b) measure heterogeneity in responses across consumer segments, and (c) evaluate the effect of information framing. The responses will be used to assess consumers' accuracy in evaluating sugar content and evaluate how this affects purchase intent and willingness to pay.



K. Gallardo E. Canales C. Sims

Obj. 4 – VacCAP: Year 1 Progress Summary

Obj. 4 Assess the potential socio-economic impact of blueberry and cranberry fruit quality improvements on market demand.	
4a. Elicit consumers' willingness to pay for blueberry cultivars and salient sensory quality attributes and fruit characteristics [Socio Economic Team]	**To whom***
Will start on Year 2	Breeding, Fruit Quality and Statistical Genetic teams, Blueberry industry partners
Expected Impact: the willingness to pay for selected fruit sensory quality attributes associated with different cultivars will provide useful information about the attributes that trigger purchase decision and repeated purchases. The quantitative value (in $/lb) for each cultivar and quality attribute will inform fruit growers and marketers about the attributes sought by consumers and will also information blueberry breeding programs about fruit traits that maximize consumer value.	
4b. Evaluate consumer behavior response to fruit tasting pricing using biometric parameters [Socio Economic Team]	**To whom**
Will start on Year 3	Breeding and Fruit Quality teams, Blueberry industry partners
Expected Impact. Information about blueberry quality traits preferred by consumers will be useful for breeders in identifying cultivars with higher consumer acceptance and potential market performance.	
4c. Estimate consumers' reactions to "added-sugar" labelling and labelling information in cranberry products [Socio Economic Team]	**To whom**
Cranberry questionnaire: developed a survey to elicit preferences and willingness to pay for different levels of sugar content in dried cranberry and cranberry juice. The survey will be implemented in October 2020. The survey will also collect information on consumers' perceptions of food science and technology, and the tradeoffs to accept novel breeding technologies when the benefit is to receive a healthier (less sugar) product.	Breeding and Statistical Genetics teams, cranberry industry partners (nurseries, processor, growers, commodity group organizations)
Expected Impact. Information on the potential impact of the added-sugar information on consumers' purchase decisions, the distribution of these impacts across segments of the population, and the impacts of communication strategies (i.e., health benefits messages to counteract the negative effect of "added-sugar" information on the Nutrition facts panel) on consumers will be helpful for cranberry breeding programs and the cranberry industry in formulating targeted marketing strategies for the promotion of cranberry products.	
Challenges & Changes: None to report.	

* To whom results are transferred during the project

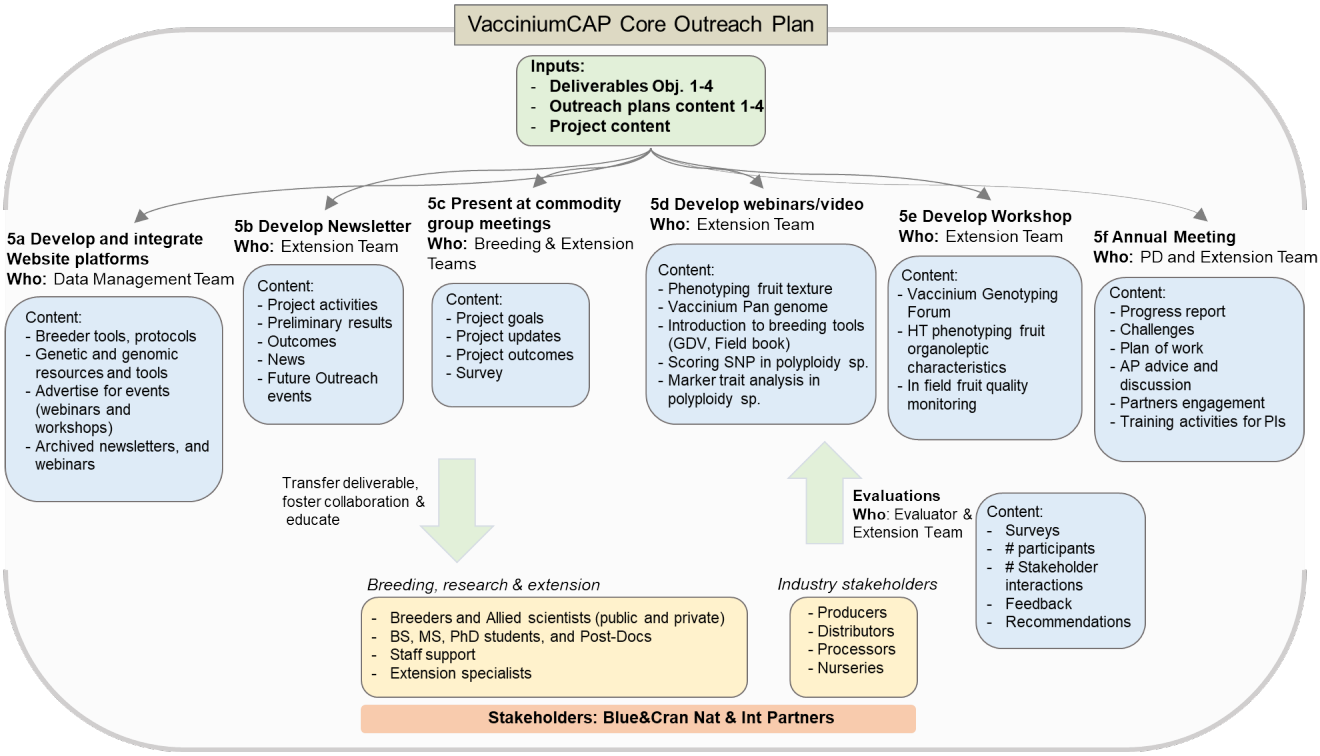
Obj. 4 – VacCAP: Plan for Year 2

Obj. 4 Assess the potential socio-economic impact of blueberry and cranberry fruit quality improvements on market demand.	
4a. Elicit consumers' willingness to pay for blueberry cultivars and salient sensory quality attributes and fruit characteristics [Socio Economic Team]	**To whom**
Finalize WTP questionnaire and experimental design	Breeding, Fruit Quality and Statistical Genetic teams, Blueberry industry partners
Implement WTP survey in conjunction with sensory analysis panel	
Analyze WTP data	
4b. Evaluate consumer behavior response to fruit tasting pricing using biometric parameters [Socio Economic Team]	**To whom**
Draft questionnaire and experimental design for study	Breeding and Fruit Quality teams, Blueberry industry partners
Finalize list of plant materials to be used in study	
4c. Estimate consumers' reactions to "added-sugar" labelling and labelling information in cranberry products [Socio Economic Team]	**To whom**
Distribute survey to panel of U.S. consumers via Qualtrics	Breeding and Statistical Genetics teams, cranberry industry partners (nurseries, processor, growers, commodity group organizations)
Collect and analyze survey data	
Outcomes communicated through publications and presentations.	
Excepted challenges. Obtaining samples of blueberry cultivars on time.	

Objective 5

Engage U.S. *Vaccinium* stakeholder groups to transfer advanced phenomic and genomic tools to build a more efficient cultivar development system

The Extension and Data management teams in collaboration with all VacCAP PIs will use background information and deliverables from the outreach plans of Objectives 1-4 to develop six outreach activities, which will represent our core outreach plan to engage stakeholders. Outreach activities will be developed to engage *Vaccinium* stakeholders by: 1) transferring knowledge and training on project deliverables, 2) educating about project outcomes, 3) fostering new collaborations, and 4) soliciting feedback on the project to fine-tune research and extension activities. Target stakeholders are national and international blueberry and cranberry partners that represent breeders, researchers (breeder's allied scientists), mentees/trainees (staff, mentored students and post docs), extension specialists, and industry stakeholders (producers, processors, distributors, and nurseries), as well as the members of the Advisory Panel (AP) that represent these audiences. Training activities will also target members of VacCAP core labs.



To achieve this objective, the extension and data management teams will:

- 5a. Update and expand online platforms. The existing Genome Database for *Vaccinium* website (GDV, https://www.vaccinium.org/) will provide open access to genetic (e.g., all QTLs) and genomic (e.g., pangenome sequences) resources developed in Obj. 1-3. A new VacCAP project website will serve as a repository of information for project participants and Vaccinium stakeholders.

- 5b.Develop newsletters. A biannual electronic newsletter will highlight project activities, preliminary results, outcomes, news, and future outreach events.

- 5c. Develop webinars. Webinars will inform breeders, researchers, and mentees/trainees about project results and deliverables, provide technical instructions on how to gain access and use these new resources, which will complement Obj. 5d.

- 5d. Develop workshops and forums. Workshops will train and educate breeders, researchers, mentees/trainees and industry stakeholders on high-throughput phenotyping methods developed and used in the project to evaluate fruit quality traits of blueberry and cranberry.

- 5e. Participate in commodity group meetings. Presentations will be delivered at annual regional grower meetings by members of the Breeding and/or Extension Team and will be facilitated by our extension collaborator network. Presentations will highlight project goals, and relevance to specific industry groups, and will provide opportunities for communication and feedback between the project team and stakeholders.

Objective 5 (Continued)

Engage U.S. *Vaccinium* stakeholder groups to transfer advanced phenomic and genomic tools to build a more efficient cultivar development system

- 5f. Annual meeting. Annual meeting extension activities will include: 1) disseminating project accomplishments to the Advisory Panel and partners; 2) promoting collaborative efforts with partners; 3) hosting workshops specific to the phase of the project.
- 5g. Engage the public (Outreach). To educate the general public about the project outcomes and impacts, team members' will present the VacCAP project and related activities through established outreach activities such as science fairs, guest lectures, and supporting high school science programs.

A. Atucha

L. Wasko DeVetter

D. Main

M. Coe

Obj. 5 – VacCAP: Year 1 Progress Summary

Obj. 5: Engage U.S. Vaccinium stakeholder groups to transfer advanced phenomic and genomic tools to build a more efficient cultivar development system	
5.a. Update and expand online platforms [Data Management team]	**To whom**
Develop VacCAP: developed project logo, developed and released the VacCAP web site, began development of the project management system.	VacCAP core labs and breeding, genetic and bioinformatics partners
Update Genome Database for Vaccicium (GDV): added new genomic and genetic data to the GDV. This included addition of (1) Transcript alignments (RefTRans, V. virgatum, Cranberry) to the Draper genome, 6 genetic maps, 73,915 genetic markers and the creation of a Blueberry pathways database, PathwayCyc, using the Draper genome. Upgraded to the Tripal 3 database platform. Created a standard Blueberry Trait Ontology in collaboration with USDA ARS scientists for use in both the Breeding Insight and BIMS platforms.	
5.b. Develop newsletters [Extension Team]	**To whom**
Develop and release newsletters: developed and released the first issue of the VacCAP newsletter.	VacCAP core labs, partners, stakeholders
Prepare article for trade magazines: published one article in *American Fruit Growers* to introduce the objectives of the VacCAP project, in collaboration with David Eddy.	Blueberry and cranberry growers, processor, breeders
Create and maintain VacCAP account/s on social media: created and maintained a VacCAP Twitter account (Twitter – VacCAP@VacciniumCAP), currently has 58 followers. Established YouTube channel (https://www.youtube.com/channel/UCpAdtvTEebzZjvJ4SJcoXwg/videos) with one video currently uploaded (webinar done summer 2020; 16 views).	VacCAP core labs, partners, stakeholders, general public
5.c. Develop webinars [Extension Team]	**To whom**
Hold webinars: organized and delivered a webinar titled: "An *Introduction to the Breeding Information System Management (BIMS) and the Field Book App*" . Participation in the webinar resulted in 11 new BIMS user accounts being created. Of the 23 participants, 15 (65%) responded to the post-webinar survey. All reported that the webinar improved their understanding of the topics, including 47% "significantly" improved, 33% "moderately" improved, 20% "slightly" improved. Most (87%) reported they would definitely recommend the presentation to colleagues; the remaining 13% might recommend; no respondents would not recommend. Detailed recommendations from participants are being considered in planning for future industry engagement.	VacCAP core labs, breeding and genetic partners
5d. Develop workshops and forum [Extension Team]	**To whom**
Hold workshops: Co-PI Zalapa delivered three workshops with large cranberry processors to introduce high throughput fruit quality analysis including texture. Industry representatives expressed interested in implementing new technologies in processing lines.	Cranberry growers and processors
5e. Participate in commodity group meetings [Extension Team]	**To whom**
Attend commodity group meetings [meetings [In collaboration with industry extension network team]: Delivered 14 presentations at grower association meetings across nine US states and Canada to introduce the VacCAP project.	Blueberry and cranberry growers, processors, distributors, nurseries and breeding partners
5f. Annual meeting [Extension Team]	**To whom**
Facilitate annual meetings targeting project participants, AP members, and national and international partners: the year 1 annual meeting was conducted online due to the Covid-19 situation and related travel restrictions.	Team members, AP members, USDA program officers

5g. Engage the public (Outreach) [Extension Team, all teams]	To whom
Perform outreach activities: participated in eight outreach events targeting K12, middle, high schools, and college students that also represent minority students. Events attract thousands of attendees.	General public, students
External Evaluation [Extension Evaluator]	**To whom**
Coordinate the design and implementation of surveys for webinar, workshop and meeting participants and assist with annual report forms for project partipants: created participant surveys for the webinar noted in 5.c above with input from team members; developed online survey portal, collected and reported data from webinar participants. Assisted with design of initial annual project report form for project Co-Pis and Co-PDs.	Team members, extension audiences
Manage, analyze, interpret and report project evaluation feedback, recommendations, and related data: collected feedback and recommendations for the project from webinar participants as highlighted above in 5.c.	Team members, extension audiences, stakeholders, USDA program officers
Assist with integration of evaluation data into project reports, annual meeting and Advisory Panel materials, and outreach materials: assisted with collation, analysis, and integration of project evaluation data and internal team annual reports into the formal project report for USDA.	Team members, extension audiences, stakeholders, USDA program officers
Expected impact. breeders, researchers, trainees/mentees will benefit from the adoption of the genetic and genomic tools developed in this project that will facilitate the application of MTA studies, and long-term will result in the next generation of blueberry and cranberry cultivars with improved fruit quality traits. Extension specialists and industry stakeholders will learn and implement accurate high-throughput phenotyping methods to effectively select fruits with desired quality characteristics. Industry stakeholders will learn which fruit quality traits affect market demand, leading to new marketing strategies to increase and sustain consumer demand. The proposed extension activities will also foster team collaboration and new collaborations outside the scope of this project, providing further value to stakeholders by ensuring that related activities continue beyond the length of this project.	
Challenges & Changes. Due to operational restrictions (total or partial lockdown) employed by funded institutions to prevent the spread of COVID-19 infections and delay of funding release from the USDA-NIFA the following activities were not performed as planned: one newsletter could not be developed; 1 workshop that was to be held at an international symposium could not be organized (symposium was postponed to 2021), and 1 webinar on phenotyping fruit texture in blueberry and cranberry was not held. Furthermore, engagement with the public and commodity groups was limited due to shutdown of physical meetings due to COVID-19.	
Addressing challenges and reccomendations. We are coordinating with team members to conduct outreach objectives that were missed due to a delay in fund release and the pandemic on an adjusted timeline. Workshops will be transitioned to webinars or done via videoconferencing given the restriction of large, in-person gathering. Grower engagement at meetings and conferences will also be done remotely when the option is available. Outreach to the general public may simply be limited due to the unique situation, but we will continue to advertise, educate, and promote our project where feasible and using social media.	

Obj. 5 – VacCAP: Plan for Year 2

Obj. 5: Engage U.S. Vaccinium stakeholder groups to transfer advanced phenomic and genomic tools to build a more efficient cultivar development system	
5.a. Update and expand online platforms [Data Management team]	**To whom**
Train core and non-core labs on GDV	VacCAP core labs, partners, stakeholders
Update VacCAP and GDV	
Distribute updates to national and international partners	
5.b. Develop newsletters [Extension Team]	**To whom**
Release additional newsletter editions	VacCAP core labs, partners, stakeholders
Prepare article for trade magazines	Industry stakeholders; growers, processors, breeders
Create and maintain VacCAP accounts on social media	VacCAP core labs, partners, stakeholders, general public
5.c. Develop webinars [Extension Team]	**To whom**
Coordinate with speakers	VacCAP core labs, partners, stakeholders
Advertise in website and newsletter	
Hold webinars	
5d. Develop workshops and forums [Extension Team]	**To whom**
Coordinate with speakers	VacCAP core labs, partners, stakeholders
Advertise through the VacCAP website, newsletter, and other networks	
Hold workshops	
5e. Participate in commodity group meetings [Extension Team]	**To whom**
Plan activities and coordinate with speakers to attend commodity group meetings [in collaboration with industry extension network team]	VacCAP core labs, partners, stakeholders
Collect survey and participation data/recommendations from stakeholders	Team members, AP members, USDA program officers
5f. Annual meeting [Extension Team]	**To whom**
Facilitate annual meetings targeting project participants, AP members, and national and international partners.	Team members, AP members, USDA program officers
5g. Engage the public (Outreach) [Extension Team, all teams]	**To whom**
Engage and educate the general public about the project outcomes and impacts through the team members' established outreach activities.	General public, students

External Evaluation [Extension Evaluator]	To whom
Coordinate the design and implementation of surveys for webinar, workshop and meeting participants and assist with annual report forms for project partipants. Continue to update these tools and processes as needed during year 2.	Team members, extension audiences
Manage, analyze, interpret and report project evaluation feedback, recommendations, and related data. Continue to update these tools and processes as needed during year 2.	Team members, extension audiences, stakeholders, USDA program officers
Assist with integration of evaluation data into project reports, annual meeting and Advisory Panel materials, and outreach materials. Continue to update these tools and processes as needed during year 2.	
Expected challenges. Due to Covid-19 public engagement and outreach might be restricted during year 2.	

VacCAP Team Publications and Presentations

Journal Article

- Farneti B, Emanuelli F, Giongo L, Toivonen P, Iorizzo M, Folta KM and Finn CE. 2020. Editorial: Interdisciplinary approaches to improve quality of soft fruit berries. Frontiers in Plant Science, section Crop and Product Physiology, 11:592222. https://doi.org/10.3389/fpls.2020.592222. Status: published. NIFA Support Acknowledged: Yes*
- 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. Frontier in Plant Science, 11:370. https://doi.org/10.3389/fpls.2020.00370. Status: published. NIFA Support Acknowledged: Yes*
- Kay Fong S, Kawash J, Wang Y, Johnson-Cicalese J, Polaschock J and Vorsa N. 2020. A low citric trait in cranberry: genetic and molecular mapping of a locus impacting fruit acidity. Tree Genetics & Genomes, 16:42. https://doi.org/10.1007/s11295-020-01432-4. Status: published. NIFA Support Acknowledged: No
- Kay Fong S, Kawash J, Wang Y, Johnson-Cicalese J, Polaschock J and N. Vorsa (2020). A low malic acid trait in cranberry fruit: genetics, molecular mapping and interaction with a citric acid locus. Tree Genetics & Genomes. Status: submitted. NIFA Support Acknowledged: Yes
- Diaz-Garcia L, Rodriguez-Bonilla L, Phillips M, Lopez-Hernandez A, Grygleski E, Atucha A and Zalapa J. 2019. Comprehensive analysis of the internal structure and firmness in American cranberry (*Vaccinium macrocarpon* L.) fruit. PlosOne, 14(9): e0222451. https://doi.org/10.1371/journal.pone.0222451. Status: published. NIFA Support Acknowledged: No*
- Günther CS, Dare AP, McGhie TK, Deng C, Lafferty DJ, Plunkett BJ, Grierson ERP, Turner J L, Jaakola L, Albert NW and Espley RV. 2020. Spatiotemporal modulation of flavonoid metabolism in blueberries. Frontiers in Plant Science, 11.545. https://doi:10.3389/fpls.2020.00545 Status: published. NIFA Support Acknowledged: No.

Peer Reviewed Book Chapter

- Vorsa N and Zalapa J. 2019. Domestication, genetics, and genomics of the American cranberry. Plant Breeding Reviews, Volume 43:279-310. Status: published. NIFA Support Acknowledged: No*

Conference Papers and Presentations

- Iorizzo M, Lila MA, Perkins-Veazie P, Pottorff M, Finn C, Vorsa N, Edger P, Bassil N, Munoz P, Zalapa J, Gallardo KR, Atucha A, Main D, Giongo L, Li C, Polashock J, Sims C, Canales E, DeVetter L, Chagne D, Espley R and Coe M. VacciniumCAP, a community-based project to develop advanced genetic tools to improve fruit quality in blueberry and cranberry. XXVII Plant & Animal Genome, January 11-15, 2020, San Diego, California, USA. Status: published. NIFA Support Acknowledged: Yes*
- Mengist MF, Grace HM, Xiong J, Kay DC, Bassil N, Hummer K, Ferruzzi M, Lila MA and Iorizzo M. Diversity in metabolites and fruit quality traits in blueberry enables ploidy and species differentiation and establishes a strategy for bioactive genetic studies. XXVII Plant & Animal Genome, January 11-15, 2020, San Diego, California, USA. Status: published. NIFA Support Acknowledged: Yes*
- Iorizzo M, Lila MA, Perkins-Veazie P, Pottorff M, Finn C, Vorsa N, Edger P, Bassil N, Munoz P, Zalapa J, Gallardo KR, Atucha A, Main D, Giongo L, Li C, Polashock J, Sims C, Canales E, DeVetter L, Chagne D, Espley R and Coe M. VacciniumCAP, a community-based project to develop advanced genetic tools to improve fruit quality in blueberry. XII International Vaccinium Symposium. Status: Submitted. NIFA Support Acknowledged: Yes*
- Pottorff M, Koch R, Giongo L, Fentie M, Munoz P, Mackey T, Bassil N, Perkins-Veazie P, and Iorizzo M. An automated and integrated phenotyping method to capture fruit texture characteristics, stem scar diameter and fruit weight in blueberry. XII International Vaccinium Symposium. Status: Submitted. NIFA Support Acknowledged: Yes*
- Deng C, Günther CS, Lafferty D, Dare AP, McGhie TK, Grierson E, Albert NW, Espley RV. 2020. Deciphering the blue colour in blueberries. XXVII Plant & Animal Genome, January 10th 11-15, 2020, San Diego, California, USA. Status: published. NIFA Support Acknowledged: Yes
- Plunkett BJ, Lafferty D, Dare AP, Albert NW, Günther CS, McGhie TK, Turner JL, Jones L, Grierson E, Schwinn KE, Davies KM, Allan AC, Jaakola L and Espley RV. 2019. Filling the Void – boosting the nutritional value of blueberry. 10th International Workshop on Anthocyanins, September 9-11, 2020, Trento, Italy. Status: published. NIFA Support Acknowledged: Yes
- Plunkett BJ, Lafferty D, Dare AP, Albert NW, Günther CS, McGhie TK, Turner JL, Jones L, Grierson E, Schwinn KE, Davies KM, Allan AC, Jaakola L and Espley RV. 2019. Filling the Void – boosting the nutritional value of blueberry. TropAg, November 10-13, Brisbane, Australia. Status: published. NIFA Support Acknowledged: Yes

VacCAP Team Publications and Presentations

- Giongo L. Blueberry and raspberry breeding in a view of higher fruit quality at harvest and post-harvest. 10/11/2019 Tanger (Morocco) Status: published. NIFA Support Acknowledged: Yes.
- Giongo L, Ajelli M, Pottorff M, Perkins-Veazie P, Bassil N, Hummer K, Farneti B and Iorizzo M. Comparative study on texture: a key trait for blueberry fruit quality breeding. XII International Vaccinium Symposium. Status: submitted

Trade Magazine

- Eddy D. Research Team Seeks to Boost Berry Quality, Jan. 3, 2019. Growing Produce magazine https://www.growingproduce.com/fruits/berries/research-team-seeks-to-boost-berry-quality. Status: published. NIFA Support Acknowledged: Yes*
- Giongo L and Iorizzo M. Sinergie di ricerca per l'industria di mirtillo gigante e cranberry. Rivista di Frutticoltura e Ortofrutticoltura. Vol. 2 (2020), 2-4. Status: published. NIFA Support Acknowledged: Yes.

Presentations at Grower Associtaion Meetings

- Cline W and Iorizzo M. VacCAP Project: A New Nationwide Project to Advance Breeding in Vaccinium Species. North Carolina Blueberry Council – 54th Annual Open House and Trade Show, January 14-15, 2020, Fayetteville, NC, USA. Status: published. NIFA Support Acknowledged: Yes*
- Zalapa J. Genetic and trait research past, present, and future. BC Cranberry Marketing Commission & BC Cranberry Growers Association Meeting. Invited research presentation. Invited by Jeff Hamilton and Todd May. Richmond, Vancouver, Canada. February 17-19, 2020. Status: published. NIFA Support Acknowledged: Yes*
- Zalapa J. Fruit Texture and quality measures. BC Cranberry Marketing Commission & BC Cranberry Growers Association Meeting. Invited research presentation. Invited by Jeff Hamilton and Todd May. Richmond, Vancouver, Canada. February 17-19, 2020. Status: published. NIFA Support Acknowledged: Yes*
- Zalapa J. Genetics, genomics, and breeding in Cranberry. UMass and Cranberry Growers Association Meeting. Invited research presentation. Invited by Dr. Hilary Sandler. Wareham, MA. January 30, 2020. Status: published. NIFA Support Acknowledged: Yes*
- Zalapa J. Wisconsin Cranberry School sponsored by the University of Wisconsin-Extension and the Wisconsin State Cranberry Growers Association. Developing techniques to measure cranberry firmness. Wisconsin Dells, WI. January 23, 2020. Status: published. NIFA Support Acknowledged: Yes*
- Zalapa J. Fruit quality measures. Wisconsin Cranberry Research Roundtable. Madison, WI. November 7, 2019. Status: published. NIFA Support Acknowledged: Yes*.
- Phillips M, Diaz-Garcia L, Grygleski E, Atucha A, Iorizzo M and Zalapa J. 2020. Cranberry fruit texture and quality measures. WI Cranberry School Proceedings Vol 28. Status: published. NIFA Support Acknowledged: Yes*
- DeVetter, LW. VacCAP: Leveraging Genetic and Genomic Resources to Enable Development of Blueberry and Cranberry Cultivars with Improved Fruit Quality Attributes. Oregon Cranberry School. Jan. 30, 2020, Bandon, OR, USA. Status: presented. NIFA Support Acknowledged: Yes*
- Finn, C. Blueberry Breeding Program Update and VacCAP. Washington Small Fruit Conference. Dec. 5, 2019, Lynden, WA, USA. Status: presented. NIFA Support Acknowledged: Yes*
- Zalapa J and Atucha A. Introducing VacCAP Project. Wisconsin State Growers Association Cranberry School, January 23, 2020, Wisconsin Dells, WI, USA. Status: published. NIFA Support Acknowledged: Yes*
- Polashock J. VacCAP Project: A New Nationwide Project to Advance Breeding in Vaccinium Species. Annual Meeting of the American Cranberry Growers Association, January 23, 2020, Columbus, NJ, USA. Status: published. NIFA Support Acknowledged: Yes.
- Allen R. VacCAP: Leveraging genetic and genomic resources to enable development of blueberry and cranberry cultivars with improved fruit quality attributes. Alma Blueberry Update January 8, 2020, Alma, GA. Status: published. NIFA Support Acknowledged: Yes
- Main M. Using crop databases and big-data to enable superior cultivar development. WA Small Fruit Conference & Lynden AG Show, December 4-6, 2019, Lynden, WA. Status: published. NIFA Support Acknowledged: Yes
- Canales E. Market Planning. Mississippi Blueberry Education Workshop. January 23, 2020, Hattiesburg, MS. Status: published. NIFA Support Acknowledged: Yes.

VacCAP Team Publications and Presentations

Press Releases

- UW scientists part of $12.8M effort to improve cranberries and blueberries: Wisconsin State Farmer, February 18, 2020. https://www.wisfarmer.com/story/news/2020/02/18/uw-scientists-part-effort-improve-cranberries-and-blueberries/4798444002. Status: published. NIFA Support Acknowledged: Yes*
- UW researchers receive grant pioneer research on cranberry genomes: Badger Herald, March 10, 2020. https://badgerherald.com/news/2020/03/10/uw-researchers-receive-grant-pioneer-research-on-cranberry-genomes. Status: published. NIFA Support Acknowledged: Yes*
- WSU scientists team up to improve blueberries, cranberries. WSU Insider, Feb. 7, 2020. https://news.wsu.edu/2020/02/07/wsu-scientists-team-12-8-million-effort-improve-blueberries-cranberries/. Status: published. NIFA Support Acknowledged: Yes*
- US (WI): Wisconsin-based researchers work to breed better cranberries. Spectrum News, February 24, 2020. https://spectrumnews1.com/wi/madison/news/2020/02/25/wisconsin-based-researchers-work-to-breed-better-cranberries. Status: published. NIFA Support Acknowledged: Yes*
- Chagne D. The importance of the humble blueberry. Genomics Aotearoa, February 26, 2020. https://sciblogs.co.nz/genomics-aotearoa/2020/02/26/the-importance-of-the-humble-blueberry/. Status: published. NIFA Support Acknowledged: Yes*

Other

- News Interview. Wisconsin-based researchers work to breed better cranberries. SpectrumNews, February 24, 2020. https://spectrumnews1.com/wi/madison/news/2020/02/25/wisconsin-based-researchers-work-to-breed-better-cranberries. Status: published. NIFA Support Acknowledged: Yes*
- Q&A. Building a Better Berry: A Cranberry Q&A With Dr. Juan Zalapa: VacCap Newsletter, August 25, 2020. https://www.vacciniumcap.org/buildingabetterberry. Status: published. NIFA Support Acknowledged: Yes*
- On-line presentation. Iorizzo M. VacCAP: A community-based project to develop advanced genetic tools to improve fruit quality in blueberry and cranberry. Online talk, organized by Ministry of Agriculture and National Institute of Agricultural Innovation. June 25, 2020. Status: published. NIFA Support Acknowledged: Yes*
- Newsletter article. DeVetter LW and Finn C. Forever Inspiring the Berry Breeding Community. VacCAP Newsletter, Aug. 25, 2020. https://www.vacciniumcap.org/node/51. Status: published. NIFA Support Acknowledged: Yes*
- US (WI): CALS scientists part of $12.8 million effort to improve cranberries and blueberries. ECALS College of Agriculture and Life Sciences University of Wisconsin Madison, February 24, 2020. https://ecals.cals.wisc.edu/2020/02/24/cals-scientists-part-of-12-8-million-effort-to-improve-cranberries-and-blueberries/?utm_source=ecals_email_newsletter&utm_medium=email&utm_campaign=ecals_email_newsletter. Status: published. NIFA Support Acknowledged: Yes*

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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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

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www.vacciniumcap.org
vaccapsocial@gmail.com | @VacciniumCAP