Cover Sheet: Request 14426

New Graduate Degree Program: PhD with the Major in Plant Breeding

Info

Process	Degree|New|Grad|Existing Type|State-funded|Residential
Status	Pending at FAC - Faculty Senate Steering Committee
Submitter	Eliana Kampf elianak@ufl.edu
Created	11/6/2019 5:08:54 PM
Updated	5/21/2020 2:41:20 PM
Description of request	The interdisciplinary Ph.D. degree in Plant Breeding is proposed to fill the demand for breeding research and for training new plant breeding graduates at the University of Florida.

Actions

Step	Status	Group	User	Comment	Updated
Department	Approved	CALS - Horticultural Sciences 514923000	Christine Chase		11/6/2019
No document changes					
College	Approved	CALS - College of Agricultural and Life Sciences	Joel H Brendemuhl	Requested edits by the CALS CC, Dean of CALS and external reviews have been incorporated.	1/28/2020
Appendix_C _Plant_Breeding_CVs.pdf Appendix_B_Plant_Breeding.pdf Appendix_ E_Plant_Breeding.pdf DocuSign_11_10_19_Dept_Chairs_Signatures_Plant_Breeding.pdf Appendix_A_Plant_Breeding_Tables_Jan_6_2020.xlsx Appendix F_Plant_Breeding.pdf Appendix_D_Plant_Breeding_External_Reviewers.pdf Plant_Breeding_Proposal_Final_01_27_20.docx					1/22/2020 1/22/2020 1/22/2020 11/13/2019 1/22/2020 1/22/2020 1/22/2020 1/27/2020
OIPR	Approved	PV - Office of Institutional Planning and Research	Cathy Lebo		2/3/2020
No document changes					
AP for Academic and Faculty Affairs	Approved	PV - Associate Provost for Academic and Faculty Affairs	Christopher Hass		2/5/2020
No document changes					
Graduate Council	Approved	GRAD - Graduate Council	Lorna M Dishman	The proposal was approved at the May 21, 2020 Graduate Council with an effective date of Fall 2021.	5/21/2020
Plant_Breeding_Proposal_Revised_May_14_2020.docx Plant Breeding Notations.docx CoverLetter MEMO Revised Plant Breeding PhD Proposal.docx Appendix_A_Plant_Breeding_Tables_April_29_2020.xlsx Chairs_Dean_DocuSign_PlantBreeding_RevisedCurriculum.pdf Plant Breeding Curriculum.docx Plant_Breeding_Catalog_Final_May_2020.docx					5/14/2020 3/12/2020 5/5/2020 5/5/2020 5/5/2020 5/14/2020 5/14/2020
University Curriculum Committee Notified	Notified	PV - University Curriculum Committee (UCC)			5/21/2020
No document changes					

Original file: Cover sheet.pdf

Step	Status	Group	User	Comment	Updated
Faculty Senate Steering Committee	Pending	FAC - Faculty Senate Steering Committee			5/21/2020
No document changes					
Faculty Senate					
No document changes					
Academic Affairs					
No document changes					
Board of Trustees					
No document changes					
Board of Governors					
No document changes					
Academic Affairs Notified					
No document changes					
Graduate School Notified					
No document changes					
Office of the Registrar					
No document changes					
OIPR Notified					
No document changes					
Academic Assessment Committee Notified					
No document changes					
College Notified					
No document changes					

APPENDIX F. Examples of CALS plant breeding alumni successfully employed in academia, industry, government and research institutions nationally and globally.

Alumni Name (Last, First Name)	Current Position - INDUSTRY, GOVERNMENT AND RESEARCH INSTITUTIONS -	Chair /Co-Chair	Graduation Year
Acharya, Ananta R.	Bioinformatics Scientist, Corteva Agrisciences, Indianapolis, IN	Quesenberry, K.	2009
Aina, Olubunmi O	Senior Biologist, Breeding & Genetics, Corteva AgriScience, Haiwaiian Islands	Quesenberry, K.	2011
Anciro, Ashlee L.	Molecular Biology Manager and Tissue Culture Research Associate	Lee, S./Whitaker, V.	2017
Barten, Jay	Tomato Breeder & Station Director, DeRuiter Seeds (Bayer), Almeria, Spain	Scott, J.	1991
Blaker, Kendra	Small Fruit Breeder, Plant Sciences, Inc., Watsonville, CA	Olmstead, J.	2013
Bowman, Kim Dean	Citrus Rootstock Breeder, USDA-AR, Ft. Pierce, Florida	Gmitter, F.	1990
Carrilo-Mendonza, Omar	Strawberry Breeder, Driscoll's, Watsonville, CA	Chaparro, Jose	2012
Carvalho, Marcelo Ayres	Forage Breeder & Germplasm Manager, EMBRAPA, Brasilia, Brazil	Quesenberry, K.	2004
Cellon, Catherine	Assistant Plant Breeder, Duda Farm Fresh Foods, Belle Glade, FL	Olmstead, J./Munoz, P.	2015
Christensen, Christian	High Chill Blueberry Breeder, Driscoll's, Watsonville, CA	Kenworthy, K.	2012
Czarnecki, David M. II	Flower Breeder, Ernst Benary of America, Inc., CA	Deng, Z.	2011
Drost, Derek	Discovery Genomics Strategy Lead, Bayer	Kirst, M./Peter, G.	2009
Freire, Marcos	Program Officer, Alliance Green Revolution in Africa (AGRA), Mozambique	Quesenberry, K.	1999
Gilbert, Jessica	Molecular Blueberry Breeder, Driscoll's, Watsonville, CA	Olmstead, J./Clark, D.	2015
Hardy, Stephanie R	Official at European Commission, Belgium	Quesenberry, K.	1986
Holderbaum, James F.	International Business & Technical Consultants, Inc. Vienna, VA	Quesenberry, K.	1989
Hossain, Maksud M.	Research Associate, Noble Research Institute, OK, US	Babar, A.	2017
Jandrew, Jason R.	Ornamental Breeder, Ball Horticultural Company	Clark, D.	2002
Jank, Liana	Forage Breeder, EMBRAPA, Campo Grande, MS, Brazil	Quesenberry, K.	2001
Kennedy, Colleen	Plant Breeder, Duda Farm Fresh Foods, CA	Whitaker, V.	2013
Kouame, Christophe M.	Senior Scientist & Country Dir., World Agroforestry Ctr. (ICRAF), Ivory Coast	Quesenberry, K.	1991
Luciani, Gabriela F.	Scientist, Bayer, Argentina	Altpeter, F.	2007
Mangandi Sanchez, Jozer	Plant Breeder, Berry Blue, Inc. Plant City, FL	Whitaker, V.	2015
Marco, Martin Alberto	Manager, Forestry Improvement Program (PROMEF), INTA, Argentina	Rockwood, D.	1987
Marino, Silvia R.	Research and Development, Wonderful Citrus, Mcallen, TX	Olmstead, J.	2012
Martens, Roy Jesse	Sugarbeet Breeder, Syngenta, Longmont, CO	Barnett, R.	1996
Moon, David	Wheat Breeder, Pioneer Wheat Breeding Program, West Memphis, AR	Quesenberry, K.	1993
Mowrey, Bruce D	Director of Plant Breeding, Driscoll's	Sherman, W.	1985
Neibaur, Isaac E.	Senior Research Associate, Corteva Agriscience, China	Altpeter, F.	2007
Nguyen, Penny	Strawberry Breeder, Driscoll's, Watsonville, CA	Clark, D.	2007
Norden, Elliot H.	Research Associate II, Driscoll's, Dover, FL	Chaparro, J.	2017
Padley, Les	Squash breeder, Syngenta Global	Lyrene, P.	2005
Piccinino, Lisa L.	Tomato Breeder, Syngenta Seeds, Naples, FL	Scott, J.	1985
Poerba, Yuyu S.	Plant Breeder, Research Center for Biology, Inst. of Science (LIPI), Indonesia	Quesenberry, K.	1996
Rodriguez-Armenta, Hilda	Blueberry Breeder, Fall Creek Farm and Nursery, Ciudad Guzman, Mexico	Olmstead, J.	2015
Sandhu, Sukhpreet	Scientist, Bayer Crop Science, USA	Altpeter, F./Blount, A.	2008
Sanhueza-Herrera, Rebeca	General Manager, SPT Chile, Quillota Province, Chile	Rockwood, D.	1999
Sierra-Lucero, Victor	Director of Innovation and Technology Transfer Office, UNAB, Chile	Rockwood, Don	1999
Smith, Sarah M.	Squash Breeder, HM Clause, CA	Deng, Z./Clark, D.	2011
Stewart, Philip Jacob	Global Plant Breeding Director, Driscoll's Strawberry, San Francisco Bay Area	Chandler, C.	2007
Tamang, Bijay	Project Forester & Analyst, F4 Tech	Rockwood, D.	2009
Taparia, Yogesh	Research Associate, Corteva Agrisciences, India	Altpeter, F.	2011

Taylor, Steven G.	Integrated Crop Technical Manager, Syngenta, Greensboro, North Carolina	Quesenberry, K.	1987
Thornton, Steven T	Maize Breeder, Corteva Agrisciences, Mississippi, USA	Tillman, B.	2014
Wente, Rebecca	Syngenta, plant breeding support position	Hutton, S.	2018
Xiaobo, Li	North American Corn Breeding Data Lead, Bayer, St. Louis, MO	Peter, G.	2009
Yang, Zhi	Business Analysis Manager, iQIYI.com, Beijing, China	Rockwood, D.	2009
Yu, Yuan	Citrus Breeder, Haisheng Corporation, China	Gmitter, F./Klee, H.	2014
Zhang, Jianxing	Assistant VP, Compliance Quantitative Operations Associate, Bank of America	Peter, G.	2015

Alumni Name (Last, First Name)	**Current Position - ACADEMIA -**	**Chair /Co-Chair** (Last, First Name)	**Graduation Year**
Acuna, Carlos Alberto	Professor and forage breeder, UNNE Corrientes, Argentina	Blount, A./Quesenberry, K.	2009
Baldessari, Jorge J.	Peanut Breeder, Instituto Nacional de Tecnologia Agropecuaria (INTA), Argentina	Tillman, B.	2008
Blount, Ann	Professor, Forage Breeding, University of Florida, North FL REC, Marianna, FL	Quesenberry, K.	1984
Cao, Zhe	Postdoctoral Researcher, University of Saskatchewan	Deng, Z./Clark, D.	2016
Chambers, Alan	Assistant Professor, Tropical Fruits Breeder, Univ. of Florida	Folta, K./Whitaker, V.	2013
Chaparro, Cesar J	Professor, Faculdad de Recursos Naturales, Univ. Nacional de Formosa, Argentina	Quesenberry, K.	1991
Chavez Velasquez, Dario J.	Extension Specialist and peach breeder, University of Georgia, Griffin	Chaparro, J.	2013
Deren, Christopher (*retired*)	Director, Rice Research and Extension Center, Stuttgart, University of Arkansas	Quesenberry, K.	1986
Gmitter, Frederick Jr	Professor, Citrus Research & Educ. Center, University of Florida	Sherman, W.	1985
Goyzueta Altamirano, Marco	Ph.D. Student in Agronomy, University of Florida	Tillman, B./Rowland, D.	2017
Griffiths, Phillip D.	Associate Professor of Horticulture, Cornell University, Geneva Station	Scott, J.	1998
Hutton, Samuel F.	Assistant Professor, Gulf Coast Research & Educ. Ctr., University of Florida	Scott, J.	2008
Itle, Rachel A.	Post-doctoral Researcher, University of Georgia	Olmstead, J.	2010
Jung, Jehyeong	Senior Scientist, Korea Institute of Science and Technology, Korea	Altpeter, F.	2012
Kemerait, Pamela Jean L	Adjunct Instructor, Abraham Baldwin Agricultural College, Tifton, GA	Chandler, C.	1998
Kilasi, Newton	Assistant Professor, Sokoine University of Agriculture, Morogoro, Tanzania	Rathinasabapathi, B.	2016
Mourao, Francisco A	Assoc. Professor, ESALQ, Universidade de Sao Paulo, USP, Brazil	Grosser, J.	1995
Mramba, Lazarus K.	Statistician, University of Florida Health	Gezan, S.	2016
Muir, James Pierre	Professor, Texas AgriLife Research, Texas A&M University System	Quesenberry, K.	1989
Phillips A., Douglas	Blueberry Extension Coordinator, University of Florida, Wimauma, FL	Munoz, P.	2017
Ribeiro de Resende, Marcio	Assistant Professor, Horticultural Sciences, University of Florida	Kirst, M.	2014
Rios, Esteban F.	Assistant Professor, Agronomy, University of Florida	Munoz, P./Kenworthy, K.	2016
Riveros Walker, Alejandro	Post-Doctorate Associate, University of Florida	Peter, G.	2014
Roach, Jack	Ph.D. student, Max Planck Plant Breeding Research, Cologne, Germany	Whitaker, V.	2015
Rodriguez, Jorge	Professor, Instituto de Recursos Geneticos y Productividad, Montecillo, Mexico	Sherman, W.	1984
Schwartz, Brian M.	Associate Professor, Turfgrass Breeding, University of Georgia, Tifton, GA	Kenworthy, K.	2008
Sinche Serra, Marco Vinicio	Professor, Escuela Politécnica Nacional, Quito, Ecuador	Altpeter, F.	2013
Topp, Bruce L	Assoc. Professor, Centre Horticulture Scs., University of Queensland, Australia	Sherman, W.	1992
Tseng, Yu-Chen	Breeder, University of Taiwan	Tillman, B.	2016
Weber, Courtney	Assoc. Professor, School of Integrative Plant Science, Horticulture, Cornell University	Sherman, W.	1994

APPENDIX E. Letters from leading national and international agricultural industry showing support for the development of the University of Florida/IFAS graduate program in Plant Breeding.

1. Support letter from Tabare Abadie, Ph.D., Lead External Academic Outreach, Corteva Agriscience, Agricultural Division of Dow DuPont, Johnston, IA.

2. Support letter from James Brusca, Vice President of Global Breeding, HM Clause, Inc., Davis, CA.

3. Support letter from Larry Pierce, Senior Director of Research & Development/Plant Breeding, Duda Farm Fresh Foods, Inc.

4. Support letter from Pilar Bañados, Ph.D., Research & Development Director, Blueberry Breeding Programs and Rafael Quevedo, Global Production Director, HORTIFRUT, Santiago, Chile.

5. Support letter from Joe Bouton, Owner and consultant, Bouton Consulting Group, LLC, Athens, GA.

6. Support letter from Jeff Trickett, Director of Sales & Marketing, Bejo Seeds, Inc.

7. Support letter from Douglas W. Heath, Senior Tomato Breeder, Bejo Seeds, Inc., Oceano, CA.

8. Support letter from Paul Orsenigo and David Basore, GMI Grower's Management, Belle Grade, FL.

9. Support letter from Michael D. Nelson, Ph.D., Vice President, Plant Sciences, Inc., Watsonville, CA.

Support letter #1 from Tabare Abadie, Ph.D., Lead External Academic Outreach, Corteva Agriscience, Agricultural Division of Dow DuPont, Johnston, IA.

CORTEVA agriscience | Agriculture Division of DowDuPont™

Johnston, Iowa, August 2018

Drs. Patricio Munoz and Marcio Rezende

University of Florida, Gainesville

I am writing to express support for University of Florida proposal to further develop a graduate program in Plant Breeding.

Corteva Agriscience, the Agricultural Division of Dow DuPont, is a science-based products and services company. Our company puts science to work by creating sustainable solutions essential to better, safer, healthier life for people all over the world. Operating in more than 130 countries, our company is one of the world's largest sources of customized solutions for the agricultural sector. Our purpose is to enrich the lives of those who produce and those who consume, ensuring progress for generations to come.

Our industry depends on the research advances of basic and applied plant sciences as well as a continuous source of outstanding talent in order to address growing global agricultural needs through creative and innovative science. Breeding of plants is a critical core expertise for a nation that intends to continue having a vibrant agriculture in the rapidly changing world and Corteva Agriscience is honored to support the training of future scientists in this field of studies.

I was excited to learn about the proposal you are putting together. The University of Florida is well recognized around the world for the diversity and success of its breeding programs, and for the high quality of the academic opportunities it provides to graduate students. We have recently partnered with the graduate students of your University by sponsoring highly successful student lead Science Symposia (2017-18, and also one planned for early 2019), as part of our global Plant Science Symposia Series, that includes more than 50 of the most prestigious Universities around the world (www.pioneer.com/Symposia). The success of these events are a testament of the excellent preparation of your graduates and their eagerness to enhance the connections with prestigious scientists and peer graduate students in the area of Plant Breeding. Developing a graduate program in Plant Breeding will hence provide the graduates of the U. Florida with further opportunities to be prepared for a successful career in the field,

strengthening the already strong training in quantitative and molecular based sciences, and matching it with field experience on your existing breeding programs.

The development of the program proposed matches with the objectives of our company to support education, and the trainees of this program will sure fit the needs of our organization in the future. Hence, we are committed to sending seminar speakers to talk about Corteva Agriscience and industry careers generally for your seminar series, and to continue supporting the student lead Symposia Series at your University. Also, trainees from this proposed program will be considered for our 3-6 months' internship program and, upon graduation, full-time employment within our company. Finally, we will be honored to serve on the External Advisory Committee of your program, and to provide ad-hoc advise if requested.

Tabare Abadie, PhD

(tabare.abadie@pioneer.com)

Lead External Academic Outreach

Corteva Agriscience, Agricultural Division of Dow DuPont

Support letter #2 from James Brusca, Vice President of Global Breeding, HM Clause, Inc., Davis, CA.

HM • CLAUSE

August 2, 2018

Dr. Samuel Hutton and Dr. Geoffrey Meru
University of Florida, Department of Horticulture Science
Gulf Coast Research and Education Center
14625 CR 672, Wimauma, FL 33598

Dear University of Florida Plant Breeding Faculty,

I am very pleased to learn of the current efforts to establish a Ph.D. degree program in plant breeding and delighted to write this letter of support for this initiative. It is well documented and often discussed that the number of University plant breeding programs, particularly in vegetables, has declined over the past decade. Applied university plant breeding programs are critical to the exploration of germplasm diversity to identify and characterize novel traits, development and release of relevant germplasm and the delivery of a pipeline of plant breeders to industry and academia alike. The global human population is estimated to reach 9.6 billion in 2050 - the need for new and adapted plant varieties (and the scientists who breed them) is clear.

With a significant number of applied plant breeders and the release of meaningful and innovative germplasm to industry, the University of Florida has been an important partner for industry. Beyond the germplasm contributions in many crops, the University of Florida has and continues to generate well-trained applied scientists impacting industry and society in plant breeding roles.

Plant breeding as a discipline becomes increasingly interdisciplinary, and the skill set required by future plant breeders is more and more complex. Beyond the diverse technical requirements in a range of scientific disciplines, today's plant breeders also need to have economics understanding, strong project management skills, leadership abilities to coordinate diverse teams in a common direction, strong communication and interpersonal skills and capacity to constructively collaborate with partners in marketing, sales, supply chain, HR and beyond. As the needs and skills of applied industry plant breeders evolve, it is important that the educational and training programs developing plant breeders evolve as well.

In my role as VP Global Breeding at HM.Clause, I oversee our plant breeding activities and teams globally. HM.CLAUSE Inc. was formed in 2008 by bringing together Harris Moran, headquartered in California, and Clause, headquartered in France. HM.CLAUSE, a business unit of the Limagrain Group, specializes in breeding, production and commercialization of vegetable seeds varieties. We work in over 20 vegetable crops in over 100 countries, and are dedicated to innovative and sustainable development of the highest quality vegetable seeds.

HM.CLAUSE, Inc.
260 Cousteau Place – Suite 210 – Davis, CA 95618 – USA
Tel. +1 (530) 747 3700 – Fax +1 (530) 747 3794
www.hmclause.com

Limagrain

HM•CLAUSE

A significant part of my strategic agenda is planning for growth and turnover for applied plant breeding roles. I am concerned that there will not be the needed supply of well-trained students to meet the needs of HM.Clause and industry in general. The University of Florida is in a unique position to grow its leadership position to meet this need. Beyond the strong history of applied plant breeding and student development at UF, through initiatives like the Challenge 2050 Project, UF continues to demonstrate its concern for global food supply and interest and capability to be a proactive partner for industry. The establishment of a Ph.D. program in plant breeding would be an important step towards continuing this legacy.

Thank you for the opportunity to share this message of support. Should you have any questions, please feel free to contact me.

Sincerely,

James Brusca

James Brusca

Global VP Breeding
Email: james.brusca@hmclause.com
Mobile USA: + (530) 650-5015

HM.CLAUSE, Inc.
260 Cousteau Place – Suite 210 – Davis, CA 95618 – USA
Tel. +1 (530) 747 3700 – Fax +1 (530) 747 3794
www.hmclause.com

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Support letter #3 from Larry Pierce, Senior Director of Research & Development/Plant Breeding, Duda Farm Fresh Foods, Inc.

July 29, 2018

There is no doubt that the University of Florida has distinguished itself from other Universities by supporting numerous applied breeding programs and professionals. This has provided substantial advantage to A. Duda & Sons on two fronts.

- The products developed through these programs have provided benefit for its business.
- As a source of trained plant breeders in Horticultural Crops for fulfilling roles in its own proprietary plant breeding programs.

In the last three years we have hired one PhD and one MS student from the University of Florida as a breeder and assistant breeder. Of particular importance was that these individuals came from programs that focused on plant breeding in horticultural crops. There are definitive differences between focus of quality attributes, breeding techniques and general propagation and breeding principles between horticultural crops and agronomic crops. Our experience is that those trained in agronomic crops typically require considerable supplemental horticultural training to become horticultural crop plant breeders.

There are very few programs in the United States that are currently training applied plant breeders with hands on training experience in horticultural crops. It is our opinion that a plant breeding degree with hands on experience in horticultural crops would be of special value. However, a plant breeding degree with agronomic experience would have less significance to our company and becomes one of many programs across the country that actually provide similar training. We would value future candidates from the University of Florida and believe it can continue to distinguish itself if it creates said degree with an opportunity to have supplemental training in horticultural crops.

The University of California currently offers an opportunity for companies like Duda to provide supplemental training for breeders that have a horticultural degree through a plant breeding academy. We are not aware of a similar opportunity to provide horticultural training to an agronomic trained plant breeder. It would be of particular value if we did not have to provide this supplemental training and would look forward to an opportunity to consider future plant breeding candidates from the University of Florida.

Larry Pierce
Senior Director Research & Development/Plant Breeding
Duda Farm Fresh Foods, Inc.
(831)229-3486
Larry.Pierce@Duda.com

Original file: Appendix_ E_Plant_Breeding.pdf

Support letter #4 from Pilar Bañados, Ph.D., Research & Development Director, Blueberry Breeding Programs and Rafael Quevedo, Global Production Director, HORTIFRUT, Santiago, Chile.

Santiago, August 10, 2018

Dr. Patricio Munoz
Blueberry Breeding and Genomics Lab.
Horticultural Science Department
IFAS - University of Florida
2211 Fifield Hall, Gainesville FL 32611, USA

REF: Support letter from Hortifrut

Dear Dr. Munoz

We are very pleased to send you this support letter to create a **Ph.D. degree program in plant breeding at the University of Florida**.

As you know Hortifrut is the largest Blueberry producer in the world with more than 25% of the global market share. "Hortifrut Genetics" is called the extensive Program of Genetic Improvement of Hortifrut Berries and whose objective is the permanent selection and development of new and better Berries for Hortifrut, its partners, its producers, its commercial platforms and its final consumers. Through the careful work of our Breeders, Hortifrut seeks to differentiate itself in the market of Berries of the world with new flavors, better quality, more attractive and healthy fruits, with a longer post-harvest life, which will allow our company to extend the dates of offer in the global market of Berries to the World Every Day.

Investing in genetic improvement is a strategic part of Hortifrut global strategy, and thus hiring plant breeders with a core formation in plant breeding, without forgetting the horticultural background is and will be a key as we keep expanding and developing new cultivars. A formal training in applied Plant Breeding will be something we in Hortifrut will definitely prefer when we chose a candidate to be incorporate in our breeding program. We value the science behind the breeding and the new knowledge in advance breeding and molecular techniques will benefit the speed and progress of our programs at Hortifrut

Without any doubt the berry industry needs well trained and up to date scientist that help us developing the Berries for the future.

Sincerely,

Pilar Bañados. Ing Agr. MS. PhD
R&D Director
Blueberry Breeding Programs
HORTIFRUT

Rafael Quevedo. Ing Agr.
Global Production Director
HORTIFRUT

Support letter #5 from Joe Bouton, Owner and consultant, Bouton Consulting Group, LLC, Athens, GA.

August 14, 2018

Dr. Esteban Rios
Assistant Professor – Forage Breeding and Genetics
University of Florida – IFAS – Agronomy Department
2005 SW 23rd Street, Bldg. 350 Off 5
Gainesville, FL 32608

Dear Esteban:
I am happy to provide my perspective on the efforts of the UF Plant Breeding Faculty to establish a PhD program in Plant Breeding.

I was a Professor at the University of Georgia (now Emeritus Professor) and a Senior VP and Division Director at the Samuel Roberts Noble Foundation. My research focused on plant breeding and genetics, but especially developing new cultivars of pasture and forage crops. After retiring, I formed a consulting company, Bouton Consulting Group LLC, and currently work with several clients to improve their ongoing plant breeding and cultivar development research and development programs (https://www.linkedin.com/in/joseph-bouton-939bb970/).

From my past experience, and especially from what I see now as a consultant, there is a continuing, and even increasing, demand for well-trained plant breeders that I am sure your proposed program will have few problems in meeting.

Seed company R&D units simply want plant breeders; especially those with training in the new biotechnologies. I am also sure that any candidate would be viewed more favorably if he/she had formal training and a degree specifically in Plant Breeding vs one with a broader degree (e.g., Ph.D. in Agronomy) for positions with these companies; including the large multinationals.

This potential program is a very good idea, and as a UF alumnus, I wish you luck with getting it approved.

Sincerely,

Joe Bouton
Owner and Consultant

1020 Powell Court
Athens, GA 30606

580-220-7688

Support letter #6 from Jeff Trickett, Director of Sales & Marketing, Bejo Seeds, Inc.

UF/IFAS Plant Breeding Workshop
University of Florida

July 31, 2018

SUBJ: Ph.D Plant Breeding

To Whom It May Concern,

I am writing to express my support for the University of Florida establishing a Ph.D program in Plant Breeding. Speaking from the Sales & Marketing side of Bejo Seeds, plant-breeding capabilities are critical to our company and its future success. Having qualified candidates for key Breeding Research roles is imperative in order to provide the product development leadership so important to our business model. We need talented and qualified individuals to fill these roles who can provide vision and insure the long new variety development cycle is kept fresh to provide the types of quality products Bejo wants to market in the future.

The University has been a significant partner to Bejo in our development of the Tomato segment and we would be happy to continue a close relationship via potential Breeding Research candidates coming out of a Ph.D program at UF.

Sincerely,

Bejo Seeds, Inc.

Jeff Trickett

Director Sales & Marketing

cc: Mark Overduin; Greg Styers; Doug Heath

July 30, 2018

To the UF/IFAS Plant Breeding Working Group,

I am providing this letter in support of the proposal to establish a PhD in Plant Breeding at the University of Florida. Being a PhD in Plant Breeding from Cornell myself I understand on a personal level the value of this degree. In my opinion it is much more than a title. A PhD in Plant Breeding is a specialization in both aspects of study, research, and title.

When I was searching for a PhD program after getting my MS in Vegetable Crops, I was surprised to find in the late 1980's that an actual PhD in Plant Breeding was rather limited to a few Universities. Luckily for me a program became available at Cornell where I had just finished my Masters.

Now I see that many more Universities have added the option of getting a PhD in Plant Breeding. I feel that the University of Florida would benefit in multiple ways from adding this degree option.

First, this option will attract more students that have a very firm idea that Plant Breeding is the specific area of focus for them. I knew it well after finishing my Masters and while I was not able to get a PhD program based on research with vegetables which were my first choice, the degree was nevertheless the right option for me. I strongly feel that this option will attract students highly motivated to excel at this area of study and research.

The University of Florida already has a strong foundation in Plant Breeding from past programs. I would like to acknowledge Dr. John [Jay] Scott. I must say I was not very aware of both Dr. Scott and another Professor that I now feel was an equally successful Plant Breeder as well as Researcher who is Dr. Randy Gardner. Both of these Professors had the unique blend of strong academic programs and being well-known Plant Breeders with extensive strong breeding programs that made them both very attractive to the commercial sector. I know that when I started with Peto Seed in 1993 that Paul Thomas told me he had tried several times to hire both Jay and Randy but they were both loyal to their University positions. Both of these breeding

programs have contributed in a very significant way to commercial plant breeding programs worldwide. I feel it is very important to continue with this and not let it wane. Indeed Dr. Sam Hutton is in my opinion continuing with excellence in the path that Dr. Scott forged as did he with his predecessors. Dr. Hutton is able to combine the areas of both molecular and applied breeding so necessary in Plant Breeding today for both the public and private sectors. As an applied tomato breeder for 26 years now I see and appreciate the value of interaction with University programs. University Plant Breeding programs can handle the early developmental breeding that is harder for us commercial breeders to do. An example of this is finding new traits of interest in wild accessions and doing the often difficult interspecific crosses. This allows the public and private sectors to interface and work together to reach common goals of research and applied results faster through collaboration.

Finally, as a Senior Plant Breeder I will be searching in about four years to hire an Assistant Breeder that I can train to take my place. Many large corporate Seed Companies will only hire a PhD for such a position and the specialization in Plant Breeding gives those people a real edge in getting such a position. Even though I do not have this restriction at Bejo, I would still prefer to hire someone with a PhD in Plant Breeding if possible. We did just that recently for the potato program.

If you have any further questions please feel free to contact me.

Sincerely,

Douglas W. Heath

Senior Tomato Breeder

Bejo Seeds, Inc.

1972 Silver Spur Place | Oceano, California, 93445 | USA

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Support letter #8 from Paul Orsenigo and David Basore, GMI Grower's Management, Belle Grade, FL.

GMI
Grower's Management

P.O. Box 130
Belle Glade, FL 33430

Phone (561) 996-6469
Fax (561) 996-6480

August 2, 2018

Dr. Germán Sandoya-Miranda
UF/IFAS Plant Breeding Working Group

Our farming operation grows and packs a wide variety of leafy vegetables for the fresh market, as well as sweet corn in the Everglades Agricultural Area(EAA) and other locations in South Florida.

We are keenly aware of the foundational successes that American agriculture has experienced in the last 200 plus years as a direct result of plant breeding, cultivar development and genetic improvement within multiple crops and plant species.

Grower's Management has historically been very supportive of the breeding programs, particularly lettuce and leafy vegetables at the Everglades Research and Education Center (EREC) in Belle Glade, Florida.

We are encouraged by the proposal to initiate a Plant Breeding PhD degree program within the University of Florida's College of Agriculture. The demand/supply equation for plant breeders is very unbalanced with a shortage of breeders in the ag industry, especially in the specialty/minor crop segment of food production. The need for well trained and effective plant breeders will continue to increase into the future as pest and environmental challenges become more intense. Post-harvest shelf life, nutritional value, crop yield optimization and improved vigor are additional economic benefits to the farmer, supply chain manager and consumer.

Employment opportunities and good jobs are abundant for those that successfully complete the proposed program. Thank you for the opportunity to provide this letter of support for a very worthy endeavor.

Paul Orsenigo

David Basore

Support letter #9 from Michael D. Nelson, Ph.D., Vice President, Plant Sciences, Inc., Watsonville, CA.

Plant Sciences Inc.
Advancing Agriculture through Science

342 Green Valley Road
Watsonville, California USA 95076

Office Phone 831.728.7771
Fax 831.728.4967

www.plantsciences.com

August 29, 2018

Vance M. Whitaker, PhD
Strawberry Breeding and Genetics
UF / IFAS Gulf Coast Research and Education Center
14625 CR 672
Wimauma, FL 33598

Dear Vance,

Thank you for the opportunity to provide input regarding the potential establishment of a cross-departmental graduate degree program in plant breeding at the University of Florida.

Plant Sciences, Inc. (PSI) is an agricultural research, consulting and production business headquartered in California. Our mission is to serve the global fruit and vegetable industries by developing superior cultivars through traditional breeding including the use of the latest genetic marker and genomics technologies. We continue to expand our work into new crops and geographies around the world. To meet our future anticipated workforce needs, we would strongly support the development of a graduate degree program specifically aimed at training students in plant breeding, genetics and utilizing the most advanced molecular technologies for crop improvement. Students who come out of graduate school with a MS or PhD degree in the specific area of plant breeding would be given greater priority over those with a more general agronomy or horticulture degree. We would anticipate that students with a plant breeding degree would have experienced a greater level of instruction and training in current breeding systems and methods relative to those graduating with a general agricultural degree.

We have hired several graduates with advanced degrees from the University of Florida over the years and have been very pleased with their capabilities and expertise. Our interest in future graduates would only increase with the potential plant breeding degree program you are looking to establish.

Sincerely,

Michael D. Nelson, PhD
Vice President

Original file: Appendix_ E_Plant_Breeding.pdf

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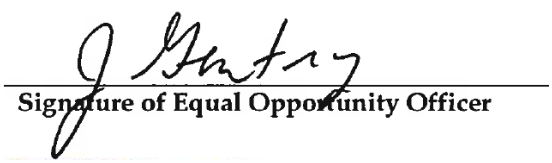
APPENDIX B. Signature of the Equal Opportunity Officer and the Library Director.



Signature of Equal Opportunity Officer

10/9/19

Date

Signature of Library Director

11/4/19

Date

This appendix was created to facilitate the collection of signatures in support of the proposal. Signatures in this section illustrate that the Equal Opportunity Officer has reviewed section II.E of the proposal and the Library Director has reviewed sections X.A and X.B.

APPENDIX C. Abbreviated Curriculum Vitae (CV) for Plant Breeding faculty members.

FREDY ALTPETER, Ph.D.
Professor of Molecular Genetics and Biotechnology
University of Florida, Institute of Food and Agricultural Sciences
Agronomy Department, Plant Molecular and Cellular Biology Program
PO Box 110500, 3085 McCarty Hall B, Gainesville, FL 32611
352-273-3418, altpeter@ufl.edu
https://agronomy.ifas.ufl.edu/faculty/

EDUCATION

University of Florida	Crop Biotechnology	Postdoc	1994-1997
University of Hohenheim, Germany	Plant Breeding & Biotechnology	Dr. Sc. Agr.	1994
University of Hohenheim, Germany	Crop Science	Dipl. Ing. Agr.	1990
Farms and estates in Germany	Crop and Animal Production	Farm Manager	1989

PROFESSIONAL EXPERIENCE

2012-present	Professor, Agronomy Department, University of Florida, Gainesville, FL
2008-2012	Associate Professor, Agronomy Department, University of Florida, Gainesville, FL
2001-2008	Assistant Professor, Agronomy Department, University of Florida, Gainesville, FL
1997-2001	Research Group Leader, Plant Genome Research Center, IPK, Gatersleben
1994-1997	Postdoc Research Associate, Dept. of Horticultural Scs., Univ. of Florida, Gainesville, FL
1991-1994	Graduate Research Assistant, Plant Breeding Dept., Univ. of Hohenheim, Germany

AREAS OF SPECIALIZATION

- Molecular physiology to unravel regulatory networks controlling photosynthetic efficiency; plant architecture, stress tolerance and biomass quality.
- Translational genomics, genome editing and metabolic engineering to optimize crop performance and sustainably produce value added bio products and fuels.
- Biotechnology and breeding of bioenergy feedstocks, cereal and turf and forage grasses.
- Risk assessment and risk management of genetically modified crops.

AWARDS AND HONORS

2018	Fellow Society for In Vitro Biology
2013 & 2018	UF Research Foundation Professorship for Distinguished Research Program
2018	UF Term Professorship for Distinguished Academic Program
2014 & 2018	UF/IFAS High Impact Publication Award
2016	Gamma Sigma Delta Senior Faculty Award of Merit
2012	Distinguished Service Award, Society for In Vitro Biology
2009	Gamma Sigma Delta Junior Faculty Award of Merit

PROFESSIONAL SERVICE AND EDITORIAL BOARDS

2019-present	Associate Editor, Scientific Reports
2017-present	Associate Editor, The Plant Genome

2008-present	Associate Editor, Plant Cell Tissue and Organ Culture: Journal of Plant Biotechnology
2008-2019	Subject Editor, Plant Breeding
2004-2009	Associate Editor, Crop Science
2018-present	Chair elect, C7 Division Crop Science Society of America
2011-2012	Member Board of Directors, Society for In Vitro Biology (SIVB)
2014-2019	Member Board of Directors, Society for In Vitro Biology (SIVB)
2011-2012	Program Chair, SIVB conference
2018-2019	Program Chair, SIVB conference
2018	Chair, 2nd International Conference on Plant Synthetic Biology
2018-2019	Member, Program Committee International Forage & Turf Breeding Confer.
2010-2012	Chair, Plant Biology Section, Society for In Vitro Biology (SIVB)
2008-2009	Chair, Plant Biotechnology Program Committee, SIVB
2007-2008	Fundraiser & Co-Chair, Plant Biotechnology Program Committee, SIVB
2010-present	Member, Membership Committee, SIVB

PRESENT JOB RESPONSIBILITIES (20 % Teaching, 80 % Research)

Courses Taught:
AGR 5307 Molecular Genetics for Crop Improvement
PCB 5530 Plant Molecular Biology and Genomics
AGR5321 Genetic Improvement of Plants
AGR4320 Plant Breeding

Research Description:
Dr. Altpeter's research program integrates translational genomics, molecular physiology and metabolic engineering for crop improvement and sustainable production of value added products. The approaches include precision genome editing, synthetic biology, and molecular dissection of regulatory networks. These research activities focus on identifying, isolating and engineering limiting factors for genetic improvement of cereals, turf, forage and biomass/bioenergy grasses. Re-designing photosynthesis, plant architecture and stress response pathways will enhance the productivity and persistence of commercially important grasses and will result in a more sustainable use of natural resources.

Alternatively, quality improvement in biofuel feedstocks that are well adapted to stress can significantly increase their value. Metabolic engineering of high biomass crops like sugarcane and miscanthus will drive the emerging bioeconomy by generating next generation biofuels and chemicals. Risk assessment and development of risk management strategies are essential components of this molecular breeding program for grass improvement.

Our most recent research breakthrough marks a paradigm shift in crop breeding by efficient homology directed precision genome editing enabling multiplexed genome editing.

CONTRACTS AND GRANTS
Extramural Grants (Directly) Supporting Dr. Altpeter's Research, Career Total:

PI	Co-PI	Total
$7,331,316	$140,318,640	$147,649,956
($6,647,849)	($8,916,500)	($15,564,349)

Major funding sources ($ 13.8M in direct support) include DOE, NSF, USDA-NIFA, US-AID, CPBR, SWFWD, Plant Biotechnology Industry

Summary of External Grant Funding Received (Share of Grant Funding Supporting F. Altpeter's Research Program) **Year 2013 – 2022**			
Role	Total	Direct Costs	Indirect Costs
Principal Investigator	$2,220,899	$1,781,046	$439,853
Co-Principal Investigator	$8,837,966	$5,745,757	$3,092,209
Totals	**$11,058,865**	**$7,526,803**	**$3,532,062**

MANAGEMENT AND TRAINING OF HUMAN RESOURCES

Graduate student committees chaired: 18
Undergraduate students trained: 46
Postdoctoral research associates supervised: 25
Visiting scientists hosted: 23

REFEREED JOURNAL ARTICLES

Senior/principal author(s) = underline
Self = bold
Graduate Student in Dr. Altpeter's program = g
Post-Doctoral Associate/Fellow in Dr. Altpeter's program = p
Visiting Scientist in Dr. Altpeter's program = v
Biological Scientist in Dr. Altpeter's program = b

1. Zhao Y. (g), Kim YJ (p.), Karan R. (p), Jung J-H. (p), Pathak B. (b), Wang D (p). Williamson B. (b), Fan C, Yu W., Dong S., Srivastava V., **Altpeter F.** Generation of a safe harbor locus for transgene stacking in sugarcane. 2019. Plant Mol. Biol. 100: 247-263.

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7. Rios, E., Kenworthy, K., Blount, A. R., Quesenberry, K., Unruh, B., Erickson, J., **Altpeter, F.** and Munoz, P. 2017. Breeding apomictic bahiagrass (*Paspalum notatum* Flugge) with improved turf traits. Plant Breeding. 136: 253-260. http://onlinelibrary.wiley.com/doi/10.1111/pbr.12459/epdf

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the juice and bagasse of lipid producing sugarcane. Biocat. Agric. Biotechn. 10: 148-155. https://www.sciencedirect.com/science/article/pii/S1878818116305059

9. Kim, J. Y.(p), Nong, G., Rice, J. D., Gallo, M., Preston, J. F. and **Altpeter, F.** 2017. *In planta* production and characterization of a hyperthermostable GH10 xylanase in transgenic sugarcane. Plant Mol. Biol. 93: 465-478. http://link.springer.com/article/10.1007%2Fs11103-016-0573-5

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13. Dermawan H. (g), R. Karan (p), J.H. Jung (p), Y. Zhao (g), S. Parajuli (g), G. Sanahuja (p), **F. Altpeter**. 2016. Development of an intragenic gene transfer and selection protocol for sugarcane resulting in resistance to acetolactate synthase-inhibiting herbicide. J. Plant Biotechn. 126: 459-468. http://link.springer.com/article/10.1007/s11240-016-1014-5.

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63. **Altpeter, F.** and U. K. Posselt. 1994. Regeneration of fertile plants from cell-suspension-derived small-cell colonies of *Lolium perenne* (L.). Plant Breeding 113: 327-330.

64. **Altpeter, F.** and U. K. Posselt. 1994. Production of high quantities of 3-acetyldeoxynivalenol and deoxynivalenol. Appl. Microbiol. Biotechnol. 41: 384-387.

BOOK CHAPTERS

1. **Altpeter, F.** and Karan R.(p): Genetic improvement of sugarcane by transgenic, intragenic and genome editing technologies. In: Achieving sustainable cultivation of sugarcane. Rott P. (ed.), Burleigh Dodds Science Publishing, Cambridge UK. Volume 2. 2018. pp.133-154.
2. Wu, H (p) and **Altpeter, F**: Sugarcane (*Saccharum* spp. hybrids). In: *Agrobacterium* protocols, methods in molecular biology. Wang, K. (ed.) Springer Science and Business Media, LLC, Heidelberg Germany. 2016. pp 307-316.
3. **Altpeter, F.** and H. Oraby (p): Sugarcane. In: Biotechnology in Agriculture and Forestry. Genetic modification of plants. Kempken F., Jung C. (eds.), Springer, Heidelberg, Germany. 2010. pp. 453-472.
4. **Altpeter, F.** and S. Sandhu (g): Genetic Transformation – Biolistics. In: Plant Cell Culture: Methods Express Davey M. and Anthony P. (eds.) Scion Publishing Ltd, Oxfordshire, United Kingdom 2009 pp. 217-240.
5. **Altpeter, F.**, M. Agharkar (g) and S. Sandhu (g): Bahiagrass. In: Compendium of transgenic crop plants. Kole, C. R., and Hall T. C. (eds.) John Wiley, Hoboken NJ, USA. 2008. Vol 1. pp. 211-223.
6. **Altpeter, F.** and V. Korzun: Rye. In: Biotechnology in Agriculture and Forestry.Transgenic crops IV. Pua, E. C. and Davey M. R. (eds.), Springer, Heidelberg, Germany. 2007. pp. 107-117.
7. **Altpeter, F**: Perennial ryegrass (*Lolium perenne L.*). In: *Agrobacterium protocols, methods in molecular biology*. Wang, K. (ed.) Humana Press, Totowa, NJ. Volume 44. 2006. pp. 55-64.
8. **Altpeter, F**: Rye (*Secale cereale L.*). In: *Agrobacterium protocols, methods in molecular biology*. Wang, K. (ed.) Humana Press, Totowa, NJ. Volume 44. 2006. pp.223-232.
9. **Altpeter, F.** and J. C. Popelka (g): Generation of transgenic rye (Secale cereale L.) plants with single and defined T-DNA inserts, following Agrobacterium-mediated gene transfer. In: Transgenic crops of the world. Curtis, I. (ed.), Kluwer Academic Publishers, Dordrecht, the Netherlands. 2004. pp.79-88.
10. **Altpeter, F.**, Y. Fang (v), J. Xu (b) and X. Ma (v): Comparison of transgene expression stability after Agrobacterium-mediated or biolistic gene transfer into perennial ryegrass (Lolium perenne L.). In: *Molecular Breeding of Forage and Turf*. Hopkins, A. (ed.), Kluwer Academic Publishers, Dordrecht, the Netherlands. 2004. pp. 255-260.
11. **Altpeter, F.**, J. Xu (g), Y. Fang (v), X. Ma (v), J. Schubert, G. Hensel (p), H. Baeumlein and V. Valkov (p): Molecular improvement of perennial ryegrass by stable genetic transformation. In: *Plant biotechnology 2002 and beyond*. Vasil, I. K. (ed.), Kluwer Academic Publishers, Dordrecht, the Netherlands. 2003. pp. 519-524.
12. Jordan, M. C., **F. Altpeter** and J. A. Qureshi: Transformation of wheat. In: *Transgenic plants and crops.* Khachatourians, G. G., McHughen, A., Scorza, R., Nip, W., Hui, Y. H. (eds.), Marcel Dekker, Inc., New York. 2002. pp. 835-848.
13. **Altpeter, F.,** I. Diaz, H. McAuslane, K. Gaddour, P. Carbonero and I. K. Vasil: Barley trypsin inhibitor CMe confers insect resistance to wheat. In: Altman, A., et al. (eds.): Current plant science and biotechnology in agriculture. Kluwer Acad. Publ., Dordrecht. 1999. pp. 453-456.

NUMBER OF ABSTRACTS PRESENTED AT CONFERENCES: 273

NUMBER OF AWARDS and HONORS FOR GRADUATE STUDENTS in DR. ALTPETER'S RESEARCH PROGRAM: 45

MD ALI BABAR, Ph.D.
Assistant Professor, World Food Crops Breeding and Genetics
University of Florida, Institute of Food and Agricultural Sciences
Agronomy Department
PO Box 110500, 3105 McCarty Hall, Gainesville, FL 32611
352-273-2213, mababar@ufl.edu
https://agronomy.ifas.ufl.edu/faculty/

EDUCATION

Oklahoma State University, USA	Crop Science	Ph.D.	2005
Bangladesh Agriculture University	Genet and plant breeding	M.S.	1998
Bangladesh Agriculture University	Agriculture	B.Sc.	1996

PROFESSIONAL EXPERIENCE

July 2013 - present	Assistant Professor, World Food Crops Breeding and Genetics, Agronomy Department, University of Florida, Gainesville
May 2013-July 2013	Site Leader and Associate Scientist, DOW Agrosciences, Sidney, IL
Oct 2010 - July 2013	Associate Scientist, Corn Breeder, DOW Agrosciences, Sidney, IL
Oct 2008 - Oct 2010	Senior Biologist, Corn Breeder, DOW Agrosciences, Sidney, IL
Aug 2005 - Aug 2008	Post-doc Research Associate, Wheat Breeding and Genetics, KSU, Manhattan

PROFESSIONAL SERVICE

National Small Grain Variety Review Board, Liaison member, Jan 1, 2018-Dec 31, 2019
National Small Grain Variety Review Board, Alternate member, Jan 1, 2016-Dec 31, 2017
American Oat Workers Executive Committee member, 2014-Present
Quaker International Nursery Program Executive Committee member, 2014-present
Member of Expert Working Group on Wheat
Co-PI AgMIP wheat
Associated Editor and Editor: Agronomy Journal and Nature-Scientific Reports
Grant Reviewer: Natural Sciences and Engineering Research Council of Canada (NSERC); Israeli Ministry of Agriculture & Rural Development

PROFESSIONAL MEMBERSHIP

Crop Science Society of America
American Society of Plant Biologists
Agronomy Society of America
Bangladesh Agriculturists Association

UNIVERSITY GOVERNANCE AND SERVICE

- ***University***
  Mentor in the University Minority Mentor Program (UMMP), Fall, 2018-present.
  Poster judge- Graduate Student Research Day 2014, 2017.
  Faculty advisor-Cupcakes for a Cure UF; fall, 2016 to summer, 2017.
- ***College***
  Advisory council of operation, Plant Science research and Education Unit, Aug 2019-Dec, 2021
  Commencement Marshal for CALS, fall 2013; spring, 2014; fall, 2017
- ***Department/Center***
  Teaching peer evaluation committee member, 2019

Agronomy Department task force for diversity and inclusion, since 2019.
Agronomy Department seminar coordinator, fall, 2016-summer 2018.
Agronomy graduate student symposium judge, spring 2018.
AGR honors and awards committee since 2018.
Agronomy graduate student symposium coordinate, spring 2017.
Agronomy Department collaboration strategic team committee member, 2014.
FFS Station manager search committee member, 2014.

PEER-REVIEW PUBLICATIONS (Total 40 career total citations-810)

Shrestha SP, **Babar MA**, Guo J, Bai G, Mergoum M, Mason RE, Gazen S, Asseng S, Blount A, Baik B, Shahi D, Khan J, Hossain MM, Avci M, and Robbins K. 2019. Identifying novel alleles associated with spike fertility, gain number and harvest index under hot and humid environment in wheat through GWAS analysis. Frontier in Plant Science (Accepted).

Guo J, Rahman A, Michael J. Mulvaney MJ*, Hossain MM, Basso K, Fethiere R, **Babar MA**. 2019. Evaluation of Edamame (Glycine max (L.) Merr.) Genotypes Suitable for Growing in Florida. Agronomy Journal. (In press)

Khan N[&], Ali S, Zandi P, Mehmood A, Ismail MI, Shahid MA and **Babar MA**. 2018. Role of sugars, amino acids and organic acids in improving plant abiotic stress tolerance. Pakistan Journal of Botany. (In press).

Khan N[&], Bano A, Rahman M, Rathinasabapathi B and **Babar MA.** 2019. UPLC-HRMS-based untargeted metabolic profiling reveals changes in chickpea (*Cicer arietinum*) metabolome following long-term drought stress. Plant, Cell, Environment, 42(1):115-132.

Kang Z, **Babar MA**[*], Khan N, Guo J, Khan J, Islam S, Shrestha S and Shahi, D. 2019. Comparative metabolomic profiling in the roots and leaves in contrasting genotypes reveals complex mechanisms involved in post-anthesis drought tolerance in wheat. PLOS ONE. 1-25. https://doi.org/10.1371/journal.pone.0213502.

Khan N, Bano A, Rahman A, Gou J, Kang Z and **Babar, MA**. 2019. Comparative physiological and metabolic analysis reveals a complex mechanism involved in drought tolerance in chickpea (*Cicer arietinum* L.) induced by PGPR and PGRs. Scientific Reports-Nature. 9:2097. https://doi.org/10.1038/s41598-019-38702-8.

Hernandez-Ochoa I[g], Pequeno D, Reynolds R, **Babar MA**, Sonder K, Milan AM, Hoogenboom G, Robertson R, Gerber S, Rowland D and Fraisse C. 2019. Adapting irrigated and rainfed wheat to climate change in semi-arid environments: Management, breeding options and land use change. European Journal of Agronomy. 109: 125915. (https://doi.org/10.1016/j.eja.2019.125915)

Khan N, Bano A and **Babar MA**. 2019. Metabolic and physiological changes induced by plant growth regulators and plant growth promoting Rhizobacteria and its impact on drought tolerance in chickpeas. PLOS ONE. https://doi.org/10.1371/journal.pone.0213040.

Khan N[&], Bano A and **Babar MA**. 2019. Interactive effects of PGPR and PGR on the physiology, yield, drought tolerance and rhizosphere of wheat grown in sandy soil. Archives of Microbiology. 201(6): 769-785.

Martin-Sarinelli J, Murphy JP, Tyagi P, Holland J, Johnson JW, Mergoum M, Mason RE, **Babar MA**, Harrison S, Sutton R, Griffey C and Brown-Guedira G. 2019. Training population selection and use of fixed covariates to optimize genomic predictions in a historical USA winter wheat panel. Theoretical and Applied Genetics. 132 (4): 1247-1261.

Thomason K[g*], **Babar MA***, Erickson JE*, Mulvaney M, Beecher C and MacDonald G. 2018. Comparative physiological and metabolomics analysis of wheat (*Triticum aestivum* L.) following post-anthesis at stress. PLOS ONE 13(6):e0197919. https://doi.org/10.1371/journal. pone.0197919

Asseng S, Martre P, Maiorano A, Rötter RP, O'Leary G, Fitzgerald G, Girousse C, Motzo R, Giunta F, **Babar MA et al.** 2018. Climate change impact and adaptation for wheat protein. Global Change Biology.1-19. DOI:10.1111/gcb.14481 (citation-6). (IF=8.997)

Mason RE, Addison CK, **Babar MA**, Acuna A, Lozada DN, Subramanian N, Arguello MN, Miller RG, Brown-Guedira G, Guedira M and Johnson JW. 2018. Diagnostic markers for vernalization and photoperiod loci improve genomic selection for grain yield and spectral reflectance in wheat. Crop Science. 58:242–252. (IF=1.635)

Hernandez-Ochoa I. Asseng M, Kassie S, Xiong BT, Robertson W, Pequeno R, Sonder K, Reynolds MP, **Babar MA.**, Molero-Milan AI and Hoogenboom G. 2018. Climate change impact on Mexico wheat production. Agricultural and Forest Meteorology. 263:373-387.

Khan N[&]; Bano A, Shahid MA, Nasim W and **Babar MA**. 2018. Interaction between PGPR and PGR for water conservation and plant growth attributes under drought condition. Biologia. 74:1-16.

Ibrahim AHM, Herrington R, Sutton R, Simoneaux B, Harrison SA, Blount AR, Murphy PJ, Barnett RD, Mason ER, **Babar MA**, Duncan RW, Rudd J, Opeña G, Nelson LR, West DR, Carson ML, Baker J, Hays DB, Johnson JW, Mergoum M and Fountain MO. 2018. Registration of 'TAMO 411' oat. Journal of Plant Registration. 12:186-189

Mason RE, Johnson JW, Mergoum M, Miller RG, Moon DE, Harrison SA, **Babar MA,** Murphy PJ, Ibrahim AMH, Sutton R and Blount AR. 2018. AR11LE24 is a soft red winter wheat adapted to the mid-south region of the United States. Journal of Plant Registration. 12:357-36.

Johnson J, Buck B, Buntin G, **Babar MA**, Mason RE, Harrison S, Murphy PJ, Ibrahim A, Sutton R, Simoneaux B, Bockelman H, Baik B, Marshall D, Cowger C, Brown-guedira G, Kolmer J, Jin Y, Chen X, Cambron Sand Mergoum M. 2018. Savoy: an adapted soft red winter wheat cultivar for Georgia and the South East regions of the USA. Journal of Plant Registration. 12:85–89.

Rahman M[&], Akond M, **Babar MA**, Beecher C, Erickson J, Thomason K, De Jong F and Mason R. 2017. LC-HRMS based non-targeted metabolomic profiling of wheat (*Triticum aestivum* L.) under post-anthesis drought stress. American Journal of Plant Sciences. 8:3024-3061.

Lozada DN, Mason RE, **Babar MA**, Carver BF, Guedira G, Merrill K, Arguello MN, Acuna A, Vieira L, Holder A, Addison C, Moon DE, Miller RG and Dreisigacker S. 2017. Association mapping reveals loci associated with multiple traits that affect grain yield and adaptation in soft winter wheat. Euphytica. 213:222.

Johnson JW, Chen Z, Buck JW, Buntin GD, **Babar MA**, Mason RE, Harrison SA, Murphy JP, Ibrahim AMH, Sutton RL, Simoneaux BE, Bockelman HE, Marshall D, Cowger C, Brown-Guedira GL, Kolmer JA, Jin Y, Chen X, Cambron SE and Mergoum M. 2017. GA 03564-12E6: a high yielding soft red winter wheat cultivar adapted to Georgia and the South East Regions of the USA. Journal of Plant Registration. 11:159-164.

Harrison SA, **Babar MA**, Barnett RD, Blount AR, Johnson JW, Mergoum M, Mason RE, Murphy JP and Ibrahim AMH. 2017. LA05006: a dual-purpose oat for Louisiana and other southeastern regions of the USA. Journal of Plant Registration. 11:89-94.

Babar MA, Blount AR, Barnett RD, Mackowiak C, Akond M, Harrison SA, Johnson JW, Mergoum M, Mason RE, Murphy P, Ibrahim AMH, Sutton R and Simoneaux B. 2017. Registration of 'FL720'

oat. Journal of Plant Registrations. 11:15-19.

Khan N[&], Bano A and **Babar MA**. 2016. The root growth of wheat plants, the water conservation and fertility status of sandy soils influenced by plant growth promoting rhizobacteria. Symbiosis. 72:195-205. ([&]visiting PhD student). (citation-18).

Talukder SK, Prasad PVV, Todd T, **Babar MA**, Poland JA, Bowden RL and Fritz AK. 2015. Effect of cytoplasmic diversity on post anthesis heat tolerance in wheat. Euphytica. 204:383-394.

Talukder SK*, **Babar MA*,** Vijayalakshmi K, Poland J A, Vara Prasad PV, Bowden RL and Fritz AK. 2014. Mapping QTL for the traits associated with heat tolerance in wheat. BMC Genetics. 15:97-109. (*Co-first author)

Zheng P, **Babar MA**, Parthasarathy S, Gibson R, Parliament K, Flook J, Patterson T, Friedemann P, Kumpatla S and Thomson S. 2014. A truncated FatB resulting from a single nucleotide insertion is responsible for reducing saturated fatty acids in maize seed oil. Theoretical and Applied Genetics. 127:1537-1547.

Prasad B, **Babar MA,** Bai G, Xu X and Klatt AR. 2009. Genetic diversity in the US hard red winter wheat cultivars as revealed by microsatellite markers. Australian Journal of Agricultural Research. 60:16-24.

Prasad B, **Babar MA**, Carver BF, M.L. ML, Raun WR and Klatt AR. 2009. Association of biomass production and canopy spectral reflectance indices in winter wheat. Canadian Journal of Plant Sciences. 89:485-496.

Babar MA, Van Ginkel M, Reynolds MP, Prasad B and Klatt AR. 2007. Heritability correlated response and indirect selection involving spectral reflectance indices and grain yield in wheat. Australian Journal of Agricultural Research. 58:432-442.

Prasad B, Carver BF, Stone ML, **Babar MA**, Raun WR and Klatt AR. 2007. Potential use of spectral reflectance indices as a selection tool for grain yield in winter wheat under Great Plains conditions. Crop Science. 47:1426-1440.

Prasad B., Carver BF, Stone ML, **Babar MA**, Raun WR and Klatt AR. 2007. Genetic analysis of indirect selection for winter wheat grain yield using spectral reflectance indices. Crop Science. 47: 1416-1425.

Babar MA, Reynolds MP, Van Ginkel M, Klatt AR, Raun WR and Stone ML. 2006. Spectral reflectance indices as a potential indirect selection criterion for wheat yield under irrigation. Crop Science. 46:578-588.

Babar MA, Reynolds MP, Van Ginkel M, Klatt AR, Raun WR and Stone ML. 2006. Spectral reflectance to estimate genetic variation for in-season biomass, leaf chlorophyll and canopy temperature in wheat. Crop Science. 46:1046-1057.

Babar MA, Van Ginkel M, Klatt AR, Prasad B and Reynolds MP. 2006. The potential of using spectral reflectance indices to estimate yield in wheat grown under reduced irrigation. Euphytica. 150:155-172.

Babar MA, Newaz MA and Jahan MAHS. 2002. Identification of selection parameters for yield improvement in French bean (*Phaseolus vulgaris* L.). Bangladesh Journal of Agricultural Sciences. 29:85-89.

Babar MA, Pandit DB, Barma NCD, Samad MA and Rahman MM. 2001. Genotype-location interaction and stability of some bread wheat genotypes for yield and thousand grain weight. Bangladesh

Journal of Agricultural Sciences. 28:233-240.

Jahan MAHS, Amin MR, Barma NCD, **Babar MA** and Bodruzzaman M. 2001. Effect of planting date and forage cutting on the growth and yield of triticale genotypes. Bangladesh Journal of Agricultural Sciences. 28:297-302.

Barma NCD, Pandit DB, **Babar MA,** Jahan MAHS and Razzaque MA. 2002. Biomass as a selection criteria for improving grain yield in wheat (*Triticum aestivum* L.). Bangladesh Journal of Agricultural Sciences. 29:91-94.

Barma NCD, Sarker ZI, **Babar MA**, Hakim A and Jahan MAHS. 1998. Combining ability and heterosis in bread wheat. Journal of Biosciences. 6:51-58.

MANUSCRIPTS UNDER REVIEW

Guo J[p*], Pradhan S[g*], Shahi D, Khan J, Mcbreen J, Bai G, Murphy JP, and **Babar MA**. 2019. Increased Prediction Accuracy Using Combined Genomic Information and Physiological Traits in A Soft Wheat Panel Evaluated in Multi-Environments. Nature Scientific Reports.

Pradhan S[g], **Babar MA**, Bai G, Khan J, Shahi D, AVCI M, Guo J, McBreen J, Asseng S, Gezan S, Baik B, Blount A, Harrison S. 2019. Genetic Dissection of Heat-responsive Physiological Traits to Improve Adaptation and Increase Yield Potential in Soft Winter Wheat. BMC Genomics. ([g]raduate student)

Ibrahim AMH, Sutton R, Johnson JW, Mergoum M, Simoneaux B, Harrison SA, Murphy JP, Mason RE, **Babar MA**, Neely C, Opeña G, Jin Y, Kolmer J, Boyles R, Cambron SE, Baik B, Brown-Guedira GL, Marshall D, and Fountain MO. 2019. Registration of 'GA06343-13E2 (TX-EL2)' Soft Red Winter Wheat. Journal of Plant Registration.

Khan N[&], Bano A and **Babar MA**. 2019. Phytohormone crosstalk under biotic and abiotic stresses and the role of PGPR. Plant physiology and biochemistry. ([&]visiting PhD student).

NON-REFEREED PUBLICATIONS (Career total 63; list of last two years)

Love B, .. **Babar MA**, Molero G, Reynolds M and J Foulkes. 2019. Raining yield potential through improved harvest index and fruiting efficiency associated with plant hormone signaling in high biomass CIMMYT spring wheat genotypes. 1st International Wheat Congress, July 21-26, Saskatoon, Saskatchewan, Canada.

Shahi D, … and **Babar MA**. 2019. Identifying novel alleles contributing increased spike partitioning index and fruiting efficiency at anthesis plus 7 days in US soft wheat through genome wide association study. Plant and Animal Genomics Conference XXVII, Juanuary12-16, San Diego, CA.

Guo J, … and **Babar MA**. 2019. Genomic Selection for Predicting Spike Fertility and Biomass Partitioning Traits Using Multiple Soft Wheat Populations. Plant and Animal Genomics Conference XXVII, Juanuary12-16, San Diego, CA.

Shrestha SP, … and **Babar MA**. 2019. Genome-wide Association Studies of Spike Fertility, Yield and Other Agronomic Traits to Dissect Heat Tolerance in Soft Wheat. Plant and Animal Genomics Conference XXVII, Juanuary12-16, San Diego, CA.

Guo J, … and **Babar MA**. 2018. Genomic Selection for Predicting Spike Fertility and Biomass Partitioning Traits using multiple soft Wheat Populations. Florida Genetic Symposium. Oct 31-Nov1, UF Cancer & Genetics Research Complex Atrium.

Shahi D, ….**Babar MA**. 2018. Genome Wide Association Studies of Stem and Spike partitioning traits in Spring Wheat (Triticum aestivum L.). Florida Genetic Symposium. Oct 31-Nov1, UF Cancer & Genetics Research Complex Atrium.

Shrestha SP, …and **Babar MA**. 2018. Genome-wide Association Studies of Spike Fertility, Harvest Index, and Yield Related Traits in Soft Wheat Under Hot and Humid Environment of Southeast USA. Florida Genetic Symposium. Oct 31-Nov1, UF Cancer & Genetics Research Complex Atrium.

Shrestha SP, …..and **Babar MA**. 2018. Identifying Traits to Improve Wheat Yield and Quality Under Heat Stress Nutritional Improvements in Sub-Saharan Africa workshop. April 23, IFAS/UF, Gainesville, FL.

Shahi D, …and **Babar MA**. 2018. Advancing Harvest Index in Wheat through Genome Wide Association Analysis of Stem and Spike partitioning traits. ASA, CSSA International Conference International Conference, Nov 4-7, 2018, Baltimore, MD.

Shrestha SP, … and **Babar MA**. **2018**. Identifying Genetic Loci for Traits to Improve Wheat Yield and Grain Number under Post-Anthesis Heat Stress Conditions. ASA, CSSA International Conference International Conference, Nov 4-7, 2018, Baltimore, MD.

Khan J, … and **Babar MA**. 2018. Identifying Noble Genetic Loci for Partitioning Traits to Improve Wheat Yield and Grain Number under Post-Anthesis drought Conditions. ASA, CSSA International Conference International Conference, Nov 4-7, 2018, Baltimore, MD.

Hossain MM, **Babar MA**, … 2018. Identifying Edamame (vegetable soybean) Suitable for Cultivation for the Fresh Food Market of Florida. Southern ASA Conference, Feb 4-6, Jacksonville, FL.

Khan N, … and **Babar MA**. 2018. UPLC-HRMS Based Non-Targeted Metabolomic Profiling in Chickpea Reveals Complex Mechanisms Involved in Drought Tolerance Induced By PGR and PGPR. Southern ASA Conference, Feb 4-6, Jacksonville, FL.

Newman C, Sumit S and **Babar MA**. 2018. Genetic variations in grain filling rate and duration in US soft wheat germplasm under post-anthesis heat stress. UF Plant Science Capstone Presentation. April 20, 2018. Fifield Hall, UF.

Shrestha SP, … and **Babar MA.** 2017. Identifying Potential Avenues for Increasing Grain Number under Post Anthesis HEAT Stress Condition. ASA, CSSA, SSSA International Conference International Conference, Oct 22-25, 2017, Tampa, FL.

Khan J, … and **Babar MA**. 2017. Genetic Variability and Association Analysis in US Soft Wheat Panel for Fruiting Efficiency Under Post Anthesis Drought and Supplemental Irrigated Conditions. ASA, CSSA, SSSA International Conference International Conference, Oct 22-25, 2017, Tampa, FL.

Avci M, …, **Babar MA**. 2017. Identifying the Genetic Loci Associated with Fruiting Efficiency and Yield Components in AGS2000/ NC06-19896 DH Population Under Post Anthesis High Temperature Stress Conditions. ASA, CSSA, SSSA International Conference International Conference, Oct 22-25, 2017, Tampa, FL.

Sarinelli JM, .., **Babar** MA and Brown-Guedira G. 2017. Training Population Selection and Use of Fixed Covariates to Optimize Genomic Predictions in a Historical Southeastern USA Winter Wheat Panel. ASA, CSSA, SSSA International Conference International Conference, Oct 22-25, 2017, Tampa, FL.

Asseng S, …..Babar MA, **et al** . 2017. Global Wheat Production Affected By Increasing Temperature and Elevated CO2. AgMIP-Wheat - Advances in Wheat Modeling. ASA, CSSA, SSSA International Conference International Conference, Oct 22-25, 2017, Tampa, FL.

Shrestha SP, … and **Babar MA**. 2017.Genetic Improvement of Harvest Index and Stay-Green Traits in US Soft Wheat Germplasm Under High Temperature Stress Condition. The Southern Regional Branch of ASA, Feb 6, 2017, Mobile, AL.

Salia I, … **Babar MA**, Boroujerdi A. 2017. Metabolic Differences in Cellular Structure of Wheat under Drought Conditions**.** Annual Biomedical Research Conference for Minority Students, November 1-4, 2017, Phoenix, Arizona.

Blount A, **Babar MA**, ... 2017. Triticale for the Southeastern U.S. for grazing and silage. Easter wheat and southern small grain workers conference, May 1-3, 2017, Purdue University, West Lafayette, Indiana.

Guedira M, …. **Babar MA**, Harrison SA, Sutton R, Griffery C, Mergoum M and Gina Brown-Guedira. 2017. Effect of Major Developmental Genes *Vernalization-1* and *Photoperiod-1* on Heading Date and Grain Yield of Winter Wheat in the Southern USA. Easter wheat and southern small grain workers conference, May 1-3, 2017, Purdue University, West Lafayette, Indiana.

Blount AR, …, **Babar MA**, Mackowiak CL and Quesenberry KH. 2018. A walk on the wild side: 2018 cool-season forage recommendations for wildlife food plots in North Florida. EDIS publication (SS-AGR-28). http://edis.ifas.ufl.edu/ag139

Blount AR, …, **Babar MA**. 2018. Cool-season forage variety recommendations for Florida. EDIS publication (SS-AGR-84). http://edis.ifas.ufl.edu/aa266

Blount AR, …, **Babar MA**. 2017. Cool-season forage variety recommendation for Florida. EDIS publication. http://edis.ifas.ufl.edu/aa266.

Blount A, …, **Babar MA**. 2017 Cool-season forage variety recommendations. 15 Sep, NFREC Beef and Forage Field Day, Marianna, FL. Proceedings. 6 pp.

VARIETY RELEASE

- **Total 14**; Oat variety- Horizon720 as major developer; 11 wheat varieties as co-developer; Legend 567 oat variety as co-developer; FL01143 Triticale as co-developer.

FUNDING (EXTRA AND INTRAMURAL)

- Total $1,368,819 (As PI from USDA, Industry, FDACS, and University of Florida)
- Total $66,722 (As Co-PI; from USDA)
- Royalty total $122,000

PEER REVIEWER

- Crop Science, Euphytica, Plant Breeding, Australian Journal of Agriculture Research, Field Crops Research, PLOS One, Molecular Breeding, Journal of Plant Registration

PATENTS

- Babar et al. 2016. FL-720 oat. PVP Certificate #201600313
- Babar et al. OAT VARIETY FL0720. June 6, 2016. United States Patent number 15/174,528.
- A.R. Blount, R.D. Barnett, S.A. Harrison, C.L. Mackowiak, M.A. Babar, and J.C. Jones. PVP awarded

2016. Plant Variety Protection (PVP) received on FL0567 (Legend 567) oat.
- A.R. Blount, R.D. Barnett, Md. A. Babar, C.L. Mackowiak and J. Jones. PVP pending. Plant Variety Protection (PVP) applied for FL01143 Awnless triticale (2016).

AWARDS
- Plant Variety protection award, 2018, University of Florida/Institute of Food and Agricultural Sciences
- Utility Patent award, 2018, University of Florida/Institute of Food and Agricultural Sciences
- Early Career Scientist Award, 2015, Institute of Food and Agricultural Sciences, University of Florida.
- Innovators' Day Award, DOW Agrosciences, 2013.
- William Outstanding Ph.D. Thesis Award in Plant Science, College of Agriculture and Natural Resources, Oklahoma State University, 2005.
- Outstanding Ph.D. Student Award, Department of Plant and Soil Sciences, Oklahoma State University, 2004.
- Dale-Weibel Memorial Graduate Scholarship, Department of Plant and Soil Sciences, Oklahoma State University, 2003.
- Travel Award, Graduate and Professional Student Government Association, Oklahoma State University, 2004.
- Gold Medal, "Outstanding M.S. Student", 1997; Bangladesh Agricultural University.

GRADUATE STUDENTS AWARDS
- Dipendra Shahi, Agricultural Women's Club Scholarship, College of Agricultural and Life Sciences, UF, for the 2019-2020 academic year
- Sumit Shrestha, UF Graduate Student Council Travel Grant, UF GSC, 2018.
- Dipendra Shahi, Paul Robin Harris Memorial Scholarship Award, the Agronomy Department, UF, 2018.
- Sumit Shrestha, Paul Robin Harris Memorial Scholarship Award, the Agronomy Department, UF, 2018.
- Muhsin AVCI, Paul Robin Harris Memorial Scholarship Award, the Agronomy Department, UF, 2017.

PRESENTATIONS (Total 19; Invited Presentation15; Volunteered 4)
- 8 internationals
- 3 nationals
- 2 regionals
- 3 state
- 3 locals

GRADUATE STUDENTS

Major Advisor (6):
- Sumit Pradhan Shrestha (Ph.D.) (completed, August, 2019)
- Mohammad Maksud Hossain (MS) (completed, May, 2019)
- Muhsin AVCI (MS) (completed, July 2018)
- Jahangir Khan (Ph.D.) (Fall, 2015 –Fall, 2019)
- Dipendra Shahi (Ph.D.) (Fall, 2016- summer, 2020)
- Jordan McBreen (MS)

Committee Member (9)
- 6 Ph.D.
- 3 MS

POST-DOC (1)

- Jia Guo (April 2017-Present)

VISITING SCHOLARS

Name	Country	Program	Funding source
Essam Adel Elshamey	Egypt	Post-doc visiting scholar (Jan-June, 2016; 6 months)	Higher education ministry of Egypt
Naeem Khan	Pakistan	Ph.D. visiting student (April to Oct, 2016; 6 months)	Higher education commission of Pakistan
Sadia Latif	Pakistan	Ph.D. visiting student (May to Dec, 2016; 6 months)	Higher education commission of Pakistan
Zhiyu Kang	China	Visiting post-doc (Sep, 2016 to August, 2017; 12 months)	China Scholarship Council (CSC)

AREA OF SPECIALIZATION

1) Variety development.
2) Genetic inheritance and genomic analysis.
3) Metabolic phenotyping.
4) High-throughput phenotyping techniques.

RESEARCH INTEREST

My research program involves genetic improvement of two major food crops (wheat and oats) for abiotic stress tolerance, particularly heat stress. Wheat is a major global source for calories and nutrients, but its production is highly limited by heat stress. Global climate change, including high temperature and unpredictable rainfall patterns, coupled with an increasing human population, is creating immense pressure on food security and sustainability. It is crucial for plant breeding programs to understand how wheat responds to high temperature and variable water stress environments, allowing development of varieties that are better adapted to abiotic stress. In fact, breeding for more stress-resilient wheat is a major strategy for achieving sustainable global crop production.

The hot and humid environment occurring throughout the life cycle of wheat produced in Florida provides a set of novel conditions perfectly suited for developing heat tolerant wheat varieties. Capitalizing on this unique research opportunity, the overall goal of my program is to develop new wheat varieties that are able to withstand heat stress while maintaining yield in the Florida environment and other global regions with similar climate conditions. The specific objectives of the program include: 1) identifying traits (such as fruiting efficiency) that are associated with increased productivity under heat stress; 2) understanding the genetic and biochemical mechanisms controlling those traits; and 3) understanding how wheat varieties that contain these improved traits will affect future climate-change scenarios through crop modelling.

An ancillary portion of my program is dedicated to exploring alternative crops for Florida to provide economic sustainability in cropping systems. This area of my program is dedicated to evaluating alternative food crops to those currently produced in Florida, including such crops as edamame (vegetable soybean) and chickpea, to support growers' livelihoods and the statewide food market.

TEACHING INTEREST

The teaching component of the position includes full responsibility (100%) for AGR3303 (Genetics), offered each fall semester; and 80% responsibility for AGR4320 (Plant Breeding, undergraduate section) and AGR5321C (Genetic Improvement of Plants, graduate section) offered each spring semester. For

AGR4320/AGR5321C, I have responsibility for developing both in class and online delivered content. These courses focus on training undergraduate and graduate students in the following areas:

- The principles, theories, and applications of genetics.
- Application of genetic principles for crop improvement.
- Understanding how genetic selection can improve the stress tolerance and other characteristics in crops.
- Selection techniques and methods that can be used in genetic improvement of self- and cross-pollinated crops.
- Molecular breeding techniques and molecular biology methods that can be used for genetic improvement of crops.

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EDUCATION

B.S.	1978	Crop Science	Texas A&M University
M.S.	1980	Major: Crop Ecology (Forages)	University of Florida
		Minor: Soil Microbiology and Nematology	
Ph.D.	1984	Plant Breeding & Genetics	University of Florida
		Minor: Soil Microbiology and Nematology	

PROFESSIONAL EXPERIENCE

1980-84	Graduate Assistant	Agronomy Department	University of Florida
1984-88	Research Associate	Agronomy Department	USDA-ARS
1988-98	Biological Scientist	North FL Research and Education Center	University of Florida

CURRENT FTE

70% research/30% extension

GRADUATE STUDENTS SUPERVISED/MEMBER

11 Ph.D. students and 12 Masters students

RESEARCH

Breeding efforts focus on physiological aspects (i.e. photoperiod and cold response) of fall-season forage production and complimentary disease, insect and nematode resistances to allow the forages to be productive outside normal growing seasons. The major forage crop effort in the program is breeding improvement in bahiagrass, *Paspalum notatum*, and evaluation of new introductions of perennial peanut, *Arachis glabrata*. Cultivar development and evaluation of other forage species (i.e. limpograss, small grains, ryegrass, clover and bermudagrass) is part of a collaborative effort with state and regional plant breeding programs to adapt new forages to the southern Coastal Plain and Peninsular Florida.

EXTENSION

Extension responsibilities include educational programming and written works on forage selection and management practices for county faculty and producers within the tri-state area of FL, AL and GA. This program supports extension faculty through EDIS publications, in-service training, field days and producer-based meetings addressing local and regional concerns.

SELECTED GERMPLASM AND VARIETIES DEVELOPED

Cultivars and Germplasm Releases (Total: 76 developed or co-developed)
Small Grains: 24 cultivars, 2 germplasm
Bahiagrass: 1 cultivar, 2 germplasm
Perennial peanut: 3 cultivars, 2 germplasm

Limpograss: 2 cultivars
Ryegrass: 34 cultivars
Soybean: 1 cultivar, 1 germplasm
Red clover: 3 cultivars
White clover: 1 cultivar

SELECTED PLANT VARIETY PROTECTION (PVP) AND PLANT PATENTS

Plant Variety Protection (PVP) FL0567 Oat (Legend 567) (2015). A.R. Blount, R.D. Barnett, C.L. Mackowiak, and J.C. Jones

Plant Variety Protection (PVP) Earlyploid ryegrass (2013). A.R. Blount, G.M. Prine, C.L. Mackowiak, J.C. Jones, K.E. Kenworthy, and P.E. Reith

Plant Variety Protection (PVP) UF-Riata bahiagrass (2013). A.R. Blount, P. Mislevy, T.R. Sinclair, and K.H. Quesenberry

Plant Variety Protection (PVP) received on Horizon 201 oat (2009). A.R. Blount and R.D. Barnett.

Plant Variety Protection (PVP) received on Horizon 321 Oat, 2006. A.R. Blount, R.D. Barnett, J.W. Johnson, P.L. Pfahler, B.M. Cunfer, and G.D. Buntin.

SELECTED PUBLICATIONS

Career Summary- Book chapters: 2; Refereed Articles: 185; Non-refereed Articles: 402; International and National Proceedings: 36; Abstracts: 235; Refereed Extension Articles: 45

Esteban Rios, Ann Blount, Phil Harmon, Cheryl Mackowiak, Kevin Kenworthy and KennethQuesenberry. 2015. Ergot resistant tetraploid bahiagrass and fungicide effects on seed yield and quality. Plant Health Progress 04/2015; 16(2):56-62. DOI:10.1094/PHP-RS-14-0051

Krueger, N.C., L.E. Sollenberger, A.R. Blount, J.M.B. Vendramini, N.L.S. Lemos, A.G. Costa, and A.T. Adesogan. 2015. Mixed stocking by cattle and goats for blackberry control in rhizoma peanut-grass pastures. Crop Sci. (in press).

Castillo, M, L. Sollenberger, A. Blount, J. Ferrell, C. Na, and C. Mackowiak. 2014. Seedbed preparation techniques and weed control strategies for strip-planting rhizoma peanut into warm-season grass pastures. Crop Sci. vol 54-4:1868-1875. DOI: 10.2135/cropsci2013.06.0408

Mullenix, M.K., L.E. Sollenberger, A.R. Blount, J.M.B. Vendramini, M.L. Silveira. 2014. Growth habit of rhizoma peanut affects establishment and spread when strip planted in bahiagrass pastures. Crop Science 01/2014; 54:2886-2892.

Blount, A.R. P.L. Pfahler, R.N. Gates and K.H. Quesenberry. 2003. Early plant selection effects on crown traits in 'Pensacola' bahiagrass with selection cycle. Crop Sci. 43:1996-1998.

Blount, A.R., R.N. Pittman, B.A. Smith, R.N. Morgan, W. Dankers, T.M. Momol and R.K. Sprenkel. 2002. A preliminary first report of Peanut Stunt Virus in perennial peanut in north Florida and southern Georgia. Plant Dis. 2002; 86:326; published online as D-2002-0122-01N, 2002.

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https://trec.ifas.ufl.edu/faculty/chambers/
www.linkedin.com/in/alanhchambers,

PURPOSE STATEMENT

I am a tropical fruits breeder creating novel cultivars through deep genomic/genetic insights and advanced molecular methods. The primary objective of my program is to increase value to growers and enhance the consumer experience. I am passionately interested in superior agronomic performance, enhanced sensory and nutritional quality, optimized sustainable production, and gaining fundamental insights enabling future genetic gains.

My rapidly expanding program includes mango, banana, papaya, passion fruit, avocado, *Vanilla*, strawberry, and other tropical/subtropical fruits. I am interested in developing domestic and international collaborations towards deploying genetic solutions that will improve access to nutritious, affordable, and abundant food irrespective of geography.

EDUCATION

Ph.D. **Horticultural Sciences**, University of Florida, August 2010 - December 2013
M.S. **Plant Pathology**, Cornell University, August 2007 - August 2010
B.S. **Genetics and Biotechnology** (Psychology minor), Brigham Young University, April 2007

PROFESSIONAL EXPERIENCE

Assistant Professor, University of Florida, Homestead, FL. Aug 2016 - *present*
Molecular Biochemist, Agro Discovery, PepsiCo R&D - Nutrition. Hawthorne, NY. Feb 2014 - August 2016
Managing multiple internal and external **collaborations** supporting PepsiCo raw material **innovation**
Genetic solutions for nutrition, productivity, processability, and sustainability for all major crops in PepsiCo portfolio
Obtained project funding for multiple consumer quality and toolbox development projects

PEER-REVIEWED PAPERS

Hu Y, Resende M, Bombarely A, Brym M, Bassil E, Chambers A. 2019. Genomics-based diversity analysis of *Vanilla* species using a *Vanilla planifolia* draft genome and Genotyping-By-Sequencing. Scientific Reports 9:3416.

Kuhn D, Livingstone D, Richards J, Manosalva P, Van den Berg N, Chambers A. 2019. Application of genomic tools to avocado (*Persea americana*) breeding: SNP discovery for genotyping and germplasm characterization. Scientia Horticulturae 246:1-11.

Chambers A. 2018. Establishing Vanilla Production and a Vanilla Breeding Program in the Southern United States. Handbook of Vanilla Science and Technology. Wiley Blackwell. 165-180.

Chambers A, Moon P, Fu Y, and Choiseul J. 2018. Yield and Fruit Quality of Sixteen Fragaria vesca

Accessions Grown in Southern Florida. HortScience. 53/10: 1396-1403.

Moon P, Fu Y, Bai J, Plotto A, Crane J, Chambers A. 2018. Assessment of fruit aroma for twenty-seven guava (Psidium guajava) accessions through three fruit developmental stages. Scientia Horticulturae. 238: 375-383.

Kuhn D, Livingstone D, Richards J, Manosalva P, Van den Berge N, Chambers A. 2018. Application of genomic tools to avocado (Persea americana) breeding: SNP discovery for genotyping and germplasm characterization. Scientia Horticulturae. 246: 1-11.

Pillet J, Chambers A, Barbey C, Bao Z, Plotto A, Bai J, Schwieterman M, Johnson T, Harrison B, Whitaker V, Colquhoun T, and Folta K. 2017. Identification of a methyltransferase catalyzing the final step of methyl anthranilate synthesis in cultivated strawberry. BMC Plant Biology. 17/147.

Saccomanno B, Chambers A, Hayes A, Mackay I, McWilliam S, Trafford S. 2016. Starch granule morphology in oat endosperm. J Cereal Sci 73:46-54.

Pillet J, Hao-Wei Yu, Chambers A, Whitaker V, Folta K. 2015. Functional identification of candidate flavonoid-pathway genes using transcriptome correlation network analysis in ripe strawberry (*Fragaria* x *ananassa*) fruits. J Ex Bot 66(15):4455-4467.

Chambers A, Plotto A, Bai J, Stodghill P, Whitaker V, Folta K. 2014. Identification of a strawberry flavor gene using an integrated genetic-genomic-analytical chemistry approach. BMC Genomics 15:217.

Chambers A, Evans S, Folta K. 2013. Methyl anthranilate and γ-decalactone inhibit strawberry pathogen growth and achene germination. Agric Food Chem 61(51):12625-33.

Chambers A, Pollard H, Folta K. 2013. Limitations of morphological ploidy estimation methods in *Fragaria*. Journal of Berry Research, 3:135-149.

Chambers A, Carle S, Wambui N, Chamala S, Bassil N, Whitaker V, Barbazuk B, Folta K. 2013. A genome-enabled, high- throughput, and multiplexed fingerprinting platform for strawberry (*Fragaria* L.). Mol. Breeding 31(3):615-629.

Chambers A, Whitaker V, Gibbs B, Plotto A, Folta K. 2012. Detection of the linalool-producing *NES1* variant across diverse strawberry (*Fragaria* spp.) accessions. Plant Breeding 131(3):437-443.

Swingle B, Bao Z, Markel E, Chambers A, Cartinhour S. 2010. Recombineering using RecTE from *Pseudomonas syringae*. Applied and Environmental Microbiology 76(15):4960-4968.

Bignell D, Seipke R, Huguet-Tapia J, Chambers A, Parry R, Loria R. 2010. *Streptomyces scabies* 87-22 contains a coronafacic acid-like biosynthetic cluster that contributes to plant-microbe interactions. MPMI 23(2):161-175.

LEADERSHIP EXPERIENCE

American Society for Horticultural Sciences, Tropical Fruit Professional Interest Group, Chair, 2018-2019

American Society for Horticultural Sciences, Orchids Professional Interest Group, Secretary, 2018

Florida State Horticultural Society, Krome Section VP 2019, VP-elect 2018

HONORS AND ACHIEVEMENTS

UNC Kenan-Flagler Business Essentials Certificate, August 2015

Eagle Scout Award. Springfield, Virginia, May 1999

ORAL PRESENTATIONS

Application of Plant Genetics and Genomics to Improve Quality and Benefit End Users. Private Company. Cincinnati, OH. Dec 6, 2018.

Trialing and Breeding New Tropical Fruits for Domestic Growers. North Carolina State University Wernsman Seminar Series. Raleigh, NC. Mar 16, 2018.

Tropical Fruit: Where Quality Beats Yield. North Carolina State University Wernsman Seminar Series. Raleigh, NC. Mar 15, 2018.

Domestic production, global innovation. Vanilla 2017. Monroe, NJ. Nov 7, 2017.

Banana Splits From Its Extinction Cycle. American Association of Cereal Chemists. San Diego, CA. Oct 10, 2017.

Overcoming limitations to tropical fruit breeding in southern Florida. American Society for Horticultural Sciences. Waikoloa, HI. Sep 20, 2017.

Yield and Fruit Quality of Commercial and Alpine Strawberry Varieties in Southern Florida. American Society for Horticultural Sciences. Washington D.C. Jul 31, 2018.

Aroma and fruit quality analysis of 20 guava varieties at three stages of fruit development. American Society of Horticultural Science. Waikoloa, HI. Sep 22, 2017.

Marker-Assisted Selection in Tropical Fruits. University of Florida AGR6322 Advanced Plant Breeding. Gainesville, FL. Oct 18, 2018.

The Future of the Florida Citrus Industry. Citrus Engineering Conference. Lake Alfred, FL. Jun 7, 2018.

Vanilla. Orchid Short Course. Gainesville, FL. Apr 20, 2018.

Overcoming limitations to tropical fruit breeding in southern Florida. University of Florida GCREC. Balm, FL. Jun 15, 2017.

Overcoming limitations to tropical fruit breeding in southern Florida. Florida State Horticultural Society. Tampa, FL. Jun 5, 2017 - Jun 5, 2017.

Tropical fruit breeding at UF-TREC: Where Vanilla isn't vanilla. Selby Botanical Gardens. Sarasota, FL. Feb 22, 2017 - Feb 22, 2017.

Vanilla Conservation, Genetics, and Opportunities for Southern Florida. Florida State Horticultural Society. Fort Lauderdale, FL. Jun 11, 2018.

Tropical Fruit Breeding at UF-TREC: A Water Cooler Talk. University of Florida.

Gainesville, FL. Apr 19, 2018.

Overcoming limitations to tropical fruit breeding in southern Florida. UF Plant Molecular and Cellular Biology. Daytona, FL. May 6, 2017.

Tropical fruit breeding at UF-TREC. Ball Horticultural. Gainesville, FL. Apr 10, 2017 - Apr 10, 2017.

Vanilla in Florida: From Wild Species to Potential Markets. University of Florida HOS5555 Tropical Fruit Production and Research. Homestead, FL. Jul 9, 2018.

Vanilla in Southern Florida: From Native Species to Commercial Considerations. Tropical Fruit and Vegetable Society. Homestead, FL. Jun 27, 2018.

The tools of tropical fruit breeding. Tropical Fruit and Vegetable Society. Homestead, FL. Aug 30, 2017 - Aug 30, 2017.

Opportunities for tropical fruit improvement at TREC. Tropical Fruit Growers Forum. Homestead, FL. May 8, 2017 - May 8, 2017.

Vanilla: Diversity, Breeding, and Quality. University of Florida TREC. Homestead, FL. Mar 1, 2018.

Tropical Fruit Concepts. UF TREC Board. Homestead, FL. Jun 21, 2017 - Jun 21, 2017.

Tropical Fruit Concepts. J&C Tropicals. Homestead, FL. May 26, 2017 - May 26, 2017.

Breeding and genetics of tropical fruit crops. University of Florida TREC. Homestead, FL. Apr 13, 2017 - Apr 13, 2017.

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EDUCATION

PhD	Plant Breeding	North Carolina State University	1993
MS	Horticultural Science	University of Florida	1986
BS	General Agriculture	University of Puerto Rico	1981

PROFESSIONAL EXPERIENCE

University of Florida	Associate Professor	2004-present
USDA-ARS	Research Geneticist	1997-2004
ForBio Research	Research Scientist	1993-1996

TEACHING EXPERIENCE

Currently responsible for teaching HOS6201 Breeding Perennial Cultivars, FRC3252 Introduction to Tropical and Subtropical Fruit, and FRC3212 Introduction to Citrus Culture and Production.

PUBLICATIONS

Maquilan, M. A., Olmstead, M. A., Olmstead, J. W., Dickson, D. W., Chaparro, J. X. 2018. Genetic analyses of resistance to the peach root-knot nematode (Meloidogyne floridensis) using microsatellite markers. Tree Genetics & Genomes. 14 (4).

Maquilan, M. A., Olmstead, M. A., Dickson, D. W., Chaparro, J. X. 2018. Inheritance of resistance to the peach root-knot nematode (Meloidogyne floridensis) in interspecific crosses between peach (Prunus persica) and its wild relative (Prunus kansuensis). Plant Breeding. 137 (5) 805-813.

Mancero-Castillo, D., Beckman, T. G., Harmon, P. F., Chaparro, J. X. 2018 A major locus for resistance to Botryosphaeria dothidea in Prunus. Tree Genetics & Genomes. 14 (2).

Duval, A., Gezan, S.A., Mustiga, G., Stack, C., Marelli, J.P., Chaparro, J., Livingstone, D., Royaert, S., Motamayor, J. C. 2017. Genetic Parameters and the Impact of Off-Types for Theobroma cacao L. in a Breeding Program in Brazil. Frontiers in Plant Science. 8.

Chavez, Dario J, Beckman, Thomas G, Chaparro, José X. 2016. Identifying the North American Plum Species Phylogenetic Signal Using Nuclear, Mitochondrial, and Chloroplast DNA Markers JASHS.141(6) 623-644.

Rahemi, A., Gradziel, T. M., Chaparro, J. X., Folta, K. M., Taghavi, T., Fatahi, R., Ebadi, A., Hassani, D. 2015 Phylogenetic relationships among the first and second introns of selected Prunus S-RNase genes. Canadian Journal of Plant Science. 95 (6) 1145-1154.

Chavez, D. J., Beckman, T. G., Werner, D. J., Chaparro, J. X. 2014. Genetic diversity in peach Prunus persica (L.) Batsch at the University of Florida: past, present and future. Tree Genetics & Genomes. 10(5) 1399-1417.

Chaparro, J. X., Conner, P. J.,Beckman, T. G. 2014. 'GulfAtlas' Peach. Hortscience 49(8) 1093-1094.

Carrillo-Mendoza, O., Chaparro, J.X.; Williamson, J. 2013. Branching and Blind Node Incidence in Interspecific Backcross Families of Peach. 2013. HortScience. 48:1119-1124

Blaker, K.M., Chaparro, J.X., and Beckman, T.G. 2013. Identification of QTLs controlling seed dormancy in peach (*Prunus persica*). Tree Genetics & Genomes. 9 (3) 659-668.

Beckman, T.G., Chaparro, J.X., and Conner, P.J. 2013. 'Gulfsnow' Peach. HortScience. 48:126-127.

Beckman, T.G.,* Chaparro, J.X., and Sherman, W.B. 2012. 'MP-29', a clonal interspecific hybrid rootstock for peach. HortScience. 47:128-131.

Rahemi, A.R., Fatahi, R., Ebadi, A., Taghavi, T., Hassani, D., Gradziel, T., Folta, K., and Chaparro, J., 2012 Genetic diversity of some wild almonds and related Prunus species revealed by SSR and EST-SSR molecular markers. Plant Systematics and Evolution. 298:173-192.

Beckman,T.B., Chaparro, J.X., and Sherman,W.B. 2012. Evidence for control of double flowering in peach via a dominant single gene locus. Acta Horticulturae 962: 139-141.

Chaparro, J.X. and Beckman,T.B. 2012. Evidence for a new single gene trait controlling premature defoliation in peach. Acta Horticulturae 962:147-149.

Chaparro, J.X., Carrillo-Mendoza*, O., Sherman,W.B., and Beckman,T.B. 2012. Evaluation of *Prunus kansuensis* as a genetic tester for peach. Acta Horticulturae 962: 151-154.

Blaker, K.M. and Chaparro, J.X. 2012. Detection of seed dormancy quantitative trait loci (QTL) in peach. Acta Horticulturae. 962:143-146.

Rahemi;, A.R., Taghavi, T., Fatahi, R., Ebadi, A., Hassani, D., Chaparro, J., and Gradziel, T. 2011. Seed germination and seedling establishment of some wild almond species. African Journal of Biotechnology. 10:7780-7786.

Rahemi, A.*, Fatahi, R., Ebadi, A., Hasani, D., Chaparro, J., Gradziel, T. and Robinson, T. L. 2011. Establishment and growth parameters of some wild almonds in Iran. Acta Horticulturae. 903: 993-998.

Rahemi, A.*, Fatahi, R., Ebadi, A., Hassani, D., Chaparro, J.X., Ak, B.E., Wirthensohn, M., and Gradziel, T. 2011. The study of seed stratification and germination in Amygdalus species of Iran. Acta Horticulturae. 912: 275-279.

Rahemi, A.,* Fatahi, R., Ebadi, A., Hassani, D., Chaparro, J. X., Ak, B. E., Wirthensohn, M., and Gradziel, T. 2011. Nut morphological characterizations of some wild almonds in Iran. Acta Horticulturae. 912: 405-410.

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EDUCATIONAL BACKGROUND

Penn State University	Horticulture	Ph.D.	1994
Clemson University	Horticulture	M.S.	1990
University of Tennessee	Horticulture	B.S.	1988

EMPLOYMENT

University of Florida	Professor	2007-present
University of Florida	Associate Professor	2001-2007
University of Florida	Assistant Professor	1995-2001
Penn State University	Ph.D. Candidate	1990-1994
Clemson University	M.S. candidate	1988-1990

PATENTS

2007 US Patent 7,192,913: *Enhancing the Fragrance of an Article*
2005 US Patent 7,217,859: *Genetic Elements Conferring Flower Petal Specific Transgene Expression*
2005 US Patent 7,253,340: *Floral organ tissue-specific expression of isopentenyl transferase*
2018 US Plant Patent PP 29,820: *Solenostemon scutellarioides* 'UF14-24-1' 'Flamethrower Salsa Verde'
2017 US Plant Patent PP 28,591: *Solenostemon scutellarioides* 'UF 13-26-7' 'Inferno'
2017 US Plant Patent PP 28,566: *Solenostemon scutellarioides* 'UF 13-42-4' 'Ruby Slipper'
2017 US Plant Patent PP 28,517: *Solenostemon scutellarioides* 'UF 13-48-27' 'French Quarter'
2016 US Plant Patent PP 27,269: *Solenostemon scutellarioides* 'UF 12-22-1' 'Campfire'
2016 US Plant Patent PP 27,288: *Solenostemon scutellarioides* 'UF12-82-3' 'Flamethrower Chipotle'
2016 US Plant Patent PP 27,500: *Solenostemon scutellarioides* 'UF 12-74-3' 'Marquee Special Effect'
2016 US Plant Patent PP 27,499: *Solenostemon scutellarioides* 'UF 12-73-5' 'Flamethrower Spiced Curry'
2016 US Plant Patent PP 27,076: *Solenostemon scutellarioides* 'UF 08-5-10' 'Marquee Blonde Bombshell'
2016 US Plant Patent PP 27,077: *Solenostemon scutellarioides* 'UF 09-8-37' 'Marquee Box Office Bronze'
2016 US Plant Patent PP 27,078: *Solenostemon scutellarioides* 'UF 08-19-10' 'Marquee Red Carpet'
2016 US Plant Patent PP 27,126: *Solenostemon scutellarioides* 'UF 10-45-12' 'Coleosaurus'
2016 US Plant Patent PP 27,140: *Solenostemon scutellarioides* 'UF 12-30-6' 'Lime Time'
2015 US Plant Patent PP 25,653: *Solenostemon scutellarioides* 'UF 11-74-5' 'Mainstreet Gran Via'
2015 US Plant Patent PP 25,652: *Solenostemon scutellarioides* 'UF 12-6-2' 'Mainstreet Sunset Boulevard'
2015 US Plant Patent PP 25,626: *Solenostemon scutellarioides* 'UF 12-35-9' 'Mainstreet Wall Street'
2015 US Plant Patent PP 25,651: *Solenostemon scutellarioides* 'UF 12-62-2' 'Mainstreet River Walk'
2015 US Plant Patent PP 25,650: *Solenostemon scutellarioides* 'UF 12-87-9' 'Mainstreet Oxford Street'
2015 US Plant Patent PP 25,627: *Solenostemon scutellarioides* 'UF 11-74-12' 'Gator Glory'
2013 US Plant Patent PP 23,585: *Solenostemon scutellarioides* 'UF 08-4-3' 'Wasabi'

2013 US Plant Patent PP 23,586: *Solenostemon scutellarioides* 'UF 08-17-4' 'Sultana'
2010 US Plant Patent PP 21,602: *Solenostemon scutellarioides* 'UF 06-04-19' 'Trusty Rusty'
2010 US Plant Patent PP 21,585: *Solenostemon scutellarioides* 'UF 06-04-06' 'Redhead'
2001 US Plant Patent PP 11,989: *Pelargonium domesticum* 'PSU 93-30-13' 'Fascination'
2000 US Plant Patent PP 11,697: *Pelargonium domesticum* 'PSU 93-11-4' 'Dandy'

UF CULTIVAR RELEASES

UF17-73-7 – released in 2019 - commercialized in 2019 by ProvenWinners Co. as 'Colorblaze Wicked Witch'
UF17-52-2 – released in 2019 - commercialized in 2019 by ProvenWinners Co. as 'Colorblaze Wicked Hot'
UF17-128-17 – released in 2019 - commercialized in 2019 by Dummen Co. as 'Stained Glassworks Eruption'
UF17-64-1 – released in 2019 - commercialized in 2019 by Dummen Co. as 'Mainstreet Beale Street'
UF17-50-5 – released in 2019 - commercialized in 2019 by Dummen Co. as 'Mainstreet Alligator Alley'
UF17-48-3 – released in 2019 - commercialized in 2019 by Dummen Co. as 'Mainstreet Boston'
UF16-91-25 – released in 2019 - commercialized in 2019 by Ball Horticultural Co. as 'Heartbreaker'
UF16-9-3 – released in 2018 - commercialized in 2018 by ProvenWinners Co. as 'Rediculous'
UF15-6-28 – released in 2018 - commercialized in 2018 by Ball Horticultural Co. as 'Flamethrower Serrano'
UF15-97-9 – released in 2018 - commercialized in 2018 by Ball Horticultural Co. as 'Flamethrower Salsa Roja'
UF15-20-6 – released in 2018 - commercialized in 2018 by Ball Horticultural Co. as 'Pinkplosion'
UF16-23-2 – released in 2018 - commercialized in 2018 by ProvenWinners Co. as 'Amazel'
UF14-24-1 – released in 2017 - commercialized in 2017 by Ball Horticultural Co. as 'Flamethrower Salsa Verde'
UF16-1-20 – released in 2017 - commercialized in 2017 by ProvenWinners Co. as 'Sedona Sunset'
UF16-5-6 – released in 2017 - commercialized in 2017 by Dummen Co. as 'Mainstreet Ocean Drive'
UF16-14-3 – released in 2017 - commercialized in 2017 by ProvenWinners Co. as 'Colorblaze Cherry Brandy'
UF16-14-5 – released in 2017 - commercialized in 2017 by ProvenWinners Co. as 'Colorblaze Kingswood'
UF16-27-1 – released in 2017 - commercialized in 2017 by Dummen Co. as 'Mainstreet Chartres Street'
UF16-45-18 – released in 2017 - commercialized in 2017 by Dummen Co. as 'Stained Glassworks Crown Jewel'
UF16-64-1 – released in 2017 - commercialized in 2017 by Dummen Co. as 'Mainstreet Ruby Road'
UF16-72-8 – released in 2017 - commercialized in 2017 by Dummen Co. as 'Mainstreet La Rambla'
UF16-88-9 – released in 2017 - commercialized in 2017 by Dummen Co. as 'Stained Glassworks Royalty'
UF 13-26-7 – released in 2016 - commercialized in 2016 by Ball Horticultural Co. as 'Inferno'
UF 13-42-4 – released in 2016 - commercialized in 2016 by Ball Horticultural Co. as 'Ruby Slipper'
UF 13-48-27 – released in 2016 - commercialized in 2016 by Ball Horticultural Co. as 'French Quarter'
UF 12-73-5 – released in 2015 - commercialized in 2015 by Ball Horticultural Co. as 'Flame Thrower Spiced Curry'
UF 12-74-3 – released in 2015 - commercialized in 2015 by Ball Horticultural Co. as 'Marquee Special Effect'
UF 13-6-11 – released in 2015 - commercialized in 2015 by ProvenWinners Co. as 'Velveteen'
UF 08-5-10 – released in 2014 - commercialized in 2014 by Ball Horticultural Co. as 'Marquee Blonde Bombshell'
UF 08-19-10 – released in 2014 - commercialized in 2014 by Ball Horticultural Co. as 'Marquee Red Carpet'
UF 09-8-37 – released in 2014 - commercialized in 2014 by Ball Horticultural Co. as 'Box Office Bronze'
UF 10-45-12 – released in 2014 - commercialized in 2014 by Ball Horticultural Co. as 'Coleosaurus'
UF 12-30-6 – released in 2014 - commercialized in 2014 by ProvenWinners Co. as 'Lime Time'
UF 12-46-2 – released in 2014 - commercialized in 2014 by Dummen Co. as 'Mainstreet Abbey Road'
UF 12-85-28 – released in 2014 - commercialized in 2014 by Dummen Co. as 'Mainstreet Broadway'
UF 12-86-9 – released in 2014 - commercialized in 2014 by Dummen Co. as 'Mainstreet Fifth Avenue'
UF 12-22-1 – released in 2014 - commercialized in 2014 by Ball Horticultural Co. as 'Campfire'

UF 12-64-1 – released in 2014 - commercialized in 2014 by Ball Horticultural Co. as TBA
UF 12-82-3 – released in 2014 - commercialized in 2014 by Ball Horticultural Co. as 'Flame Thrower Chipotle'
UF 11-23-7 – released in 2013 - commercialized in 2013 by ProvenWinners Co. as 'Ruby Dream'
UF 11-23-31 – released in 2013 - commercialized in 2013 by ProvenWinners Co. as 'Golden Dream'
UF 11-73-8 – released in 2013 - commercialized in 2013 by ProvenWinners Co. as 'Cranberry Bog'
UF 11-77-18 – released in 2013 - commercialized in 2013 by ProvenWinners Co. as 'The Whirlpool'
UF 11-74-5 – released in 2013 - commercialized in 2013 by Dummen Co. as 'Mainstreet Gran Via'
UF 12-6-2 – released in 2013 - commercialized in 2013 by Dummen Co. as 'Mainstreet Sunset Boulevard'
UF 12-9-2 – released in 2013 - commercialized in 2013 by Dummen Co. as 'TBA'
UF 12-35-9 – released in 2013 - commercialized in 2013 by Dummen Co. as 'Mainstreet Wall Street'
UF 12-62-2 – released in 2013 - commercialized in 2013 by Dummen Co. as 'Mainstreet River Walk'
UF 12-87-9 – released in 2013 - commercialized in 2013 by Dummen Co. as 'Mainstreet Oxford Street'
UF 11-74-12 – released in 2013 - commercialized in 2013 by The University of Florida as 'Gator Glory'
UF 10-8-1 – released in 2012 - commercialized in 2012 by ProvenWinners Co. as 'Marooned'
UF 10-61-13 – released in 2012 - commercialized in 2012 by ProvenWinners Co. as 'Spumoni'
UF 10-81-1 – released in 2012 - commercialized in 2012 by ProvenWinners Co. as 'Neptune's Net'
UF 08-4-3 – released in 2011 - commercialized in 2011 by Ball Horticultural Co. as 'Wasabi'
UF 08-17-4 – released in 2011 - commercialized in 2011 by Ball Horticultural Co. as 'Sultana'
UF 08-46-24 – released in 2011 – commercialized in 2011 by Cottage Hill Farms as 'Radiant Panache'
UF 09-6-1 – released in 2011 – commercialized in 2011 by Cottage Hill Farms as 'Lemon Zinger'
UF 09-27-1 – released in 2011 – commercialized in 2011 by Cottage Hill Farms as 'Velour Magic'
UF 09-8-57 – released in 2011 - commercialized in 2011 by ProvenWinners Co. as 'Cocomint'
UF 09-8-87 – released in 2011 - commercialized in 2011 by ProvenWinners Co. as 'Keystone Kopper'
UF 09-18-1 – released in 2011 - commercialized in 2011 by ProvenWinners Co. as 'Burgundy Lace'
UF 07-10-10 – released in 2010 - commercialized in 2010 by ProvenWinners Co. as 'Rebel Rouser'
UF 07-24-5 – released in 2010 - commercialized in 2010 by ProvenWinners Co. as 'Dirty Martini'
UF 08-19-12 – released in 2010 - commercialized in 2010 by ProvenWinners Co. as 'Cordial Cherry'
UF 08-43-23 – released in 2010 - commercialized in 2010 by ProvenWinners Co. as 'Alligator Tears'
UF 06-12-19 – released in 2009 - commercialized in 2009 by ProvenWinners Co. as 'Sunset Strip'
UF 06-13-65 – released in 2009 - commercialized in 2009 by ProvenWinners Co. as 'Radical Wonder'
UF 06-13-132 – released in 2009 - commercialized in 2009 by ProvenWinners Co. as 'Snazzy'
UF 06-21-35 – released in 2008 - commercialized in 2008 by ProvenWinners Co. as 'Limon Blush'
UF 06-04-06 – released in 2008 - commercialized in 2010 Ball Horticultural Co. as 'Redhead'
UF 06-04-19 – released in 2008 - commercialized in 2010 Ball Horticultural Co. as 'Trusty Rusty'
UF 04-33-5 – released in 2006 - commercialized in 2006-7 Ball Horticultural Co. as 'Electric Lime'
UF 04-47-64 – released in 2006 - commercialized in 2006-7 by ProvenWinners Co. as 'Frilly Milly'
UF 04-69-01 – released in 2006 - commercialized in 2006-7 by ProvenWinners Co. as 'Splish Splash'
UF 06-2-78 – released in 2006 - commercialized in 2006-7 by ProvenWinners Co. as 'Pineapple Splash'
UF 06-4-18 – released in 2006 - commercialized in 2006-7 by ProvenWinners Co. as 'Lancelot'
UF 06-21-30 – released in 2006 - commercialized in 2006-7 by ProvenWinners Co. as 'Lemon Sunsation'
UF 06-40-01 – released in 2006 - commercialized in 2006-7 by ProvenWinners Co. as 'Big Red Judy'
UF 03-6-1 – released in 2005 - commercialized in 2005-6 by ProvenWinners Co. as 'Twist n' Twirl'
UF 03-8-10 – released in 2005 - commercialized in 2005-6 by ProvenWinners Co. as 'Royal Glissade'

RELEVANT RECENT PUBLICATIONS

Kim, J.Y., Swanson, R.T., Alvarez, M.I., Johnson, T.S., Cho, K.H., Clark, D.G., Colquhoun, T.A. 2019 Down Regulation of P-coumarate 3-hydroxylase in Petunia Uniquely Alters the Profile of Emitted Floral Volatiles. Scientific Reports: 9(1):8852.

Cho, K.H., Kim, J.Y., Tester, J.M., Valad, L.K., Alvarez, M.I., Colquhoun, T.A., Laux, V.Y., and Clark, D.G. In press. Strong fluorescence expression of ZsGreen1 in petunia flowers by *Agrobacterium*-mediated transformation. *J. Amer. Soc. Hort. Sci*

Keene, S.A., Johnson, T.S., Sigler, C.L., Kalk, T.N., Genho, P., Clark, D.G., and Colquhoun, T.A. submitted. A survey of the floral volatile profiles of *Hemerocallis* L. species and hybrids. *Phytochemistry*.

Cho, K.H., Laux, V.Y., Kim, J.Y., Wallace-Springer, N., Clark, D.G., Folta, K.M., and Colquhoun, T.A., 2019. Effects of Light Quality on Vegetative Cutting and In Vitro Propagation of Coleus (*Plectranthus scutellarioides*). HortScience 54(5):926-935.

Sun, J., Sigler, C., Beaudoin, G., Joshi, J., Patterson, J., Cho, K., Ralat, M., Gregory, J., Clark, D., Deng, Z., Colquhoun, T., and Hanson A. 2019. Parts-prospecting For a High-efficiency Thiamin Thiazole Biosynthesis Pathway. *Plant Physiology* 179:958-968.

Mennella, J., Colquhoun, T. A., Bobowski, N.K., Olmstead, J.W., Bartoshuk, L., and Clark, D.G. 2017. Farm to Sensory Lab: Taste of Blueberry Fruit by Children and Adults. *Journal of Food Science* 82:1713-1719.

Dewar, P. E., Keene, S. A., Kalk, T. N., Clark, D. G., & Colquhoun, T. A. 2016. Identifying the Drivers of a Foliage Plant Purchasing Decision via Contemporary Psychophysics. *J Hortic*, *3*(177), 2376-0354.

Johnson, T. S., Schwieterman, M. L., Kim, J. Y., Cho, K. H., Clark, D. G., & Colquhoun, T. A. 2016. Lilium floral fragrance: A biochemical and genetic resource for aroma and flavor. *Phytochemistry*, *122*, 103-112.

Thomas A Colquhoun, Michael L Schwieterman, Derek J Snyder, Jennifer J Stamps, Charles A Sims, Asli Z Odabasi, Harry J Klee, Denise M Tieman, James W Olmstead, David G Clark, Linda M Bartoshuk 2016. Laboratory Demonstration of Volatile Enhanced Sweetness. *Chemical Senses* 40:622-623.

Gilbert, J.L., Guthart, M.J., Gezan, S.A., de Carvalho, M.P., Schwieterman, M.L., Colquhoun, T.A., Bartoshuk, L.M., Folta, K.M., Sims, C.A., Clark, D.G., and Olmstead, J.W. 2015. Identifying Breeding Priorities for Blueberry Flavor Using Biochemical, Sensory and Genotype by Environment Analyses. *PLoS ONE* 10(9): e0138494.

Olmstead, M.A., Gilbert, J.L., Colquhoun, T.A., Clark, D.G., Kluson, R., and Moskowitz, H.R. 2015. In pursuit of the perfect peach: consumer-assisted selection of peach fruit traits. *HortScience* 50:1202-1212.

Langer, K.M., Jones, C.R., Jaworski, E.A., Rushing, G.V., Kim, J.Y., Cline, K.C., Clark, D.G., and Colquhoun, T.A. 2014. *PhDAHP1* is required for floral volatile benzenoid/phenylpropanoid biosynthesis in a *Petunia* x *hybrida* cv 'Mitchell Diploid' flower. *Phytochemistry* 103:22-31.

Gilbert, J.L., Schwieterman, M.L., Colquhoun, T.A., Clark, D.G., Moskowitz, H.R., and J.W. Olmstead 2014. Consumer-Assisted Selection of Blueberry Fruit Quality Traits. *HortScience* 49:864-873.

Schwieterman, M.L., Colquhoun, T.A., Bartoshuk, L.M., Jaworski, E.A., Gilbert, J.L., Tieman, D.M., Odabasi, A.Z., Moskowitz, H.R., Folta, K.M., Klee. H.J., Sims, C.A., Whitaker, V.M., and D.G. Clark 2014. Strawberry Flavor: Diverse Chemical Compositions, a Seasonal Influence, and Effects on Sensory Perception. PLOSONE 9(2):e88446.

Colquhoun, T.A., Schwieterman, M.L., Gilbert, J.L., Jaworski, E.A., Langer, K.M., Jones, C.R., Rushing, G., Clark, D.G., and K.M. Folta 2013. Light Modulation of Plant Flavor and Aroma Compounds in Select Fruits and Flowers. *Postharvest Biol. Technol.* 86: 37-44.

Gilbert, J.L., Schwieterman, M.L., Colquhoun, T.A., Clark, D.G., and J.W. Olmstead 2013. Potential for Increasing Southern Highbush Blueberry Flavor Acceptance by Breeding for Major Volatile Components. *HortScience* 48(7): 835–843.

Kessler, D., C. Diezel, D.G. Clark, T.A. Colquhoun and I.T. Baldwin. 2013. Petunia flowers solve the defence/apparency dilemma of pollinator attraction by deploying complex floral blends. *Ecology Letters* 16(3):299-306.

Levin L.A., Langer K.M., Clark D.G., Callaway J.L., Moskowitz H.R. and T.A. Colquhoun. 2012. Using Mind Genomics to Identify Essential Elements of a Flower Product. *HortScience* 47(11):1-8.

Colquhoun T.A., D.M. Marciniak, A.E. Wedde, J.Y. Kim, M.L. Schwieterman, L.A. Levin, A. Van Moerkercke, R.C. Schuurink and D.G. Clark. 2012. A peroxisomally localized acyl-activating enzyme is required for volatile benzenoid formation in a Petunia x hybrida cv. 'Mitchell Diploid' flower. *Journal of Experimental Botany* 63(13):4821-4833.

Tieman D, Bliss P, McIntyre LM, Blandon-Ubeda A, Bies D, Odabasi AZ, Rodríguez GR, van der Knaap E, Taylor MG, Goulet C, Mageroy MH, Snyder DJ, Colquhoun T, Moskowitz H, Clark DG, Sims C, Bartoshuk L, Klee HJ. 2012. The chemical interactions underlying tomato flavor preferences. *Current Biology* 5;22(11):1035-1039

Colquhoun T.A., L.A. Levin, H.R. Moskowitz, V.M. Whitaker, D.G. Clark and K.M. Folta 2012. Framing the perfect strawberry: An exercise in consumer-assisted selection of fruit crops. *Journal of Berry Research* 2:45-61.

AWARDS

Penn State University College of Agricultural Sciences Outstanding Alumnus – 2018

Penn State University Armsby Honors Society – 2018

Society of American Florists Gold Medal Award – 2014

University of Florida Research Foundation Professorship – 2013

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EDUCATION

Ph.D., Huazhong Agricultural Univ. (China), 1988.
M.S., Huazhong Agricultural Univ. (China), 1985.
B.S., Sichuan Agricultural Univ. (China), 1982.

PROFESSIONAL WORK EXPERIENCE

2015 – Present: Professor, Univ. of Florida (UF), Gulf Coast Res. and Ed. Center (GCREC), Wimauma, FL
2009 – 2015: Associate Professor, UF, GCREC
2002 – 2009: Assistant Professor, UF, GCREC
1999 – 2002: Assistant-In Citrus Molecular Genetics and Biology, UF, Citrus Research and Education Center (CREC), Lake Alfred, FL
1998 – 1999: Postdoctoral Research Associate, UF, CREC
1996 – 1998: Postdoctoral Research Associate, Univ. of Alberta, Department of Agricultural, Food, and Nutritional Sciences, Molecular Biology and Biotechnology Center, Edmonton, AB, Canada
1993 – 1996: Visiting Scholar, UF, CREC
1992 – 1993: Associate Professor, Huazhong Agricultural University (HAU), Department of Horticulture, Wuhan, China
1988 – 1992: Assistant Professor (Lecturer), HAU, Department of Horticulture
1982 – 1988: Graduate Assistant, HAU, Department of Horticulture

SUMMARY OF RESEARCH ACCOMPLISHMENTS

1. 90 refereed articles published in more than 20 journals, with some having been cited more than 100 times.
2. Nine book chapters published by major international publishers, 34 articles published in conference proceedings and other journals, and 137 published abstracts.
3. Developed and released 22 new caladium cultivars, with novel ornamental characteristics, improved tuber yield, disease resistance, and/or stress tolerance; granted 20 plant patents for new caladium cultivars; signed nearly 50 licenses for commercial production; marketed and used across the U.S. and as many as forty foreign countries in the world. These new introductions have increased grower incomes, reduced pesticide use, and improved overall plant performance for consumers.
4. Developed and released four triploid sterile, non-invasive Lantana camara cultivars, granted four plant patents for these cultivars, applied for IP protection in Australia and Japan. The cultivars are in commercial production in U.S., Canada, Australia, and Japan. Growers and consumers have sought non-invasive lantana varieties. These cultivars are ideal replacement of the invasive types: The protect native plants species and the environment while allowing growers and consumers to continue enjoying the benefits of lantana being easy to grow and produce, tolerant of tough landscape conditions and stresses, attracting pollinators, butterflies and bees, and saving water.
5. Developed and released 12 new gerbera daisy cultivars with improved resistance to powdery mildew and plant performance, granted seven plant patents for these cultivars, and established

collaborative genetic improvement projects with top-notch horticultural firms in the world.

6. Discovered very valuable sources of resistance for major diseases in multiple horticultural crops and developed disease screening techniques. Including sources of resistance to Fusarium tuber rot, Pythium root rot, and Xanthomonas leaf blight in caladium, and sources of strong resistance to powdery mildew, the most destructive disease in gerbera daisy and Coreopsis. These sources of resistance have been induced to new caladium and gerbera cultivars, and also served as very valuable germplasm for commercial and private breeding programs.
7. Discovered, located, cloned and/or characterized important resistance/defense genes for major diseases in citrus, gerbera, impatiens and caladium, including the gene locus for citrus tristeza virus (CTV) resistance, strong candidate genes for citrus greening resistance, major quantitative trait loci for powdery mildew resistance in gerbera daisy, resistance genes for downy mildew resistance in impatiens, and defense genes for Pythium root rot resistance in caladium. These findings and molecular tools are fueling the development of a new generation of cultivars that can reduce the use of pesticides and better protect workers and the environment.
8. Revealed that production of unreduced female gametes via apomeiosis and apomictic seed production are the primary reproductive biological causes of lantana's strong invasive potential, discovered valuable diploids and tetraploids that lack these biological properties, and developed effective ploidy manipulation and screening strategy to sterilize lantana and other invasive ornamental plants.
9. Revealed the modes of inheritance and genetic linkage relationship for six important ornamental foliar traits in caladium, identified major QTL and chromosomal intervals for seven major plant and flower traits in petunia,
10. Awarded $5.9 million research grants, including $2.3 million from federal competitive grant programs, as PI or Co-PI (fund allocated to Deng).

CULTIVAR RELEASES, PLANT AND UTILITY PATENTS

1. Utility patent (1): Plant genes conferring resistance to citrus tristeza virus (7,126,044).

2. Plant cultivars released (37):

Caladium cultivars (22): 'Firecracker Red', 'Garden White', 'Summer Rose', 'Cranberry Star', 'Passionista', 'Sizzle', '75-14', 'UF-331', 'UF-340', 'UF-404' 'UF-18-49', 'UF-48-5', 'UF-85-8', 'UF-172', 'UF 44-4', 'UF 4412', 'UF 4424', 'UF-R304', 'UF-R813', 'UF-R1012', 'UF-R1022' ('Icicle'), and 'UFR1409'.

Gerbera cultivars (12): 'UF Multi-flora Peach', 'UF Multi-flora Pink Frost', 'UF Enduring White', 'UF Enduring Burgundy', 'UFGE 4141', 'UFGE 7014', 'UFGE 7015', 'UFGE 7023', 'UFGE 7032', 'UFGE 7034', 'UFGE 7031', and 'UFGE 7080'.

Lantana cultivars (4): 'UF-T3', 'UF-T4', 'UF-1011-2' (Bloomify™ Rose), and 'UF-1013A-2A' (Bloomify™ Red).

3. Plant patents (PP) (31):

Caladium plant patents (20): PP20,461 - 'Firecracker Red' caladium; PP20,448 - 'Garden White' caladium; PP20,446 - 'Summer Rose' caladium; PP20,792 – 'Cranberry Star' caladium; PP21,089 – '75-14' caladium; PP21,347 – 'UF-340' caladium; PP22,055 – 'UF331' caladium; PP24,327 – 'UF-48-5' caladium; PP24,431 – 'UF-18-49' caladium; PP24,432 – 'UF-172' caladium; PP24,680 – 'UF 44-4' caladium; PP24,681 – 'UF-85-5' caladium; PP25,598 – 'UF 4424' caladium; PP25,612 – 'UF 4412' caladium; PP26,591 – 'Passionista' caladium; PP26,592 – 'Sizzle' caladium; U.S. PP26,833 – 'Fiesta' caladium; U.S. PP27,154 – 'Cosmic Delight' caladium; U.S. PP27,155 – 'Hearts Desire' caladium; and U.S. PP29,249 – 'Icicle' caladium.

Gerbera plant patents (7): PP23,373 – 'UFGE 7014' gerbera; PP23,488 - 'UFGE 7015' gerbera; PP23,448 - 'UFGE 7032' gerbera; PP23,433 - 'UFGE 7034' gerbera; PP23,373 - 'UFGE 7014' gerbera; PP23,346 - 'UFGE 4141' gerbera; PP24,792 - 'UFGE 7080'; and PP24,793 - 'UFGE 7031'.

Lantana plant patents (4): PP24,057 – 'UF-T3' lantana; PP24,043 – 'UF-T4' lantana; U.S. PP29,267 – 'UF-1011-2' lantana; and U.S. PP29,292 – 'UF-1013A-2A' lantana.

PUBLICATIONS

1. Book chapters (9):

Deng, Z. 2018. Caladium breeding. In: J.V. Huylenbroeck (ed). Handbook of plant breeding: Ornamental crops. Springer International Publishing AG, Switzerland. https://doi.org/10.1007/978-3-319-90698-0_12.

Deng, Z. and K. Bhattarai. 2018. Gerbera breeding. In: J.V. Huylenbroeck (ed). Handbook of plant breeding: Ornamental crops. Springer International Publishing AG, Switzerland. https://doi.org/10.1007/978-3-319-90698-0_17.

Deng, Z. 2016. Breeding for disease resistance in florists' crops, pp 1-31. In: R.J. McGovern and W.H. Elmer (eds.). Handbook of Plant Disease Management. Handbook of Florists' Crops Diseases. Springer International Publishing, Switzerland (invited, in press). DOI: 10.1007/978-3-319-32374-9_4-1.

Deng, Z. 2013. Molecular markers in caladium: Development, characterization and applications. pp. 214-227. In: K.G. Ramawat and J.M. Merillon (eds.). Bulbous Plants Biotechnology. CRC Press, Boca Raton, FL, US (invited).

Deng, Z. 2012. Caladium breeding and genetics: Recent advances. pp. 53-61. In: J.A. Teixeira da Silva (ed.). Floriculture and Ornamental Biotechnology 6 (Special Issues 1). Global Science Books, London, UK (invited).

Gmitter Jr., F.G., **Z. Deng**, and C. Chen. 2007. Cloning and characterization of disease resistance genes. pp. 287-305. In: Iqrar A. Kahn (ed.). Citrus Genetics, Breeding and Biotechnology. CAB International, Nosworthy Way, Wallingford, Oxfordshire, OX10 8DE, UK.

Deng, Z. 2006. Disease resistance gene analogs: Isolation, identification and applications. pp. 358-366. In: J.A. Teixeira da Silva (ed.). Floriculture, Ornamental and Plant Biotechnology: Advances and Topical Issues (1st Edition). Global Science Books, London, UK.

Deng, Z. 1996. Applications of plant growth regulators in citriculture (in Chinese), pp. 196-208. In: D. Li (ed.). Citriculture. Agriculture Publishing House, Beijing, China.

Deng, Z. 1996. Freezes and freezing prevention in citriculture, p. 209-214. In: D. Li (ed.). Citriculture. Agriculture Publishing House, Beijing, China.

2. Refereed publications (93; [g] and [p] indicate graduate students and postdocs under supervision, respectively):

Bechtloff, A., C. Reinhardt-Adams, S. Wilson, **Z. Deng**, and C. Wiese. 2019. Insights from Southeastern US nursery growers guide research for sterile ornamental cultivars. J. Environ. Hort. 37(1):9-18.

[g] Cao, Z., [p] Y. Guo, Q. Yang, Y. He, M. Fetouh, R.M. Warner, and **Z. Deng**. 2019. Genome-wide identification of quantitative trait loci for important plant and flower traits in petunia using a high-density linkage map and an interspecific recombinant inbred population derived from *Petunia integrifolia* and *P. axillaris*. Horticulture Research (in press).

[p] Peng, Z., [g] K. Bhattarai, [p] S. Parajuli, and **Z. Deng**. 2019. Transcriptome analysis of young ovaries reveals candidate genes involved in gamete formation in Lantana camara. Plants 8(8):263. https://doi.org/10.3390/plants8080263

Sun, J., C.L Sigler, G.A. Beaudoin, J. Joshi, J.A. Patterson, K.H. Cho, M.A. Ralat, J.F. Gregory, D.G. Clark, **Z. Deng**, T.A. Colquhoun, and A.D. Hanson. 2019. Parts-prospecting for a high-efficiency thiamin thiazole biosynthesis pathway. Plant Physiology. DOI: https://doi.org/10.1104/pp.18.01085.

Xavier, K., A. KC, N.A. Peres, **Z. Deng**, W.S. Castle, W. Lovett, and G.E. Vallad. 2019. Characterization of Colletotrichum species causing anthracnose of pomegranate in the southeastern U.S. Plant Disease. https://doi.org/10.1094/PDIS-03-19-0598-RE

[g] Bhattarai, K., [g] W. Wang, [g] Z. Cao, and **Z. Deng**. 2018. Comparative analysis of impatiens leaf transcriptomes reveal candidate genes for resistance to downy mildew caused by plasmopara obducens. International Journal of Molecular Science 19(7). pii: E2057. doi: 10.3390/ijms19072057.

[g] Cao, Z., Y. Guo, Q. Yang, Y. He, M. Fetouh, R.M Warner, and **Z. Deng**. 2018. Genome-wide search for quantitative trait loci controlling important plant and flower traits in petunia using an interspecific recombinant inbred population of Petunia axillaris and Petunia exserta. G3: Genes, Genomes, Genetics. https://doi.org/10.1534/g3.118.200128.

Chen, L., L. Wei, L. Katin-Grazzini, J. Ding, X. Gu, Y. Li, T. Gu, R. Wang, X. Lin, **Z. Deng**, R.J. McAvoy, F.G. Gmitter Jr., Z. Deng, Y. Zhao, and Y. Li. 2018. A method for the production and expedient screening of CRISPR/Cas9-mediated non-transgenic mutant plants. Horticulture Research 5:13. Doi:10.1038/s41438-018-0023-4.

Deng, Z. and N.A. Peres. 2018. 'Icicle' – A white lance-leaved caladium cultivar for containers and shady landscapes. HortScience 53:1076-1079; doi:10.21273/HORTSCI13073-18.

Freyre, R., **Z. Deng**, and V.A. Zayas. 2018. Fruitless and semi-dwarf Ruellia simplex R13-5-3, R15-24-17, and R16-1-1. HortScience 53(10):1528-1533.

Huang, M., M.L. Roose, Q. Yu, D. Du, Y. Yu, Y. Zhang, **Z. Deng**, E. Stover, and F.G. Gmitter Jr. 2018. Construction of high-density genetic maps and detection of QTLs associated with Huanglongbing tolerance in Citrus. Frontiers in Plant Science. https://doi.org/10.3389/fpls.2018.01694.

[g] Wang, W., Y. He, [g] Z. Cao, and **Z. Deng**. 2018. Induction of tetraploids in impatiens (impatiens walleriana) and characterization of their changes in morphology and resistance to downy mildew. HortScience 53:925-931; doi:10.21273/HORTSCI13093-18.

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3. Publications in Conference Proceeding/Journal Publications (34)

Deng, Z. W. Castle, G. Vallad, S. Agehara, M. Thetford, and J.C. Diaz-Perez. 2018. Pomegranate: An emerging fruit crop in southeast United States. Acta Horticulturae (in press).

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Zhang, W.C., S. Xiao, J. Luo, **Z. Deng**, X.X. Deng, and F. Wang. 1988. Investigation and utilization of citrus varietal resources in China. Proceedings of the Sixth International Citrus Congress, Tel Aviv, Israel. pp. 291-294.

PRESENTATIONS at professional conferences

	Invited	**Contributed/selected**	**Total**
International	5	48	53
National	4	24	28
Regional and state	32	34	66
Local	23	8	31
Others	7		7
Total	71	114	185

EXTERNAL GRANTS & CONTRACTS (2003-2018)

	Deng's Share	**From USDA programs (Deng's share)**
As principal investigator	$3,237,954	$369,611
As co-principal investigator	$2,690,490	$1,941,412
Total	$5,928,444	$2,311,023

MEMBERSHIP AND ACTIVITIES with ASHS

- ASHS member since 2003.
- Served as chair of three ASHS working groups (Invasive Plant Research 2012-2013; Ornamental Plant Breeding – 2010-2011; Asian Horticulture 2007-2008).
- Served as committee member of two ASHS committees (Cross-Commodity Publication Award 2013-2016; Outstanding International Horticulturist Award 2012-2015).
- Organized two workshops at ASHS annual conferences (2008, 2011).
- Moderated three ASHS workshop (2008, 2011, 2014).

- Attended ASHS annual meetings and made more than 43 presentations at ASHS annual meetings.
- Published 50 papers in three ASHS journals.
- Reviewed more than 50 manuscripts for three ASHS journals.

INTERNATIONAL ACTIVITIES

- Awarded the Ding Ying Guest Professorship by the South China Agricultural University.
- Served on the editorial boards for international/foreign journals.
- Organized and chaired one workshop at the 29th International Horticultural Congress.
- Organized and chaired workshops at the International Conference on Plant and Animal Genomes.
- Invited to give 21 talks/lectures to international researchers, professors, graduate students, and growers at six foreign institutes.
- Advise and supervise two international visiting graduate students and seven international visiting scholars.
- Invited to review manuscripts for 15 international journals.
- Collaborated with five international scholars from four countries.
- Invited to give presentations at seven international conferences.
- Participated in and made 44 presentations at some 21 international conferences.

MANJUL DUTT, Ph.D.
Research Assistant Scientist
Citrus Research and Education Center
Horticultural Sciences Department
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EDUCATION

Orissa University of Agriculture and Technology	B.Sc.	01/06/1998	Agriculture
Mahatma Phule Agricultural University	M.Sc.	06/30/2001	Horticulture
University of Kentucky	M.S.	04/30/2005	Plant and Soil Science
University of Florida	Ph.D.	12/18/2006	Horticultural Sciences

PERSONAL STATEMENT

Dr. Manjul Dutt received his PhD degree in grapevine biotechnology from the University of Florida. In 2013, he was hired as a Research Assistant Scientist at the University of Florida. His position involves research responsibilities in Citrus Genetics and Biotechnology. The main emphasis of his research is on the development of strategies to combat Huanglongbing, a deadly phloem vectored disease of citrus. His current emphasis is on the development of rootstocks that can withstand this disease. His research is focused on the utilization of Systemic Acquired Resistance (SAR) to develop HLB tolerance. Dr. Dutt was the first to report on successful transgene mediated resistance to HLB in sweet oranges. He has also developed enriched citrus by overexpressing several R2R3 MYB genes affecting the anthocyanin biosynthesis pathway. Dr. Dutt emphasizes the development of genetically modified plants using intragenic technologies to produce a consumer acceptable product. In 2019, Dr Dutt was elected as a Fellow of the Indian Society for Horticultural Sciences for his contribution to citrus improvement.

POSITIONS AND EMPLOYMENT

2013 to present	Research Assistant Scientist	Citrus Research and Education Center, UF
2013 to 2016	Adjunct Professor of Biology	Polk State College, Winter Haven, Florida
2007-2013	Post-Doctoral Scholar	Citrus Research and Education Center, UF
2003-2006	Research Assistant	Department of Horticultural Sciences, UF
2003	Editorial Assistant	New Crops Opportunities Center, University of Kentucky
2001- 2003	Research Assistant	Department of Horticulture, University of Kentucky
2000-2001	Trainee - Horticulture Information	Chordia Technologies (I) Pvt. Ltd., Pune, India

OTHER EXPERIENCE AND PROFESSIONAL MEMBERSHIPS

American Association for the Advancement of Science
American Society for Horticultural Science
The American Pomological Society
National Association of Plant Breeders
Indian Society for Horticultural Sciences

COMMITTEE MEMBERSHIPS

Chair, ASHS Plant Biotechnology working group 2014-2015
Secretary, ASHS Tropical Horticultural Crops working group 2013-2015
Secretary, ASHS Citrus working group 2017-18
Chair, ASHS Citrus working group 2018-19
Chair, ASHS Association of Horticulturists from Indian Subcontinent 2019-2020.
Member, Graduate Student Advisory committee, ASHS, 2017-2020.
Member, ASHS Collegiate Activities Committee 2019- 2023.

SELECTED PUBLICATIONS (Last 4 years)

1. Liu, Z., X. X. Ge, W. Qiu, J. M. Long, H. H. Jia, W. Yang, M. Dutt, X. M. Wu and W Guo. 2018. Overexpression of a B3 transcription factor *CsFUS3* promotes somatic embryogenesis in Citrus. Plant Science 277: 121-131.

2. Dutt, M., L. Erpen, and J.W. Grosser, 2018. Genetic transformation of the 'W Murcott' tangor: comparison between different techniques. Scientia Horticulturae, *242:*90-94.

3. Hijaz, F., Y., Nehela, S. E., Jones, M., Dutt, J. W., Grosser, J. A., Manthey and N. Killiny. 2018. Metabolically engineered anthocyanin-producing lime provides additional nutritional value and antioxidant potential to juice. Plant Biotechnology Reports, 12(5):329-346.

4. Kaur, P., P. Gonzalez, M. Dutt, and E. Etxeberria. 2018. Identification of sieve elements and companion cell protoplasts by a combination of brightfield and fluorescence microscopy. Applications in Plant Sciences 6(9): e1179.

5. Erpen L, Tavano ECR, Harakava R, Dutt M, Grosser JW, Piedade SMS, Mendes BMJ, Mourao Filho FAA (2018) Isolation, characterization, and evaluation of three Citrus sinensis-derived constitutive gene promoters. Plant Cell Reports 37(8): 1113–1125.

6. Killiny N, Jones SE, Nehela Y, Hijaz F, Dutt M, Gmitter FG, Grosser JW (2018) All roads lead to Rome: Towards understanding different avenues of tolerance to huanglongbing in citrus cultivars. Plant Physiology and Biochemistry129:1-10.

7. Dutt M, Zambon FT, Erpen L, Soriano L, Grosser J. 2018. Embryo-specific expression of a visual reporter gene as a selection system for citrus transformation. PLOS ONE 13 (1):e0190413..pone.0190413

8. Erpen L, Devi HS, Grosser JW, Dutt M . 2018. Potential use of the DREB/ERF, MYB, NAC and WRKY transcription factors to improve abiotic and biotic stress in transgenic plants. Plant Cell, Tissue and Organ Culture 132 (1):1-25.

9. Dutt, M., L. Erpen, G. Ananthakrishnan, R.H. Brlansky, I. Maiti and J.W. Grosser. 2016. Comparative Expression Analysis of Five Caulimovirus Promoters in Citrus. Plant Cell Organ Tissue Culture 126:229–238.

10. Kandel, R, D.R. Bergey, M. Dutt, V. Sitther, Z.T. Li, D. J. Gray and S.A. Dhekney. 2016. Evaluation of a Grapevine-derived Reporter Gene System for Precision Breeding of Vitis. Plant Cell Organ Tissue Culture. 124:599–609.

11. Dutt, M., D. Stanton and J.W. Grosser. 2016. Ornacitrus: Development of Genetically Modified Anthocyanin Expressing Citrus with both Ornamental and Fresh Fruit Potential. Journal of the American Society for Horticultural Sciences 141:54-61.

12. Orbović, V., M. Ćalović, M. Dutt, J.W. Grosser and G. Barthe. 2015. Production and characterization of transgenic Citrus plants carrying p35 anti-apoptotic gene. Scientia Horticulturae 197:2003-211.

13. Dutt M., G. Barthe, M. Irey, J. Grosser. 2015. Transgenic Citrus Expressing an *Arabidopsis* NPR1 Gene Exhibit Enhanced Resistance against Huanglongbing (HLB; Citrus Greening). PLoS ONE 10(9): e0137134.

BOOK CHAPTERS (last 4 years)

1. Grosser, J., M. A. Germana, P. Aleza, P. Kaur, N. Wang and M. Dutt. 2019. Citrus Biotechnology. In: M. Talón, F. Gmitter and J.R. Marco Caruso (eds), The genus Citrus, Elsevier.
2. Dutt, M. 2019. Transgenic strategies for the management of greening disease (huanglongbing) in citrus. In: K.L. Chadha, S.K. Singh, J. Prakash and V.B. Patel (eds.) Shaping the future of Horticulture. Kruger Brentt publishers, pp. 23-33.
3. Omar, A., M. Dutt, F. Gmitter and J.W. Grosser. 2015. Somatic embryogenesis – Still a Relevant Technique in Citrus Improvement. In: M. A. Germana and M Lambardi (eds) In vitro plant embryogenesis in higher plants: Methods in Molecular Biology 1359:289-327.

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EDUCATION

B. A.	Rutgers - State University of New Jersey	English	1978
M. S.	Rutgers - State University of New Jersey	Horticulture	1981
Ph.D.	University of Florida	Horticulture	1985

POSITIONS HELD

Professor	University of Florida, IFAS, CREC	1997- now
Associate Professor	University of Florida, IFAS, CREC	1991-1997
Assistant Professor	University of Florida, IFAS	1985-1991
Graduate Assistant	University of Florida, IFAS	1982-1985
Research Assistant	Rutgers - State University of New Jersey	1979-1981

APPOINTMENT
Research 0.95 FTE; Teaching 0.05 FTE

DEPARTMENTAL AFFILIATION
Horticultural Sciences
Plant Molecular and Cellular Biology (PMCB)

HONORS AND AWARDS
University of Florida Research Foundation Professor; 2011-2014.
Florida Fruit and Vegetable Association Researcher of the Year; 2011.

BRIEF DESCRIPTION OF JOB DUTIES

The goal of this position is to provide leadership and expertise for a research program devoted first to the development of new citrus rootstock and scion cultivars for the Florida citrus industry. Classical and contemporary genetic approaches are utilized as appropriate for specific research objectives. Basic breeding and genetic research objectives, along with applications of genomic science techniques, are pursued when information gained can contribute to increased efficiency in achievement of the breeding program objectives, or when the results can lead directly to cultivar improvements.

CULTIVAR PATENTS

Sugar Belle® 'LB8-9', mandarin hybrid. First commercial marketing, 2009; patent granted 2010.
Valquarius™ 'SF14W-62', sweet orange, 2010.

Valenfresh™ 'N7-3', sweet orange, 2010.
'UF 950', mandarin hybrid, 2013.
'UF 914', a grapefruit hybrid free of the compounds responsible for the "grapefruit juice effect", 2015.
'Bingo', mandarin hybrid that is very early maturing, completely seedless, and easy to peel, 2017.
'11-1-24', sweet orange, a low seeded, midseason sweet orange, 2017.

PUBLICATIONS

BOOK CHAPTERS (last 6 years)

Chen, C., A. R. Lo Piero, and F. Gmitter Jr. Pigments in citrus. In: Pigments in Fruits and Vegetables; Genomics and Dietetics. Chen, C. (Ed.). Springer, New York. 2015, pp. 165-187.

Omar, A. A., Dutt, M., Gmitter, F. G., and Grosser, J. W. Somatic embryogenesis: still a relevant technique in citrus improvement. In: In Vitro Embryogenesis in Higher Plants, Methods in Molecular Biology. Germana, M. A. and Lambardi, M. (Eds.). Springer, New York. 2016, pp. 289-327.

REFEREED JOURNAL (last 6 years)

Aritua, V., Achor, D., Gmitter, F. G., Albrigo, G., **Wang, N.** Transcriptional and microscopic analyses of citrus stem and root responses to *Candidatus* Liberibacter asiaticus infection. PLoS ONE, 2013, 8(9): e73742, DOI: 10.1371/journal.pone.0073742.

Cancalon, P.F. and **Gmitter Jr., F.G.** New grapefruit and pummelo cultivars with very low furanocoumarin contents are good candidates to provide a solution to the drug interaction problem. Fruit Processing, 2013, 23:126-129.

Chen, C. and Gmitter Jr., F. G. Mining of haplotype-based expressed sequence tag single nucleotide polymorphisms in citrus. BMC Genomics, 2013, 14:746. DOI:10.1186/1471-2164-14-746.

Fan, J., Chen, C., Achor, D.S., Brlansky, R.H., Li, Z-G., and **Gmitter Jr., F.G**. Differential anatomical responses of tolerant and susceptible citrus species to the infection of '*Candidatus* Liberibacter asiaticus'. Physiological and Molecular Plant Pathology, 2013, 83:69-74.DOI:10.1016/j.pmpp.2013.05.002

Germana, M. A., Aleza, P., Carrera, E., Chen, C., Chiancone, B., Constantino, G., Dambier, D., Deng, X., Federici, C. T., Froehlicher, Y., Guo, W., Ibanez, V., Juarez, J., Kwok, K., Luro, F., Machado, M. A., Naranjo, M., A., Navarro, L., Ollitrault, P., Rios, G., Roose, M. L., Talon, M., Xu, Q., and **Gmitter, F. G.** Cytological and molecular characterization of three gametoclones of *Citrus clementina*. BMC Plant Biology, 2013, 13:129. DOI:10.1186/1471-2229-13-129.

Shen, X., Orbovic, V., Dutt, M., Castle, W. S., and Gmitter Jr., F. G. Direct shoot organogenesis in *Murraya paniculata* (L.) Jack: A prerequisite for genetic transformation. HortScience, 2013, 48:938-941.

Chen, C., Bock, C. H., Okie, W. R., Gmitter Jr., F. G., Jung, S., Main, D., Beckman, T. G., and Wood, B. W. Genome-wide characterization and selection of expressed sequence tag simple sequence repeat primers for optimized marker distribution and reliability in peach. Tree Genetics and Genomes, 2014, 10.1007/s11295-014-0759-4.

Favaro, M. A., Micheloud, N. G., Roeschlin, R. A., Chiesa, M. A., Castagnaro, A. P., Vojnov, A. A., Gmitter Jr., F. G., Gadea, J., Rista, L. M., Gariglio, N. F., and **Marano, M. R.** Surface barriers of mandarin cv. 'Okitsu' leaves make a major contribution to canker disease resistance. Phytopathology, 2014, 104:970-976.http://dx.doi.org/10.1094/PHYTO-10-13-0277-R.

Wei, X., Chen, C., Yu, Q., Gady, A., Yu, Y., Liang, G., and Gmitter Jr., F. G. Novel expression patterns of carotenoid pathway-related genes in citrus leaves and fruits. Tree Genetics and Genomes, 2014, 10:439-448. 10.1007/s11295-013-0688-7.

Wei, X., Chen, C., Yu, Q., Gady, A., Yu, Y., Liang, G., and **Gmitter Jr., F. G.** Comparison of carotenoid accumulation and biosynthetic gene expression between Valencia and Rohde Red Valencia sweet oranges. Plant Science, 2014, 227:28-36. DOI: 10.1016/j.plantsci.2014.06.016.

Wu, G. A., Prochnik, S., Jemkins, J., Salse, J., Hellsten, U., Murat, F., Perrier, X., Ruiz, M., Scalabrin, S., Terol, J., Takita, M.A., Labadie, K., Poulain, J., Jabbari, K., Cattonaro, F., Del Fabbro, C., Pinosio, S., Zuccolo, A., Chapman, J., Grimwood, J., Tadeo, F. R., Estornell, L. H., Muñoz-Sanoz, J. V., Ibanez, V., Herrero-Ortega, A., Aleza, P., Pérez-Pérez J., Ramón, D., Brunel, D., Luro, F., Chen, C., Farmerie, W. G., Desany, B., Kodira, C., Mohiuddin, M., Harkins, T., Fredrikson, K., Burns, P., Lomsadze, A., Borodovsky, M., Reforgiato, G., Freitas-Astúa, J., Quetier, F., Navarro, L., Roose, M., Wincker, P., Schmutz, J., Morgante, M., Machado, M. A., Talon, M., Jaillon, O., Ollitrault, P., **Gmitter, F., and Rokhsar, D.** Sequencing of diverse mandarin, pummelo and orange genomes reveals complex history of admixture during citrus domestication. Nature Biotechnology, 2014, 32:656-662. doi:10.1038/nbt.2906.

Chen, C., Yu, Q., Wei, X., Cancalon, P. F., and **Gmitter Jr., F. G.** Identification of genes associated with low furanocoumarin content in grapefruit. Genome, 2015, 10:537-545. 1139/gen-2014-0164.

de Paula Santos Martins, C., Pedrosa, A. M., Du, D., Goncalves, L. P., Yu, Q., **Gmitter Jr., F. G.**, and **Costa, M. G. C.** Genome-wide characterization and expression analysis of major intrinsic proteins during abiotic and biotic stresses in sweet orange (*Citrus sinensis* L. Osb.). PLoS ONE, 2015, 10(9): e0138786. doi:10.1371/journal.pone.0138786.

Du, D., Rawat, N., Deng, Z., and **Gmitter Jr., F. G.** Construction of citrus gene coexpression networks from microarray data using random matrix theory. Horticulture Research, 2015, 2. doi:10.1038/hortres.2015.26.

Rawat, N., Kiran, S. P., Du, D., Gmitter Jr., F. G., and **Deng, Z.** Comprehensive meta-analysis, co-expression, and miRNA nested network analysis identifies gene candidates in citrus against Huanglongbing disease. BMC Plant Biology, 2015, DOI 10.1186/s12870-015-0568-4.

Satpute, A. D., Chen, C., Gmitter Jr., F. G., Ling, P., Yu, Q., Grosser, M. R., and **Grosser, J. W.** Cybridization of grapefruit with 'Dancy' mandarin leads to improved fruit characteristics. J. Amer. Soc. Hort. Sci., 2015, 140:427-435.

Yu, Q., Plotto, A., Baldwin, E. A., Bai, J., Huang, M., Yu, Y., Dhaliwal, H. S., and **Gmitter, F. G.** Proteomic and metabolomic analyses provide insight into production of volatile and non-volatile flavor components in mandarin hybrid fruit. BMC Plant Biology, 2015, 15:76. doi:10.1186.s12870-015-0466-9.

Chen, X., **Gao, Z.**, House, L., Ge, J., Zong, C. and Gmitter, F. Opportunities for western food products in China: the case of orange juice demand. Agribusiness, 2016, DOI: 10.1002/agr.21453.

Yu, Y., Chen, C., and **Gmitter Jr., F. G.** QTL mapping of mandarin (*Citrus reticulata*) fruit characters using high-throughput SNP markers. Tree Genetics and Genomes, 2016, 12:77, DOI 10.1007/s11295-016-1034-7.

Stover, E. W., Kahn, T., Roose, M., Siebert, T., Vidalakis, G., Krueger, R., Gmitter, F., and Grosser, J. Citrus. In: Register of New Fruit and Nut Cultivars List 48. Eds: Gasic, K, Preece, J. E., and Karp, D., HortScience, 2016, 51:620-652.

Ferrarezi, R. S., Wright, A. L., Bowman, B. J., Schumann, A. W., Gmitter, F. G., and Grosser, J. W. Protected fresh grapefruit cultivation systems: Antipsyllid screen effects on plant growth and leaf transpiration, vapor pressure deficit, and nutrition. HortTechnology, 2017, 27:666-674 doi:10.21273/HORTTECH03789-17.

Ferrarezi, R. S., Wright, A. L., Bowman, B. J., Schumann, A. W., Gmitter, F. G., and Grosser, J. W. Protected fresh grapefruit cultivation systems: Antipsyllid screen effects on environmental variables inside closures. HortTechnology, 2017; 27:675-681 doi:10.21273/HORTTECH03790-17.

Huang, M., Valim, M. F., Feng, S., Reuss, L., Yao, L., Gmitter, F., and **Wang, Y.** Characterization of the major aroma-active compounds in peel oil of an HLB-tolerant mandarin hybrid using aroma extraction dilution analysis and gas chromatography-mass spectrometry/olfactometry. Chemosensory Perception, 2017, doi 10.1007/s12078-017-9221-y.

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Killiny, N., Valim, M. F., Jones, S. E., Omar, A. A., Hijaz, F., Gmitter Jr., F. G., and Grosser, J. W. Metabolically speaking: Possible reasons behind the tolerance of 'Sugar Belle' mandarin hybrid to huanglongbing. Plant Physiology and Biochemistry, 2017, 116:36-47, doi: 10.1016/j.plaphy.2017.05.001.

Omar, A. A., Murata, M., Yu, Q., Gmitter Jr., F. G., Chase, C. D., Graham, J. H. and **Grosser, J. W.** Production of three new grapefruit cybrids with potential for improved citrus canker resistance. In Vitro Cell. Dev. Biol.-Plant, 2017, doi: 10.1007/s11627-017-9816-7.

Rawat, N, Kumar, B., Albrecht, U., Du, D., Huang, M., Yu, Q., Zhang, Y., Duan, Y-P., Bowman, K.D., Gmitter Jr., F.G., and **Deng, Z.** Genome resequencing and transcriptome profiling reveal structural diversity and expression patterns of constitutive disease resistance (CDR) genes in Huanglongbing-tolerant *Poncirus trifoliata* and its hybrids. Horticulture Research 4, 2017, doi:10.1038/hortres.2017.64.

Roeschlin, R. A., Favaro, M. A., Chiesa, M. A., Alemano, S., Vojnov, A. A., Castagnao, A. P., Filippone, M. P., Gmitter Jr., F. G., Gadea, J. and **Marano, M. A.** Resistance to citrus canker induced by a variant of *Xanthomonas citri* ssp.*citri* is associated with a hypersensitive cell death response involving autophagy-associated vacuolar processes. Molecular Plant Pathology, 2017, 18:1267-1281. Doi: 10.1111/mpp.12489.

Wei, X., Hu, H., Tong, H., and **Gmitter Jr., F. G.** Profiles of gene family members related to carotenoid accumulation in Citrus genus. Journal of Plant Biology, 2017, 60:1-10. doi 10.1077/s12374-016-0902-x.

Yu, Q., Chen, C., Du, D., Huang, M., Yao, J., Yu, F., Brlansky, R. H., and **Gmitter Jr., F. G.** Reprogramming of a defense signaling pathway in rough lemon and sweet orange is a critical element of the early response to '*Candidatus* Liberibacter asiaticus'. Horticulture Research, 2017, 4; doi:10.1038/hortres.2017.63.

Yu, Y., Bai, J., Chen, C., Plotto, A., Baldwin, E. A., and **Gmitter, F. G.** Comparative analysis of juice volatiles in selected mandarins, mandarin relatives and other citrus genotypes. Journal of the Science of Food and Agriculture, 2017, doi 10.1002/jsfa.8563.

Yu, Y., Bai, J., Chen, C., Plotto, A., Baldwin, E. A., and **Gmitter Jr., F. G.** Identification of QTLs controlling aroma volatiles using a 'Fortune' x 'Murcott' (*Citrus reticulata*) population. BMC Genomics, 2017, 18:646, doi 10.1186/s12864-017-4043-5.

Chen, L., Li, W., Katin-Grazzini, L., Ding, J., Gu, X., Li, Y., Gu, T., Wang, R., Lin, X., Deng, Z., McAvoy, R. J., Gmitter, F. G., Deng, Z., Zhao, Y., and **Li, Y.** A method for the production and expedient screening of CRISPR/Cas9-mediated non-transgenic mutant plants. Horticulture Research, 2018, 5:13, doi 10.1038/s41438-018-0023-4.

Du, D., Du, X., Mattia, M. R., Wang, Y., Yu, Q., Huang, M., Yu, Y., Grosser, J. W., and **Gmitter Jr., F. G.** LTR retrotransposons from the *Citrus x clementina* genome: characterization and application. Tree Genetics and Genomes, 2018, 14:43, https://doi.org/10.1007/s11295-018-1257-x.

Feng, S., Suh, J. H., Gmitter, F. G., and **Wang, Y.** Differentiation between flavors of sweet orange (*Citrus sinensis*) and mandarin (*Citrus reticulata*). Journal of Agricultural and Food Chemistry, 2018, 66:203-211. doi: 10.1021/acs.jafc.7b04968.

Killiny, N., Jones, S., Nehela, Y., Hijaz, F., Dutt, M., Gmitter, F. G., and Grosser. J. W. All roads lead to Rome: Towards understanding different avenues of tolerance to huanglongbing in citrus cultivars. Plant Physiology and Biochemistry, 2018, 129:1-10. https://doi.org/10.1016/j.plaphy.2018.05.005.

Huang, M., Roose, M. L., Yu, Q., Du, D., Yu, Y., Deng, Z., Stover, E., **Gmitter Jr., F. G.** Construction of high-density genetic maps and detection of QTLs associated with Huanglongbing tolerance in citrus. Frontiers in Plant Science, 2018, https://doi.org/10.3389/fpls.2018.01694.

Suh, J. H., Niu, Y. S., Wang, Z., Gmitter, F. G., and **Wang, Y.** Metabolic analysis reveals altered long-chain fatty acid metabolism in the host by Huanglongbing disease. Journal of Agricultural and Food Chemistry, 2018, 66:1296-1304. doi: 10.1021/acs.jafc.7b05273.

Wang, Z., Yu, Q., Shen, W., El Mohtar, C. A., Zhao, X. and **Gmitter Jr., F. G.** Functional study of *CHS* gene family members in citrus revealed a novel *CHS* gene affecting the production of flavonoids. BMC Plant Biology, 2018, 18:189. https://doi.org/10.1186/s12870-018-1418-y.

Wei, X., Song, M., Chen, C., Tong, H., Liang, G., and **Gmitter Jr., F. G.** Juice volatile composition differences between Valencia orange and its mutant Rohde Red Valencia are associated with carotenoid profile differences. Food Chemistry, 2018, 245:223-232. https://doi.org/10.1016/j.foodchem.2017.10.066.

Wu, G. A., Terol, J., Ibanez, V., López-García, A., Pérez-Román, E., Borredá, C., Domingo, C., Tadeo, F. R., Carbonell-Caballero, J., Alonso, R., Curk, F., Du. D., Ollitrault, P., Roose, M. L., Dopazo, J., **Gmitter, F. G., Rokhsar, D. S,** and **Talon, M.** Genomics of the origin and evolution of *Citrus*. Nature, 2018, 554: 311–316. doi:10.1038/nature25447.

Yu, Y., Chen, C., Huang, M., Yu, Q., Du, D., Mattia, M. R., and **Gmitter Jr., F. G.** Genetic diversity and population structure analysis of citrus germplasm with single nucleotide polymorphism markers. Journal of the American Society for Horticultural Science, 2018, 143:399-408. https://doi.org/10.21273/JASHS04394-18.

Calovic, M., Yu, Q., Orbovic, V., Gmitter, F. G., Grosser J. W. and Chen, C. New somatic hybrid mandarin tetraploids generated by optimized protoplast fusion and confirmed by molecular marker analysis and flow cytometry. Journal of the American Society for Horticultural Science, 2019, 144:151-163. DOI: 10.21273/JASHS04563-18.

Deng, H., Achor, D., Etxeberria, E., Yu, Q., Du D., Stanton, D., Liang, G., and Gmitter, F. G. Phloem regeneration is a mechanism for Huanglongbing-tolerance of 'Bearss' lemon and 'LB8-9' Sugar Belle® mandarin. Frontiers in Plant Science, 2019. DOI: 10.3389/fpls.2019.00277.

Yao, L., Yu, Q., Huang, M., Hung, W., Grosser, J., Chen, S., Wang, Y., and **Gmitter Jr., F. G.** Proteomic and metabolomic analyses provide insight into the off-flavour of fruits from citrus trees infected with 'Candidatus Liberibacter asiaticus'. Horticulture Research, 2019. DOI: 10.1038/s41438-018-0109-z.

Yu, Q., Huang, M., Jia, H., Yu, Y., Plotto, A., Baldwin, E. A., Bai, J., Wang, N., and **Gmitter, F. G.** Deficiency of valencene in mandarin hybrids is associated with a deletion in the promoter region of the valencene synthase gene. BMC Plant Biology 19, 2019. DOI: 10.1186/s12870-019-1701-6.

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EDUCATION

1984	Ph.D.	Univ. Kentucky, Lexington, KY, Agronomy/Plant Breeding & Genetics
1979	M.S.	Morehead State University, Morehead, KY, Biology
1976	B.A.	Thomas More College, Fort Mitchell, KY, Biology

PROFESSSIONAL EXPERIENCE

2017	Term Professorship Award
2017	"Investments for the Future" Award, University of Bordeaux, France
2013	Elected ASHS Fellow
2009	2nd Step-Professorship, UF
2006-2008	University of Florida Research Foundation Professorship
2005	ASHS Outstanding Career Researcher Award
2002-Present	Step-Professorship, UF
2000-Present	Co-Director – Core Citrus Transformation Laboratory, CREC
1999	UF Provost Faculty Merit Award
1994-Present	Professor, University of Florida, IFAS, CREC
1989-1994	Associate Professor, University of Florida, IFAS, CREC
1984-1989	Assistant Professor, University of Florida, IFAS, CREC
1980-1984	Graduate Research Assistant, University of Kentucky, Dept. of Agronomy
1982-1983	Laboratory Instructor-Genetics, University of KY, College of Agriculture
1978-1980	Quality Control Technician, Kahn's Meat Packing Co., Cincinnati, Ohio
1976-1978	Graduate Research Assistant, Dept. of Biology, Morehead State University
1974-1975	Undergraduate Research Assistant, Thomas More College Biology Station

RESEARCH PROGRAM NARRATIVE

My research program in citrus variety improvement addresses all major citrus production problems in Florida, and also strives to develop new cultivars that will provide growers with new marketing opportunities. Using a team-oriented approach, my program is integrated with other members of the IFAS/CREC cultivar improvement team (F. G. Gmitter, W. S Castle, and G. A. Moore) as well as entomologists, pathologists, and physiologists. I have been a consistently productive full professor, as evidenced by a 'Superior' faculty evaluation every full year that I have been employed by UF (29 consecutive years). Our citrus **somatic hybridization** program is the most successful in the world, resulting in somatic hybrid plants from more than 200 parental combinations. Our successes in somatic hybridization have allowed us to initiate rootstock breeding and selection at the tetraploid level (a completely unique approach), resulting in the selection of more than 150 superior individual hybrids called **"tetrazygs"** to date. Progress has also been made towards the development of rootstocks with improved tolerance of *Diaprepes* root weevil, blight and salinity. More recently, my program has focused on breeding, screening, and field testing new rootstocks (diploid and tetraploid) with focus on development of rootstocks suitable for ACPS (Advanced Citrus Production Systems) and that impart

tolerance or resistance to HLB in grafted scions. Seventeen new UFR rootstocks from our program showing enhanced tolerance of HLB (as compared to commercial rootstocks) were recently fast-track released for use in the Florida Citrus Industry, including 7 tetraploids and 2 diploids developed in my program. Most recently, we have used a high throughput method to screen thousands of hybrid rootstock candidates for ability to impart HLB tolerance to grafted scions, and identified several promising candidates. Numerous tetraploid somatic hybrids that combine elite diploid scion material have been produced and several flowering somatic hybrids are being used as pollen parents in our triploid breeding program (under the direction of F. G. Gmitter). We have built the largest collection of quality monoembryonic diploid females and quality tetraploid pollen parents in the world. More than 20,000 triploid hybrids have been recovered from interploid crosses followed by embryo rescue, with a good percentage of these being fathered by somatic hybrids (in collaboration with FG Gmitter). Progress has also been made in the development of improved acid fruits (lemons and limes) and ornamental citrus; new seedless triploid lemon and lime selections have been approved for release. **Somatic cybridization** was used to create the recently released 'Summer Gold' grapefruit, that extends the grapefruit harvest season by several months, with fruit sweeter than any commercial grapefruit cultivar. This technology is also being used to transfer mtDNA potentially conferring canker resistance from kumquat to highly susceptible grapefruit cultivars. Because sweet oranges and grapefruit are not amenable to conventional breeding, my program has focused on the generation of **somaclonal variation** to produce new cultivars. We have the largest field study in the world to evaluate somaclonal variation in woody fruit trees. Several improved processing oranges have been released, including a Hamlin clone with improved juice color, seedless Valencia clones, Valencia clones with higher yields and lbs. solids production, the new very high quality OLL oranges that are showing better tolerance to HLB, and most recently two early-maturing Valencia clones that have potential to replace Hamlin in the juice industry. Working closely with research associate Dr. Manjul Dutt, we have developed an **alternative citrus transformation** method that utilizes a citrus anthocyanin gene for selection (replacing GFP) and plant recovery via somatic embryogenesis - resulting in transgenic plants containing no bacterial resistance genes (more consumer friendly). Major emphasis is now on the utilization of transgenic approaches to develop cultivars resistant to citrus greening (HLB) and canker. A major effort is underway to transfer proven anti-microbial peptide constructs and constructs that turn on SAR (Systemic Acquired Resistance) to citrus. Initial greenhouse and field challenges of transgenic citrus plants with HLB and canker look quite promising, and two SAR-induction genes are working successfully in multiple cultivars. Transgenic sweet orange trees overexpressing the Valencia β-1,3-glucanase gene also look promising. Our program is now focusing on the development of all-edible plant gene and eventually all-citrus gene transformation in efforts to increase consumer acceptance of GMO citrus.

PUBLICATIONS LAST 5 YEARS

BOOKS CHAPTERS:

1. Germana, M.A., Aleza, P., Grosser, J.W., Dutt, M., and Wang, N. Citrus Biotechnology. In: (M. Talon and FG Gmitter, Eds.). In: The Genus Citrus. Elsevier, Cambridge MA. (in press).
2. Ollitrault, P., Germanà, M.A., Froelicher, Y. Cuenca, J., Aleza, P. Morillon, R., Grosser, J.W. and Guo, W.W. Ploidy manipulation for citrus breeding, genetics and genomics. In: (A. Gentile, Ed.) The Citrus Genome. Springer-Nature. (in press).
3. Forner-Giner, M.A., Continella, A., and Grosser, JW. Citrus Rootstock Breeding and Selection. In: (A. Gentile, Ed.) The Citrus Genome. Springer-Nature. (in press).

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1. Stover, E., D. Hall, G.A. Moore and J.W. Grosser. "HLB-Related Responses of Valencia Orange on Eight Citrus Rootstocks in Greenhouse Trials". Hort-Technology (in press).
2. Mayara, M., A. Omar, C.D. Chase, Z. Mou, J.W. Grosser and J.H. Graham. 2019. Novel Plastid-Nuclear Genome Combinations Enhance Resistance to Citrus Canker in Cybrid Grapefruit. Frontiers in Plant Science (Section: Plant Microbe Interactions). Front. Plant Sci., 07 January 2019 https://doi.org/10.3389/fpls.2018.01858
3. Calović, M., Q. Yu, V. Orbović, F.G. Gmitter Jr.and J.W. Grosser. 2019. New Somatic Hybrid Mandarin Tetraploids Generated By Optimized Protoplast Fusion and Confirmed by Molecular Marker Analysis and Flow Cytometry. JASHS (in press)
4. Zambon, F.T., D. M. Kadampakeni and J.W. Grosser. 2019. Ground Application Overdoses of Manganese Show a Therapeutic Effect in Sweet Orange Trees Infected With Candidatus Liberibacter asiaticus. HortScience 54(6), 1077-1086. https://doi.org/10.21273/HORTSCI13635-18
5. Dutt, M., L. Erpen, and J.W. Grosser, 2018. Genetic transformation of the 'W Murcott' tangor: comparison between different techniques. Scientia Horticulturae, 242:90-94.
6. Hijaz, F., Y., Nehela, S. E., Jones, M., Dutt, J. W., Grosser, J. A., Manthey and N. Killiny. 2018. Metabolically engineered anthocyanin-producing lime provides additional nutritional value and antioxidant potential to juice. Plant Biotechnology Reports, 12(5), 329-346.
7. Erpen L, Tavano ECR, Harakava R, Dutt M, Grosser JW, Piedade SMS, Mendes BMJ, Mourao Filho FAA (2018) Isolation, characterization, and evaluation of three Citrus sinensis-derived constitutive gene promoters. Plant Cell Reports. doi:10.1007/s00299-018-2298-1
8. Dutt M, Zambon FT, Erpen L, Soriano L, Grosser J. 2018. Embryo-specific expression of a visual reporter gene as a selection system for citrus transformation. PLOS ONE 13 (1):e0190413.pone.0190413
9. Erpen L, Devi HS, Grosser JW, Dutt M. 2018. Potential use of the DREB/ERF, MYB, NAC and WRKY transcription factors to improve abiotic and biotic stress in transgenic plants. Plant Cell, Tissue and Organ Culture 132 (1):1-25.
10. Donglang, D., X. Du,Y. Qibin, M. Mattia, M. Huang, Y Yu, JW Grosser and FG Gmitter. 2018. LTR retrotransposons from the Citrus x clementina genome characterization and application. Tree Genetics and Genomes 14: 43 https://doi.org/10.1007/s11295-018-1257-x
11. Omar, A. A., Murata, M. M., El-Shamy, H. A., Graham, J. H., & Grosser, J. W. (2018). Enhanced resistance to citrus canker in transgenic mandarin expressing Xa21 from rice. Transgenic Research, 27, 179-191.
12. Dutt, M., L. Erpen, and J.W. Grosser, 2018. Genetic transformation of the 'W Murcott' tangor: comparison between different techniques. Scientia Horticulturae, 242:90-94.
13. Kiliny, N, SE Jones, Y Nehela, F. Hijza, M. Dutt, FG Gmitter and JW Grosser. 2018. All roads lead to Rome: Towards understanding different avenues of tolerance to huanglongbing in citrus cultivars. Plant Physiology and Biochemistry 18;129:1-10. doi: 10.1016/j.plaphy.2018.05.005.
14. Erpen, L., E.C.R. Tavano, R. Harakava, M. Dutt, J.W.Grosser, S.M.S. Piedale, B M J. Mendes and F.A.A. Mourae Filho. 2018. Isolation, characterization and evaluation of three Citrus sinensis-derived gene promoters. Plant Cell Reports. https://doi.org/10.1007/s00299-018-2298-1
15. Dutt M, Zambon FT, Erpen L, Soriano L, Grosser J. 2018. Embryo-specific expression of a visual reporter gene as a selection system for citrus transformation. PLOS ONE 13 (1):e0190413..pone.0190413

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17. Omar AA, Murata MM, Yu Q, Gmitter FG, Jr., Chase CD, Graham JH, Grosser JW (2017) Production of three new grapefruit cybrids with potential for improved citrus canker resistance. In Vitro Cellular & Developmental Biology - Plant 53:256-269.
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19. Ferrarezi, R.S., A.L. Wright, B.J. Boman, A.W. Schumann, F.G. Gmitter and J.W. Grosser. 2017. Protected Fresh Grapefruit Cultivation Systems: Antipsyllid Screen Effects on Environmental Variables inside Enclosures. HortTechnology 27(5): 675-681.
20. Ferrarezi, R.S., A.L. Wright, B.J. Boman, A.W. Schumann, F.G. Gmitter and J.W. Grosser. 2017. Protected Fresh Grapefruit Cultivation Systems: Antipsyllid Screen Effects on Plant Growth and Leaf Transpiration, Vapor Pressure Deficit, and Nutrition. HortTechnology 27(5): 668-674.
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22. Dutt, M., L. Erpen, G. Ananthakrishnan, R.H. Brlansky, I. Maiti and J.W. Grosser. 2016. Comparative Expression Analysis of Five Caulimovirus Promoters in Citrus. Plant Cell Organ Tissue Culture 126:229–238.
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24. Dutt, M. and J.W. Grosser. 2016. Intragenic Mediated Genetic Improvement of Citrus: What Have We Learnt? Acta Horticulturae 1135, 85-96.
25. Kandel, R., M. Dutt, J.W. Grosser, D.J. Gray, Z.T. Li, V. Sitther, D.R. Bergey and S.A Dhekney. 2016. Evaluation of plant-based reporter systems for improvement of cold-hardy grape cultivars. Acta Horticulturae 1115, 57-62.
26. Jie, K.D., Wang, H.Q., Wang, X.P., Liang, W.J., Xie, Z.Z., Yi, H.L., Deng, X.X., Grosser, J.W., and Guo, W.W. 2013. Extensive Citrus triploid breeding by crossing monoembryonic diploid females with allotetraploid male parents. Scientia Agricultura Sinica, 46(21):4550-4557.
27. Omar, A.A., Dutt, M. , Gmitter, F.G., and J.W. Grosser. Somatic Embryogenesis: Still a Relevant Technique in Citrus Improvement. Maria Antonietta Germanà and Maurizio Lambardi (eds.), In Vitro Embryogenesis in Higher Plants, Methods in Molecular Biology, vol. 1359, pp. 289-327, DOI 10.1007/978-1-4939-3061-6_13, © Springer. 2016.
28. Orbović V, Grosser JW. Citrus transformation using juvenile explants. Methods Mol. Biol. 1224:245-57. doi: 10.1007/978-1-4939-1658-0_20. 2015.
29. Zhang, Y., Barthe, G., J.W. Grosser and N. Wang. Transcriptome analysis of root response to a mysterious disease citrus blight based on the newly assembled Swingle citrumelo draft genome. Submitted to: Molecular Plant-Microbe Interactions.
30. Dutt, M., L. Erpen, G. Ananthakrishnan, R.H. Brlansky, I. Maiti and J.W. Grosser. 2016. Comparative Expression Analysis of Five Caulimovirus Promoters in Citrus. Submitted to: Plant Cell Organ Tissue Culture.
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32. Orbović, V., M. Ćalović, M. Dutt, J.W. Grosser and G. Barthe. 2015. Production and characterization of transgenic Citrus plants carrying p35 anti-apoptotic gene. Scientia Horticulturae. 197:203-211. http://dx.doi.org/10.1016/j.scienta.2015.09.038
33. Xie, Kai-Dong, Q.M. Xia, X.P. Wang, W.J. Liang, X.M. Wu, J.W. Grosser and W.W. Guo. 2015. Cytogenetic and SSR-marker evidence of mixed disomic, tetrasomic, and intermediate inheritance in a citrus allotetraploid somatic hybrid between 'Nova' tangelo and HB'pummelo. Tree Genetics & Genomes 11:112 DOI 10.1007/s11295-015-0940-4
34. Dutt M., G. Barthe, M. Irey, J. Grosser. 2015. Transgenic Citrus Expressing an Arabidopsis NPR1 Gene Exhibit Enhanced Resistance against Huanglongbing (HLB; Citrus Greening). PLoS ONE 10(9): e0137134. doi: 10.1371/journal.pone.0137134.
35. Satpute, A.D., Chen, C., Gmitter, F.G. Jr., Ling, P., Yu, Q., Grosser, M.R., Chase, C.D., and J.W. Grosser. 2015. Cybridization of grapefruit with 'Dancy' mandarin leads to improved fruit characteristics. J. Amer. Soc. Hort. Sci. 140(5):427–435.
36. Dutt, M., Dhekney S.A., Soriano L., Kandel R., Grosser J.W. 2014. Temporal and spatial control of gene expression in horticultural crops. Horticulture Research 1: 14047.
37. Grosser, J.W., D. Kainth and M. Dutt. 2014. Production of colchicine-induced autotetraploids in Pummelo (*Citrus grandis* Osbeck) through indirect organogenesis. HortScience. 49(7): 944-948.
38. Xu, S.X., Cai, D.F., Tan, F.Q., Fang, Y.N., Xie, K.D., J.W. Grosser and W.W Guo. 2014. Citrus somatic hybrid: an alternative system to study rapid structural and epigenetic reorganization in allotetraploid genomes. Plant Cell Tis Organ Cult. DOI 10.1007/s11240-014-0551-z
39. Xie, K.D., Want, X.P., Biswas, M., Liang, W.J., Xu, Q., J.W. Grosser and W.W. Guo. 2014. 2n megagametophyte formed via SDR contributes to tetraploidization in polyembryonic 'Nadorcott' tangor crossed by citrus allotetraploids. Plant Cell Rep. DOI 10.1007/s00299-014-1643-2
40. Zheng B-B, Fang Y-N, Pan Z-Y, Sun L, Deng X-X, Grosser JW, Guo W-W. 2014. iTRAQ-Based Quantitative Proteomics Analysis Revealed Alterations of Carbohydrate Metabolism Pathways and Mitochondrial Proteins in a Male Sterile Cybrid Pummelo. Journal of Proteome Research. 13:2998-3015

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1. Gmitter, FG, E Stover, R Driggers, G McCollum and JW Grosser. 2018. The Citrus Improvement Pipelines Continue to Provide Growers New Planting Options. Coming in July issue of Citrus Industry Magazine.
2. Ferrarezi, RS, JW Grosser, FG Gmitter, E Stover and KD Bowman. 2018. Field Testing of New HLB-Tolerant Scions and Rootstocks. Citrus Industry Magazine (June issue).
3. Gmitter, FG, Y. Zhang and J.W. Grosser. 2018. CRISPR, Genome Editing, and Gene Discovery: What Will This Mean for Florida Citrus? Citrus Industry Magazine, 99:12-15.
4. Grosser, J.W. and F.G. Gmitter. 2017. New planting options feature improved varieties. Citrus Industry Magazine, February 2016. Vol. 97, No. 2.
5. Spyke,P, J. Sherrod and J.W. Grosser. Controlled Release Fertilizer (CRF) Boosts Health of HLB Trees- Part 1. Citrus Industry Magazine, April 2017. Vol. 98, No. 4
6. Spyke,P, J. Sherrod and J.W. Grosser. Controlled Release Fertilizer (CRF) Boosts Health of HLB Trees – Part 2: Case Studies. Citrus Industry Magazine, May 2017. Vol. 98, No. 5

7. Dutt, M. and J.W. Grosser. Engineering HLB Tolerant/Resistant Citrus – Progress on Several Fronts. Citrus Industry Magazine, November 2017. Vol. 98, No. 11.
8. Dutt, M., E. Nielsen and J.W. Grosser. Finger lime could be new crop for citrus growers. January 2017. Vol. 98, No. 1.
9. Grosser, J.W. and F.G. Gmitter. Time to get serious about trialing new scion/rootstock combinations. August 2017. Vol. 98, No. 8.
10. Grosser, J.W. The Resilient Citrus Industry is Not Going Away. OP-ED Piece published in the Lakeland Ledger, Nov.24th, 2017.
11. Grosser, J.W. and F.G. Gmitter. 2016. New planting options feature improved varieties. By Jude Grosser and Fred Gmitter. Citrus Industry, February 2016, Volume 97 (2), Pages 14-16.
12. Grosser, J.W., Z. Viloria and M. Dutt. 2015. New acid citrus selections for Florida. Citrus Industry Magazine. 96-7: pp. 30-33.
13. Dutt, M. and J.W. Grosser. 2015. Using genetically modified biotechnology to improve citrus. Citrus Industry Magazine. 96-9: pp. 10-13.
14. Grosser, J.W., Gmitter, F.G., and W.S. Castle. 2015. New Sweet Orange cultivars for the Florida Citrus Industry from UF/IFAS/CREC. Citrus Industry Magazine. 96-3:pp.10-18.
15. Johnson, E., J.W. Grosser and J.H. Grosser. 2015. Rootstocks and HLB – What's happening below ground? 96-10: pp. 8-9.
16. Hu, C., F.G. Gmitter, J.W. Grosser and M. Ritenour. Evaluation of postharvest quality of six recently released Citrus cultivars in Florida. Proceedings of FSHS 2015. In Press [HP-15]

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EDUCATION

Huazhong Agricultural University	M.S	07/1998	Horticulture
University of Georgia	Ph.D.	11/2008	Horticulture
University of California-Davis	Postdoc	11/2013	Plant Science

PERSONAL STATEMENT

I have been trained in tissue culture, genetics, genomics and molecular biology for more than 15 years, with specific training and expertise in genome editing, genomics and genetic mapping. The research focuses in my lab include 1) development of Begonia with enhanced heat tolerance and improved insect resistance 2) development of snapdragons with improved anthocyanin synthesis. I have developed strong leadership skills in supervising and mentoring lab personnel and project progresses, and have demonstrated the ability of successfully administering the projects (e.g. recruiting and training research personnel and managing budget), and the skills of managing multiple tasks simultaneously. My strong research expertise and lab management skills made it possible to publish my data in high impact journals like *PNAS*, *PLANT CELL*, *PLANT JOURNAL* and *PLANT PHYSIOLOGY*.

PROFESSIONAL EMPLOYMENT

1998-2003	Assistant Research Scientist, Guangdong Pomology Institute, China
2003-2008	Graduate Research Assistant, University of Georgia, Athens, GA
2009-2013	Postdoctoral Researcher, University of California-Davis, CA
2013-2016	Associate Specialist, University of California-Davis, CA
2017.2-present	Assistant Professor, University of Florida

PROFESSIONAL MEMBERSHIPS

2007-	Member, American Society of Plant Biologist
2017-	Member, American Society for Horticultural Science
2017-	Member, Florida Nursery, Growers and Landscaping Association
2017-	Member, Society of In Vitro Biology
2017-	Ad hoc Reviewer, United States Department of Agriculture (USDA) Grant Proposals

HONORS

2007	Outstanding Research Poster Award Plant Center Retreat, UGA.
2003-2008	Graduate Research Assistantship at University of Georgia.

EDITORIAL SERVICE

Ad hoc reviewer for more than 20 journals including Plant Physiology, Plant Journal, Journal of Experimental Botany etc.

ONGOING RESEARCH SUPPORT

FL DEPT OF AG AND CONSUMER SER Huo (PI) 1/1/2019-12/31/2020
Development of Hop Cultivars and Their Production Management System for Florida Growers

USDA/NIFA Huo (PI) 2/28/2019-02/27/2023
Genetic and Molecular Dissection of a Shared microRNA Regulatory Complex for Seed Germination and Flowering in Lettuce under High Temperature

SELECTED PEER-REVIEWED RELEVANT PUBLICATIONS

(Selected from 35 peer-reviewed publications and reviews)

- Wei M, Zhuang Y, Li H, Li PH, Shu D, Huo HQ, Huang WZ, Wang SH, The cloning and characterization of Hypersensitive to Salt Stress (HSS) gene highlights the involvement of NAD in stress-induced accumulation of ABA and proline, **The Plant Journal** (in press)
- Lin MF, Xiang DY, Chen XY and Huo HQ (**2019**) Role of Characteristic Components of Humulus lupulus in Promoting Human Health, **Journal of Agricultural and Food Chemistry**, 30:8291
- Pu X, Liu L, Li P, Huo H, Dong X, Xie K, Yang H, Liu L (**2019**) A CRISPR/LbCas12a-based method for highly efficient multiplex gene editing in Physcomitrella patens, **The Plant Journal** (doi.org/10.1111/tpj.14478)
- Shao X, Wu S, Dou T, Zhu H, Hu C, Huo HQ et al (**2019**), Using CRISPR/Cas9 genome editing system to create MaGA20ox2 gene modified semi-dwarf banana, **Plant Biotechnology Journal** (doi.org/10.1111/pbi.13216)
- Dou TX, Shao XH, Hu CH, Liu SW, Sheng O, Bi FS, Deng GM, Ding LJ, Li CY, Dong T, Gao HJ, He WD, Peng XX, Zhang S, Huo HQ, Yang QS, Yi GJ (**2019**) Host-induced gene silencing of Foc TR4 ERG6/11 genes exhibits superior resistance to Fusarium wilt of banana, **Plant Biotechnology Journal** (doi.org/10.1111/pbi.13204)
- Zhu YX, Yin JL, Liang YF, Liu JQ, Jia JH, Huo HQ, Wu ZF, Yang RL, Gong HJ (**2019**) Transcriptomic dynamics provide an insight into the mechanism for silicon-mediated alleviation of salt stress in cucumber plants, **Ecotoxicology and Environmental Safety**, 174:245-254
- Zhao DD, Wang X, Chen JC, Huang ZF, Huo HQ, Jiang CL, Huang HJ, Zhang CX, Wei SH (**2019**) Selection of reference genes for qPCR normalization in buffalobur (Solanum rostratum Dunal), **Scientific Reports**, 9:6948
- He JF, Li P, Huo HQ, Liu LN, Tang T, He MX, Huang JH, Liu L (**2019**) Heterologous expression of HpBHY and CrBKT increases heat tolerance in Physcomitrella patens. **Plant Diversity**
- Sun MT, Jiang FL, Cen BJ, Huo HQ, Wu Z (**2019**) Antioxidant enzymes act as indicators predicting intension of acquired and maintenance of acquired thermotolerance and the relationships between basal, acquired and maintenance of acquired thermotolerance of tomato. **Scientia Horticulturae** 247, 130-137
- Yin JL, Jia JH, Lian ZY, Hu YH, Guo J, Huo HQ, Zhu YX, Gong HJ (**2019**), Silicon enhances the salt tolerance of cucumber through increasing polyamine accumulation and decreasing oxidative damage. **Ecotoxicology and Environmental Safety**, 169:8-17

- Li P, Yang H, Wang L, Liu HJ, Huo HQ, Zhang CJ, Liu AZ, Zhu AD, Hu JY, Lin YJ, Liu L (**2019**), Physiological and transcriptome analyses reveal short-term responses and formation of memory under drought stress in rice. **Frontiers in Genetics**, 10
- Zhang X, Huo HQ, Sun XH, Zhu J, Dai HY, Zhang YG (**2019**) Nanocrystallization of Anthocyanin Extract from Red-Fleshed Apple' QN-5' Improved Its Antioxidant Effect through Enhanced Stability and Activity under Stressful Conditions. **Molecules** 24 (7), 1421
- Li P, Yang H, Liu GJ, Ma WZ, Li CH, Huo HQ, He JF, Liu L (**2018**), PpSARK regulates moss senescence and salt tolerance through ABA related pathway. **International Journal of Molecular Sciences** 19 (9), 2609
- Sun H, Duan YK, Qi XC, Zhang LY, Huo HQ and Gong HJ (**2018**), Isolation and functional characterization of *CsLsi2*, a silicon efflux transporter gene. **Annals of Botany**, 122: 641-648.
- Li P, Yang H, Liu GJ, Ma WZ, Li CH, Huo HQ, He JF, Liu L (**2018**) PpSARK Regulates Moss Senescence and Salt Tolerance through ABA Related Pathway. **International Journal of Molecular Sciences** 19(9): 2609
- Zuo CW, Deng GM, Li B, Huo HQ, Li CY, Hu CH, Kuang RB, Yang QS, Dong T, Sheng O, Yi GJ (**2018**) Germplasm screening of Musa spp. for resistance to *Fusarium oxysporum* f. sp. *cubense* tropical race 4 (Foc TR4). **European Journal of Plant Pathology** 151:723–734
- Bertier LD, Ron M, Huo HQ, Bradford KJ, Michelmore RW, High resolution analysis of the efficiency, heritability and editing outcomes of CRISPR/CAS9-induced modifications of *NCED4* in lettuce (*Lactuca sativa*) (**2018**) **G3: Genes, Genomics, Genetics** 8(5):1513-1521
- Xiang Y, Lai F, He G, Li Y, Yang L, Shen W, Huo HQ et al. (**2017**) Alleviation of Rosup-induced oxidative stress in porcine granulosa cells by anthocyanins from red-fleshed apples. **PLoS ONE** 12(8): e0184033.
- Végh A, Incze N, Fábián A, Huo HQ, Bradford KJ, Balázs E and Soós V (**2017**) Comprehensive Analysis of DWARF14-LIKE2 (DLK2) Reveals Its Functional Divergence from Strigolactone-Related Paralogs. **Frontiers in Plant Science**. 8:1641.
- Sun H, Guo J, Duan Y, Zhang T, Huo HQ and Gong H (**2017**), Isolation and functional characterization of *CsLsi1*, a silicon transporter gene in *Cucumis sativus*. **Physiol Plantarum**, 159: 201–214.
- Li J, Hu X, Huang X, Huo HQ, Li J, Zhang D, Li P, Ouyang K and Chen X (**2017**) Functional identification of an EXPA gene (NcEXPA8) isolated from the tree Neolamarckia cadamba, **Biotechnology & Biotechnological Equipment**, DOI: 10.1080/13102818.2017.1362960
- Li J, Hu X, Huang X, Huo HQ, Li J, Zhang D, Li P, Ouyang K and Chen X (**2017**) Functional identification of an EXPA gene (NcEXPA8) isolated from the tree Neolamarckia cadamba, **Biotechnology & Biotechnological Equipment**, DOI: 10.1080/13102818.2017.1362960

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  Recommended by Faculty 1000
- Huo HQ, Dahal P, Kunusoth K, Claire M, Bradford KJ. (2013), Expression of 9-cis-EPOXYCAROTENOID DIOXYGENASE4 is essential for thermoinhibition of lettuce seed germination, but not for seed development or stress tolerance, **The Plant Cell**, 25:884-900
- Huo HQ, Henry I., Coppoolse E, Comai L., Bradford, KJ.(2016) Bulk segregant whole genome sequencing in parallel to identify EMS mutations in lettuce, **The Plant Journal**, 88(3): 345-360.
  Featured by Editor-in-Chief

- Conner JA, Mookkana MA, Huo HQ, Chaea K, Ozias-Akins P, (2015) Parthenogenesis gene of apomict origin elicits embryo formation from unfertilized eggs in a sexual plant. **PNAS**, 112(36): 11205
- Huo HQ, Bradford KJ (2015), Molecular and Hormonal Regulation of Thermoinhibition of Seed Germination, **Advances in Plant Dormancy**, pp3-33.
- Kong LQ, Huo HQ, Mao PS, (2015) Antioxidant response and related gene expression in aged oat seed. **Frontiers in Plant Science**, 6: 158
- Yoong FY, O'Brien LK, Truco MJ, Huo HQ, Sideman R, Hayes R, Michelmore RW, Bradford KJ**,** (2016), Genetic variation for lettuce seed germination thermotolerance is associated with temperature- sensitive regulation of *ETHYLENE RESPONSE FACTOR1* (*ERF1*), **Plant Physiology**, 170(1):472
- Huo HQ, Conner JA, Ozias-Akins P, (2009) Genetic mapping of apomixis in *Pennisetum squamulatum* using retrotransposon-based markers. **Theor Appl Genet** 119:199–212
- Huo HQ, Deng XX (1999) Utilization and conservation of embryogenic calluses of citrus. **Plant Physiology Communication**, 36:181-187
- Huo HQ, Hao YJ, Deng XX (2000) Introduction of embryogenic calluses of Mandarin citrus. **Acta Biologiae Experimentals Sinica**, 32(3) 289-295

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EDUCATION

Ph.D. 2008	**University of Florida**, Horticulture
M.S. 2004	**University of Minnesota**, Agronomy
B.S. 2000	**Mississippi State University**, Agronomy

PROFESSIONAL EXPERIENCE

2018 – present	Associate Professor, Horticultural Sciences Department, Gulf Coast Research and Education Center, University of Florida
2010 – 2018	Assistant Professor, Horticultural Sciences Department, Gulf Coast Research and Education Center, University of Florida
2008 – 2010	Postdoctoral Research Scientist, Horticultural Sciences Department, Gulf Coast Research and Education Center, University of Florida
2004 – 2008	Doctoral Dissertation, Horticultural Sciences Department, Gulf Coast Research and Education Center, University of Florida Advisor: Prof. J.W. Scott
2000 – 2004	Master's Thesis, Department of Plant Sciences, University of Minnesota Advisor: Prof. Jim Orf

HONORS AND AWARDS

- Vance Publishing 2014 Finalist "40 under Forty"

SYNERGISTIC ACTIVITIES

Teaching

- AGR6325L Guest lecturer for Plant Breeding Techniques (Spring, odd years)
- AGR6322 Guest lecturer for Advanced Plant Breeding (Fall 2014, 2016)
- HOS1014 Vegetable Gardening. Fall 2005
- VEC3221C Guest lecturer for Commercial Vegetable Production (Fall 2014)

PEER-REVIEWED PUBLICATIONS (past 5 years)

S. Kunwar, Y.-C. Hsu, S.-F. Lu, J.-F. Wang, J.B. Jones, S. Hutton, M. Paret, and P. Hanson. 2019. Characterization of tomato (*Solanum lycopersicum*) accessions for resistance to phylotype I and phylotype II strains of the *Ralstonia solanacearum* species complex (*RSSC*) under high temperature. Plant Breeding. (in press)

Padmanabhan, C., Q. Ma, R. Shekaste-band, K. S. Stewart, S. F. Hutton, J.W. Scott, Z. Fei and K.-S. Ling. Comprehensive transcriptome analysis and functional characterization of *PR-5* for its involvement in tomato *Sw-7* resistance to tomato spotted wilt tospovirus Scientific Reports. 9:7673. https://doi.org/10.1038/s41598-019-44100-x

Soyk, S., Z.H. Lemmon, F.J. Sedlazeck, J.M. Jimenez-Gomez, M. Alonge, S. Hutton, J. Van Eck, M.C. Schatz, and Z.B. Lippman. 2019. Duplication of a domestication locus neutralized a cryptic variant that caused a breeding barrier in tomato. Nature Plants (in press).

Gill, U., J.W. Scott, R. Shekasteband, E. Ogundiwin, C. Schuit, D.M. Francis, S.-C. Sim, H. Smith, S.F. Hutton. 2019. *Ty-6*, a major begomovirus resistance gene on chromosome 10, is effective against Tomato yellow leaf curl virus and Tomato mottle virus. Theor. Appl. Genet. https://doi.org/10.1007/s00122-019-03298-0

Smith H.A., C.A. Nagle, C.M. MacVean, G.E. Vallad, and S.F. Hutton. 2018. Comparing host plant resistance, repellent mulches, and at-plant insecticides for management of *Bemisia tabaci* MEAM1 (Hemiptera: Aleyrodidae) and *Tomato yellow leaf curl virus*. J. Econ. Entom. https://doi: 10.1093/jee/toy333

Yan, Z., A. Pérez-de-Castro, M.J. Díez, S.F. Hutton, R.G. Visser, A.M. Wolters, Y. Bai, J. Li. 2018. Resistance to *Tomato yellow leaf curl virus* in tomato germplasm. Front. Plant Sci. 9:1198. doi: 10.3389/fpls.2018.01198.

Lee, T.G., S.F. Hutton, and R. Shekaste-band. 2018. Fine mapping of the *brachytic* locus on the tomato genome. HortScience 143:239-247.

Kunwar, S., F. Iriarte, Q. Fan, E.E. da Silva, L. Ritchie, N.S. Nguyen, J.H. Freeman, R.E. Stall, J.B. Jones, G.V. Minsavage, J. Colee, J.W. Scott, G.E. Vallad, C. Zipfel, D. Horvath, J. Westwood, S.F. Hutton, and M.L. Paret. 2018. Transgenic expression of *EFR* and *Bs2* genes for field management of bacterial wilt and bacterial spot of tomato. Phytopath. 108:1402-1411

Lee, T.G., R. Shekaste-band, N. Menda, L.A. Mueller, and S.F. Hutton. 2018. Molecular markers to select for the *j-2*-mediated jointless pedicel in tomato. HortScience. 53:153-158.

Li, J., J. Chitwood, N. Menda, L. Mueller, and S.F. Hutton. 2018. Linkage between the *I-3* Gene for Resistance to Fusarium Wilt Race 3 and Increased Sensitivity to Bacterial Spot in Tomato. Theor. Appl. Genet. 131:145-155.

Raid, R.N., J.R. Allingham, J.E. Funderburk, T. Skarkinsky, S.F. Hutton, W.W. Turechek, and S. Adkins. 2017. First report of *Tomato chlorotic spot virus* in sweet basil (*Ocimum basilicum*) and purslane (*Portulaca oleracea*) in Florida. Plant Health Progress. 18:126-128.

Hutton, S.F., J.W. Scott, and J.H. Freeman. 2017. Fla. 8970 Hybrid Tomato; Fla. 7781B and Fla. 8872B Breeding lines. HortScience 52:782-783.

Hutton, S.F. and J.W. Scott. 2017. Fla. 7907C; 2017. Fla. 7907C; a Fla. 7907 near-isogenic tomato inbred line containing the begomovirus resistance gene, *Ty-1*. HortScience 52:658-660.

CE. de Jensen, I.E. Badillo-Vargas, G. Frantz, H.C. Mellinger, W. Turechek, S.F. Hutton, J.E. Funderburk, R.A. Naidu, and S. Adkins. 2017. First report of *Tomato chlorotic spot virus* in non-Solanaceous weeds erect spiderling (*Boerhavia erecta*) and Asian spiderflower (*Cleome viscosa*), and sweet chili pepper (*Capsicum chinense*) in Puerto Rico. Plant Health Progress. 18:17-18.

Lee, S., V.M. Whitaker, and S.F. Hutton. 2016. Mini Review: Potential applications of non-host

resistance for crop improvement. Front. Plant Sci. http://dx.doi.org/10.3389/fpls.2016.00997.

Hutton, S.F., Y. Ji, and J.W. Scott. 2015. Fla. 8923; a tomato breeding line with begomovirus resistance gene *Ty-3* in a 70kb *Solanum chilense* introgression. HortScience 50:1257-1259.

Scott, J.W., S.F. Hutton, and J.H. Freeman. 2015. Fla. 8638B and Fla. 8624 tomato breeding lines with begomovirus resistance genes *ty-5* plus *Ty-6* and *Ty-6*, respectively. HortScience 50:1405-1407.

Caro, M., M.G. Verlaan, O.Julian, R. Finkers, A.-M. A Wolters, S.F. Hutton, J.W. Scott, R. Kormelink, R.G.F. Visser, M.J. Diez, A. Perez-de-Castro, Y. Bai. 2015. Assessing the genetic variation of *Ty-1* and *Ty-3* alleles conferring resistance to tomato yellow leaf curl virus in a broad tomato germplasm. Mol. Breed. 35:132.

Yang, X., H. Kundariya, Y.-Z. Xu, A. Sandhu, S.F. Hutton, M. Zhang, S.A. Mackenzie. 2015. MSH1-derived epigenetic breeding potential in tomato. Plant Physiol. 168:222-232.

Menda, N., S. Strickler, J. Edwards, A. Bombarely, D. Dunham, G. Martin, L. Mejia, S. Hutton, M. Havey, D. Maxwell, and L. Mueller. 2014. Analysis of wild-species introgressions in tomato inbreds uncovers ancestral origins. BMC Plant Biol. 14:287.

Yang, X., M. Caro, S.F. Hutton, J.W. Scott, Y. Guo, X. Wang, H. Rashid, D. Szinay, H. de Jong, R.G.F. Visser, Y. Bai, and Y. Du. 2014. Fine Mapping of the Tomato Yellow Leaf Curl Virus Resistance Gene *Ty-2* on Chromosome 11 of Tomato. Molecular Breeding 34:749-760.

Hutton, S.F., J.W. Scott, and G.E. Vallad. 2014. Association of the Fusarium wilt race 3 resistance gene, *I-3*, on chromosome 7 with increased susceptibility to bacterial spot race T4, and characterization of a bacterial spot resistance QTL on chromosome 11 in tomato. J. Amer.Soc. Hort. Sci. 139:282-289.

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EDUCATION

2004 *Doctor of Philosophy* in Crop Science, Breeding and Genetics, Oklahoma State University
1996 *Master of Science* in Crop Science, Breeding and Genetics, Texas Tech University
1994 *Bachelor of Science* in Agronomy, *Cum Laude*, Texas Tech University

EXPERIENCE

2016-present *Professor,* Agronomy Department, University of Florida
2010-2016 *Associate Professor,* Agronomy Department, University of Florida
2004-2010 *Assistant Professor,* Agronomy Department, University of Florida
1999-2004 *Instructor,* Tarleton State University
2001-2004 *Graduate Research Assistant*, Oklahoma State University
1998-1999 *Research Associate*, Texas A&M University
1997-1998 *Manager, Research and Development*, Thomas Brothers Grass, Ltd, Granbury, Texas
1995-1996 *Graduate Research Assistant*, Texas Tech University

PROFESSIONAL ACTIVITIES/SERVICE

- 2018 Award of Merit for the Turfgrass Producers of Florida
- 2017 NACTA Educator Award
- Alpha Zeta National Honorary Agricultural Fraternity
- Outstanding Senior in Agronomy - 1994-1995
- Soils Team - 1993-1995 - Treasurer
- Gamma Sigma Delta
- American Society of Agronomy
- Crop Science Society of America
- Florida Turfgrass Association
- Golf Course Superintendents Association of America
- Multi-state Coordinating Committee for Plant Breeding
- Turfgrass Breeders Association
- USDA Turf and Forage Crop Germplasm Committee
- National Grass Variety Review Board

GRADUATE STUDENT ADVISING

Candidate's Role	Career Total
Chair Ph.D	3
Co-Chair Ph.D	3
Chair Master's	5
Co-Chair Master's	2
Member Ph.D	17
Member Master's	12
Total	42

TEACHING

Courses Taught at the University of Florida

- AGR 3303 – Genetics
- AGR 6325 – Plant Breeding Techniques

SUMMARY OF EXTERNAL GRANT FUNDING SINCE 2010

Role	Total	Direct Costs	Indirect Costs
Principal Investigator	566,591	557,075	9,516
Co-Principal Investigator	238,600	186,977	51,623
Totals	872,191	811,052	61,139

PUBLICATIONS SINCE 2013

1. Liu W.[g], **K.E. Kenworthy**, G.E. MacDonald, J.B. Unruh, L.E. Trenholm, R.G. Leon. 2019. Application timing affects tolerance of zoysiagrass to fluazifop-p-butyl and safening effect of triclopyr. Crop. Sci. 59:1789-1798.

2. Liu W.[g], **K.E. Kenworthy**, G.E. MacDonald, J.B. Unruh, L.E. Trenholm, R.G. Leon. 2019. Transgressive segregation and maternal genetic effects of non–target site fluazifop-P-butyl tolerance in Zoysia spp. Weed Sci. https://doi.org/10.1017/wsc.2019.26

3. Liu W.[g], G.E. MacDonald, J.B. Unruh, **K.E. Kenworthy**, L.E. Trenholm, R.G. Leon. 2019. Variation in tolerance mechanisms to fluazifop-P-Butyl among selected zoysiagrass lines. Weed Sci. doi:10.1017/wsc.2019.6.

4. Zhang, J.[p], S. Virk, W. Porter, **K. Kenworthy**, D. Sullivan, and B. Schwartz. 2019. Applications of unmanned aerial vehicle based imagery in turfgrass field trials. Front. Plant Sci. doi: 10.3389/fpls.2019.00279.

5. Zhang, J.[p], B. Poudel[g], **K. Kenworthy**, J.B. Unruh, D. Rowland, J.E. Erickson and J. Kruse. 2019. Drought responses of above-ground and below-ground characteristics in warm-season turfgrass. Journal of Agronomy and Crop Science. 205:1-12. DOI:10.1111/jac.12301.

6. Schwartz, B. M., W. W. Hanna, L.L. Baxter, P.L. Raymer, F. Clint Waltz, A.R. Kowalewski, A. Chandra, A. D. Genovesi, B.G. Wherley, G.L. Miller, S.R. Milla-Lewis, C.C. Reynolds, Y. Wu, D.L. Martin, J.Q. Moss, M.P. Kenna, J. B. Unruh, **K.E. Kenworthy**, J. Zhang[p] and P. Munoz. 2018. 'DT-1', a Drought-Tolerant Triploid Turf Bermudagrass. HortScience53(11):1711-1714. doi: 10.21273/HORTSCI13083-18.

7. Schwartz, B., J. Zhang[p], **K. Kenworthy**, G. Miller, C. Peacock, B. Sladek[g] and C. Christensen[g]. 2018. Nitrogen Rate and Mowing Height Affect Seasonal Performance of Zoysiagrass Cultivars. Agronomy J. 110: 6: 2114-2123.

8. Benda, N.D.[&], N.C. Flor[g], P.F. Harmon and **K.E. Kenworthy**. 2017. Response of seashore paspalum genotypes to two isolates of Sclerotinia homoeocarpa. International Turfgrass Society Research Journal 13:454-458. doi:10.2134/itsrj2016.06.0474.

9. Christensen, C.[g], J. Zhang[p], **K.E. Kenworthy**, J. Erickson, J. Kruse and B.M. Schwartz. 2017. Classification of zoysiagrass genotypes on rooting capacity and associated performance during drought. International Turfgrass Society Research Journal 13. DOI: 10.2134/itsrj2016.05.0417

10. Flor, N.C.[g], P.F. Harmon, **K.E. Kenworthy**, L. Datnoff, R.N. Raid, and R. Nagata. 2017. Screening St. Augustinegrass genotypes for brown patch and large patch disease resistance. Crop Sci. 57.89-97.
11. **K.E. Kenworthy**, P.E. Reith, G.M. Prine, A.R. Blount, and K.H. Quesenberry[&]. 2017. Registration of 'FL Red' - A Later Maturing Tetraploid Annual Ryegrass. Journal of Plant Registrations 11:46-50. doi:10.3198/jpr2016.02.0009crc.

12. Patton, A.J., B.M. Schwartz and **K.E. Kenworthy**. 2017. Zoysiagrass (Zoysia spp.) history, utilization, and improvement in the United States: A review. Crop Sci. 57:37-72.

13. Pereira, M.[&], E.F. Rios[g], **K.E. Kenworthy**, K.H. Quesenberry[&], A. Blount, J. Erickson, F. Altpeter and P.R. Munoz. 2017. Comparisons of turf-type bahiagrass (Paspalum notatum Flugge) lines for root and shoot traits under various nitrogen regimes. International Turfgrass Society Research Journal 13. doi: 10.2135/cropsci2016.06.0468.

14. Quesenberry, K.H.[&], **K.E. Kenworthy** and D. Harrison[&]. 2017. Ploidy characterization of Axonopus by meiotic chromosome counts and flow cytometry. International Turfgrass Society Research Journal 13. doi: 10.2135/cropsci2016.10.0906.

15. Rios, E.[g], **K. Kenworthy**, A. Blount, K. Quesenberry[&], B. Unruh, J. Erickson, F. Altpeter, and P. Munoz. 2017. Breeding apomictic bahiagrass (Paspalum notatum Flügge) with improved turf traits. Plant Breeding. doi:10.1111/pbr.12459.

16. Xing L.[g], S. Gezan, **K. Kenworthy**, J. B. Unruh, and P. Munoz. 2017. Improved genetic parameter estimations in zoysiagrass by implementing post hoc blocking. Euphytica 213(195): 1-10. doi: 10.1007/s10681-017-1984-3.

17. Zhang, J.[p], Glenn, B.[g], Unruh, J.B., Kruse, J., **Kenworthy, K.**, Erickson, J., Rowland, D. and Trenholm, L. 2017. Comparative performance and daily light integral requirement of warm-season turfgrasses in different seasons. *Crop Science*. 57(4):2273-2282.

18. Zhang, J.[g], **Kenworthy, K.**, Unruh J. B., Erickson, J. and G. MacDonald. 2017. Changes of Leaf Membrane fatty acid composition and saturation level of warm-season turfgrass during drought stress. *Crop Science*. 57(5):2843-2851.

19. Zhang, J.[g], **K.E. Kenworthy**, J.B. Unruh, B.P. Poudel[g], J. Erickson, D.L. Rowland and J. Kruse. 2017. Physiological responses to soil drying by warm-season turfgrass species. Crop Sci. 57:111-118. doi:10.2135/cropsci2016.05.0316.

20. Aryal, S. K[g]., W. T. Crow, R. McSorley, R. M. Giblin-Davis, and **K. E. Kenworthy**. 2016. Integrated Pest Management of Nematodes on Bermudagrass Turf. Crop, Forage & Turfgrass Management 2. doi:10.2134/cftm2015.0144.

21. Fuentealba, M.P.[g], Zhang, J.[p], **Kenworthy, K.E.**, Erickson, J., Kruse, J., and L. Trenholm. 2016. Transpiration responses of warm-season turfgrass in relation to progressive soil drying. Scientia Horticulturae 198:249-253.

22. **Kenworthy, K.E.**, P.E. Reith[&], G.M. Prine, A.R. Blount and K.H. Quesenberry[&]. 2016. Registration of 'FL PE', a later-maturing diploid annual ryegrass. Journal of Plant Registrations 10(1):5-9.

23. Zhang, J.[g], Unruh, J.B., **Kenworthy, K.E.**, Erickson, J., Christensen, C., Kruse, J., and D. Rowland. 2016. Phenotypic plasticity and turf performance of zoysiagrass in response to reduced light intensities. *Crop Science* 56:1-12.

24. Aryal[g], S.K., W.T. Crow, R. McSorley, R.M. Giblin-Davis, D.L. Rowland, B. Poudel[g], and **K.E. Kenworthy**. 2015. Effects of infection by *Belonolaimus longicaudatus* on rooting dynamics among St. Augustinegrass and bermudagrass genotypes. Journal of Nematology 47(4):322-331.

25. Fuentealba, M.P.[g], Zhang, J.[p], **Kenworthy, K.E.**, Erickson, J., Kruse, J., and L. Trenholm. 2015. Root development and profile chracteristics of bermudagrass and zoysiagrass. HortScience 50 (10): 1429-1434.

26. Glenn, B.[g], B. Brecke, J.B. Unruh, J. Ferrell, **K. Kenworthy**, and G. MacDonald. 2015. Evaluation of alternative herbicides for southern crabgrass (*Digitaria ciliaris*) control in St. Augustinegrass. Weed Tech. http:/dx.doi.org/10.1614/WT-D-14-00094.1.

27. Lu, H., R. Nagata, **K. Kenworthy**, R. Cherry, K. Quesenberry[&], and P. Busey. 2015. Registration of 'NUF-76' St. Augustinegrass. J. of Plant Registrations. doi:10.3198/jpr2014.10.0073crc.

28. Quesenberry, K.H.[&], W.T. Crow and **K.E. Kenworthy**. 2015. Effect of *Belonolaimus longicaudatus* on root parameters of St. Augustinegrass cultivars. Nematropica. 45:96-101.

29. Rios, E.[g], A. Blount, P. Harmon, C. Mackowiak, **K. Kenworthy**, and K. Quesenberry[&]. 2015. Ergot resistant tetraploid bahiagrass and fungicide effects on seed yield and quality. Plant Health Progress. doi:10.1094/PHP-RS-14-0051.

30. Rios, E.F.[g], **K.E. Kenworthy**, and P.R. Munoz. 2015. Association of phenotypic traits with ploidy and genome size in annual ryegrass. Crop Sci. doi:10.2135/cropsci2015.01.0039.

31. Zhang, J.[p], J.B. Unruh, and **K. Kenworthy**. 2015. Turf performance of bahiagrass, centipedegrass, and St. Augustinegrass cultivars under a linear gradient irrigation system. HortScience 50(3):491-495.

32. Chandra, A., A.D. Genovesi, B.G. Wherley, S.P. Metz, J.A. Reinert, Y-Z. Wu, P. Skulkaew, M.C. Engelke, D. Hargey, L.R. Nelson, B.M. Schwartz, P.L. Raymer, Y.Q. Wu, D.L. Martin, S.R. Milla-Lewis, G. Miller, **K.E. Kenworthy**, and P. Munoz. 2014. Registration of 'DALSA 0605' St. Augustinegrass. J. of Plant Registrations 9(1):27-34.

33. Harris-Shultz, K.R., S. Milla-Lewis, A.J. Patton, **K. Kenworthy**, A. Chandra, F.C. Waltz, G.L. Hodnett, and D.M. Stelly. 2014. Detection of DNA and ploidy variation within vegetatively propagated zoysiagrass cultivars. J. Amer. Soc. Hort. Sci. 139:547-552.

34. Huang, T.[g], O. Kostromytska, **K.E. Kenworthy**, E.A. Buss. 2014. Zoysiagrass genotype responses to *Sphenophorus venatus vestitus (Coleoptera: Curculionidae)* J. Econ. Entomol. 107(4):1535-1542.

35. Ma, L.[g], **K.E. Kenworthy**, H. Lu, R. Cherry. 2014. Genetic variability of reproductive traits in common carpetgrass. HortScience 49(7):856-858.

36. Quesenberry, K.[&], P. Munoz, A. Blount, **K. Kenworthy**, W. Crow. 2014. Breeding forages in Florida for resistance to nematodes. Crop and Pasture Science 65:1192–1198.

37. Leon, R.G., J.B. Unruh, B.J. Brecke, and **K.E. Kenworthy**. 2014. *Characterization* of Fluazifop-P-butyl tolerance in zoysiagrass cultivars. Weed Technology 28(2):385-394.

38. Flor, N.C.[g], P. Munoz, P. Harmon, **K. Kenworthy**. 2013. Response of seashore paspalum genotypes to dollar spot disease. International Turfgrass Society Research Journal 12:119-126.

39. Kimball, J.A.[g], M.C Zuleta, **K.E. Kenworthy**, V.G. Lehman, K.R. Harris-Shultz, S. Milla-Lewis. 2013. Genetic relationships in *Zoysia* species and the identification of putative interspecific hybrids using simple sequence repeat markers and inflorescence traits. Crop Sci. January. 53(1):285-295.

40. Kimball, J.A.[g], M.C. Zuleta, **K.E. Kenworthy**, H. Lu, S.R. Milla-Lewis. 2013. Molecular markers enable the identification of contaminants in production fields of 'Captiva' St. Augustinegrass. International Turfgrass Society Research Journal 12:267-273.

41. Ma, L.[g], H. Lu, R. Cherry, H. McAuslane and **K. Kenworthy**. 2013. Effect of time and testing method in determining St. Augustinegrass resistance to southern chinch bugs (Hemiptera: Blissidae). J. Entomol. Sci. 48(2):161-165.

42. Milla-Lewis, S.R., M.C. Zuleta, G.A. Van Esbroeck, K.H. Quesenberry[&], **K.E. Kenworthy**. 2013. Cytological and molecular characterization of genetic diversity in *Stenotaphrum*. Crop Sci. January. 53(1):296-308.

43. Mulkey, S.E.[g], M.C. Zuleta, G.A. Van Esbroeck, H. Lu, **K.E. Kenworthy**, S.R. Milla-Lewis. 2013. Genetic analysis of a St. Augustinegrass germplasm collection using AFLP markers. International Turfgrass Society Research Journal 12:281-291.

44. Quesenberry, K.H.[&], **K.E. Kenworthy**, W.T. Crow, P.F. Harmon, H. Lu, S. Milla-Lewis. 2013. Lance nematode effects on rooting of two St. Augustinegrass cultivars. International Turfgrass Society Research Journal 12:357-361.

45. Poudel B.[g], D. Rowland, J. Erickson, J.B. Unruh, **K. Kenworthy**. 2013. Nitrogen partitioning comparisons among warm-season turfgrass species. International Turfgrass Society Research Journal 12:503-507.

46. Rios, E.[g], A. Blount, J. Erickson, K. Quesenberry[&], F. Altpeter, C. Cellon, **K. Kenworthy**. 2013. Root and shoot characterization of mutant turf-type bahiagrasses. International Turfgrass Society Research Journal 12:509-516.

47. Rios, E.F.[g], A. Blount, **K.E. Kenworthy**, A.A. Carlos, and K.H. Quesenberry[&]. 2013. Seasonal expression of apospory in bahiagrass. Tropical Grasslands 1:116-118.

48. Zhang, J.[g], J.B. Unruh, **K.E. Kenworthy**. 2013. Zoysiagrass cultivar responses under a linear gradient irrigation system. International Turfgrass Society Research Journal.12:179-185.

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(352) 846.0900, mkirst@ufl.edu
https://www.forestgenomics.org/

EDUCATION

Federal University of Santa Maria (Brazil)	Forestry Engineering	B.S.	1996
Federal University of Viçosa (Brazil)	Genetics and Improvement	M.Sc.	1999
NC State University	Genetics and Functional Genomics (co-major)	Ph.D.	2003
Cornell University (Buckler Lab)	Genomics of maize diversity	Postdoc	2004

PROFESSIONAL EXPERIENCE

2016 Director, Plant Molecular and Cellular Biology Graduate Program, University of Florida
2015 Professor, School of Forest Resources and Conservation, University of Florida
2011 Founder RAPiD Genomics LLC, CEO (2011-2012), Scientific Consultant (2012-present)
2010 Co-Director Cooperative Forest Genetics Research Program
2005 Member Genetics Institute, University of Florida

SELECTED PUBLICATIONS (*65 publications since 2003, h-index 36*)

Hodel et al. (2018) Linking genome signatures of selection and adaptation in non-model plants: exploring potential and limitations in the angiosperm Amborella. Curr Opin Plant Biol. 42:81.

Tieman et al. (2017) A chemical genetic roadmap to improved tomato flavor. Science 355:391.

Fahrenkrog et al. (2017) Genome-wide association study reveals putative regulators of bioenergy traits in Populus deltoides. New Phytol. 213:799.

Vazquez et al. (2016) Increased proportion of variance explained and prediction accuracy of survival of breast cancer patients with use of whole-genome multiomic profiles. Genetics 203:1425.

Albert et al. (2013) The Amborella genome and the evolution of flowering plants. Science 342:1467.

Maron et al. (2013) Aluminum tolerance in maize is associated with higher MATE1 gene copy-number. PNAS 110:5241.

Resende et al. (2012) Accuracy of Genomic Selection Methods in a Standard Data Set of Loblolly Pine (Pinus taeda L.). Genetics 190:1503.

Harfouche et al. (2012) Accelerating the domestication of forest trees in a changing world. Trends in Plant Sciences 17:64-72.

Drost et al. (2010) Diversification in the genetic architecture of gene expression and transcriptional networks in organ differentiation of Populus. PNAS 107:8492-8497.

Grattapaglia et al. (2009) Genomics of growth traits in forest trees. Curr Opin Plant Biol. 12:148-156.

CURRENT FUNDING ($20M+ funding as principal investigator since 2006)

1. Genome and transcriptome based prediction, and regulator inference, of molecular and whole-plant phenotypes; Agency: National Science Foundation; Award: $1,956,424; Period: 3/15/15-2/28/20.

2. Phylogenomic discovery and engineering of nitrogen fixation into the bioenergy woody crop poplar; Agency: DOE; Award: $7,309,576; Period: 09/20/17-09/20/22.

TEACHING
GMS 6231 Genomics and Bioinformatics
PCB 5065 Advanced Genetics

SYNERGISTIC ACTIVITIES

- *Industry/University research collaboration* – Kirst is the co-Director of the Cooperative Forest Genetics Research Program. Kirst also co-founded the start-up biotech company RAPiD Genomics LLC (www.rapid-genomics.com).

- *Professional/graduate training* – Kirst leads the development and organization of several training workshops on genomic prediction, including the "Phenotype Prediction Using Genomic Data Workshop"

- *Graduate and high-school curriculum development* – Kirst developed the curriculum of the main course in advanced genomics at the University of Florida, and is currently the lead instructor

- *Scientific or external advisory board member* for four projects funded by Genome Canada and the European Commission (2011-present).

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PROFESSIONAL PREPARATION

B.S. Psychology, University of Massachusetts, Amherst (1974)
Ph.D. Biochemistry, University of Massachusetts, Amherst (1980)
Senior Fellow in the laboratory of Dr. Eugene Nester, Dept. of Microbiology, University of Washington (1980-1984)

APPOINTMENTS

1995- Eminent Scholar, Dickman Chair for Tomato Improvement, University of Florida, Dept. of Horticultural Sciences, Genetics Institute and Plant Molecular and Cellular Biology Program.
1992-95 Fellow, Monsanto Company.
1984-92 Senior Scientist, Monsanto Company.

PUBLICATIONS

(i) **Products most closely related to the proposed project:**

1. Tieman DM, McIntyre L, Blandon-Ubeda A, Bies D, Odabasi A, Rodriguez G, van der Knaap E, Taylor M, Goulet C, Mageroy MH, Snyder D, Colquoun T, Moskowitz H, Sims C, Clark D, Bartoshuk L, Klee H. 2012. The chemical interactions underlying tomato flavor preferences. Current Biology 22:1-5.

2. Zhang B, Tieman DM, Chen J, Xu Y, Chen K, Fei Z, Giovannoni J, Klee HJ. (2016) Loss of tomato flavor quality during chilling is associated with reduced expression of volatile biosynthetic genes and a transient alteration in DNA methylation. Proc. Natl. Acad. Sci USA, 113: 12580-12585.

3. Liu Z, Alseek S, Brotman Y, Zheng Y, Fei Z, Tieman D, Giovannoni J, Fernie A, Klee H. (2016) Characterization of Solanum *pennellii* chromosome 4 fruit quality-associated metabolite QTLs. Frontiers in Plant Science, doi: 10.3389/fpls.2016.01671.

4. Tieman D, Zhu G, Resende M, Lin T, Nguyen C, Bies D, Rambla JL, Ortiz Beltran K, Taylor M, Zhang B, Ikeda H, Liu Z, Fisher J, Zemach I, Monforte A, Zamir D, Granell A, Kirst M, Huang S, Klee H. (2017) A chemical genetic roadmap to improved tomato flavor. Science, 355: 391-394.

5. Garbowicz K, Liu Z, Alseekh S, Tieman D, Taylor M, Kuhalskaya A, Ofner I, Zamir D, Klee H, Fernie A, Brotman Y. (2018) Quantitative trait loci analysis identifies a prominent gene involved in the production of fatty-acid-derived flavor volatiles in tomato. Mol. Plant, doi: 10.1016/j.molp.2018.06.003

(ii) **Five other significant products:**

1. Fernie AR, Klee HJ. 2011. The use of natural genetic diversity in the understanding of metabolic organization and regulation. Frontiers in Plant Physiology. DOI: 10.3389/fpls.2011.00059.

2. Goulet C, Mageroy MH, Lam N, Floystad A, Tieman DM, Klee HJ. 2012. The role of an esterase in flavor volatile variation within the tomato clade. Proc. Natl. Acad. Sci. USA. 109: 19009-19014.

3. Goulet C, Kamiyoshihara Y, Lam N, Richard T, Taylor M, Tieman D, Klee HJ. 2015. Divergence in the Enzymatic Activities of a Tomato and *Solanum pennellii* Alcohol Acyltransferase Impacts Fruit Volatile Ester Composition, Mol. Plant. 8: 153-162

4. Liu Z, Alseek S, Brotman Y, Zheng Y, Fei Z, Tieman D, Giovannoni J, Fernie A, Klee H. (2016) Characterization of Solanum *pennellii* chromosome 4 fruit quality-associated metabolite QTLs. Frontiers in Plant Science, doi: 10.3389/fpls.2016.01671.

5. Klee H, Tieman D. (2018) The genetics of fruit flavor preferences. Nature Reviews Genetics. doi:10.1038/s41576-018-0002-5

SYNERGISTIC ACTIVITIES

- Editor-in-Chief, The Plant Journal 2002-2009.
- Qiushi Chair Professor, Zhejiang University, Hangzhou China 2014-
- American Society of Plant Biologists Science Policy Committee 2014-2016
- President, American Society of Plant Biologists 2017-2018

SEONGHEE LEE, Ph.D.
Assistant Professor, Strawberry Molecular Genetics and Genomics
Gulf Coast Research and Education Center
Horticultural Science Department
Institute of Food and Agricultural Sciences, University of Florida
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https://gcrec.ifas.ufl.edu/gcrec-facultystaff-directory/seonghee-lee/

EDUCATION

2006	Ph.D., North Dakota State University - Plant Pathology
1999	M.S., Chungbuk National University (South Korea) - Plant Pathology
1997	B.S., Chungbuk National University (South Korea) - Agricultural Biology

PROFESSIONAL EXPERIENCE

2016 ~ present	**Assistant Professor**, Horticultural Science Department, UF/IFAS Gulf Coast Research and Education Center, Wimauma, USA **Faculty Member**, Plant Molecular and Cellular Biology Program, UF
2015 ~ 2016	**Research Assistant Professor**, Horticultural Science Department, UF/IFAS Gulf Coast Research and Education Center
2009 ~ 2014	**Senior Research Associate**, The Samuel Roberts Noble Foundation, Ardmore, Oklahoma, USA
2007 ~ 2009	**Postdoctoral Research Associate**, Dale Bumpers National Rice Research Center, USDA-ARS, Stuttgart, Arkansas, USA
2006 ~ 2007	**Postdoctoral Research Associate**, Department of Plant Pathology, Pennsylvania State University, University Park, Pennsylvania, USA
2002 ~ 2006	**Ph.D Graduate Assistant**, Department of Plant Pathology, North Dakota State University, Fargo, North Dakota, USA
2000 ~ 2002	**Research Assistant**, Department of Plant Pathology, Washington State University, Pullman, Washington State, USA
1989 ~ 1999	**B.S and M.S**, Department of Plant Pathology, Chungbuk National University, South Korea

PROFESSIONAL ACTIVITIES

Reviewer: Phyotopathology, Plant Science, Plant Cell, PLoS ONE, BMC Research Notes, In Vitro Cellular and Developmental Biology, Plant Molecular Biology Report, PeerJ
Board of Reviewing Editor: Frontiers in Plant Science, section Horticultural and Crop Science
Host Resistance Committee Member: American Phytopathological Society
DNA Test Team Member, USDA/NIFA RosBREED Project

AWARDS / HONORS

2016	UF/IFAS Early Career Scientist Award
2010	Recipient of National Science Foundation (NSF) sponsored Travel Award, 21st International Conference on Arabidopsis Research
2008	Recipient of National Science Foundation (NSF) sponsored Travel Award, The 6th International Symposium on Rice Functional Genomics, Jeju, South Korea, 2008
2002, 2003	Graduate School Fellowship, North Dakota State University

COMPETITIVE RESEARCH GRANTS AWARDED

Project title: Molecular breeding for charcoal rot resistance in strawberry
PI: Seonghee Lee (2019-2022)
Grant agency: Florida Department of Agriculture and Consumer Services (FDACS)

Project title: Next-generation disease resistance breeding and management solutions for strawberry
Co-PI: Seonghee Lee (2018-2021)
Grant agency: USDA Specialty Crop Research Initiative (SCRI)

Project title: Development of CRISPR/Cas gene-editing technology in strawberry.
PI: Seonghee Lee (2016-2019)
Grant agency: University of Florida, Institute of Food and Agricultural Science

Project title: The DNA-test and marker-assisted seedling selection program: Improving fruit quality and disease resistance in Florida strawberries
PI: Seonghee Lee (2017-2021)
Grant agency: Florida Strawberry Research and Education Foundation (FSREF)

Project title: Application of molecular markers to breed more effectively for Phytophthora crown rot resistance in strawberry.
PI: Seonghee Lee (2015-2017)
Grant agency: Florida Strawberry Research and Education Foundation (FSREF)

PEER-REVIEWED PUBLICATIONS (LAST 3 YEARS)

1. Barbey, C. R., Hogshead, M. H., Schwartz, A. E., Mourad, N. Verma, S., Lee, S., Whitaker, V. M. and Folta, K. M. 2019. The genetics of differential gene expression related to fruit traits in strawberry. ***Frontiers in Genetics*** (submitted).
2. Oh, Y., Zurn, J. D., Bassil, N., Whitaker, V. M. and Lee, S. 2019. The strawberry DNA testing handbook. ***HortScience*** (submitted).
3. Oh, Y., Chandra, S. and Lee, S. 2019. Development of subgenome-specific markers for *FaRXf1* conferring resistance to bacterial angular leaf spot in allo-octoploid strawberry. ***International Journal of Fruit Science*** (accepted with revision)/
4. Barbey, C., Lee S., Verma, S., Bird, K. A., Yocca, A. E., Edger, P. P., Knapp, S. J., Whitaker, V. M. and Folta, K. M. 2019. Disease resistance genetics and genomics in octoploid strawberry. ***G3: Genes, Genomes, Genetics*** (accepted with revision).
5. Gill, S. U. P, Lee, S.c, Jia, Y. and Mysore, S. K. 2018. Exploring natural variation for rice sheath blight resistance in *Brachypodium distachyon*. ***Plant Signaling & Behavior*** doi.org/10.1080/15592324.2018.1546527
6. Lee, S., Rojas, C., Oh, S., Kang, M., Choudhury, S. R., Lee, H-K., Allen, R. D., Pandey, S. and Mysore, K. S. 2018. Nucleolar GTP-binding protein 1-2 (NOG1-2) interacts with Jasmonate-zim-domain protein 9 (JAZ9) to regulate stomatal aperture during plant immunity. ***International Journal of Molecular Sciences*** 1922; doi:10.3390/ijms19071922.
7. Anciro, A. G, Mangandi, J. g, Verma, S.b, Peres, N., Whitaker, V. M. and Lee, Sc. 2018. FaRCg1: a quantitative trait locus conferring resistance to Colletotrichum crown rot caused by *Colletotrichum gloeosporioides* in octoploid strawberry. ***Theoretical and Applied Genetics*** 131(10):2167-2177.

8. Forcelini, B. B.g, Lee, S., Oliveira, M. S. g and Peres, N. Ac. 2018. Development of high-throughput SNP genotyping assays for rapid detection of strawberry *Colletotrichum* species and the G143A mutation. ***Phytopathology*** doi: 10.1094/PHYTO-04-18-0128-R.
9. Noh, Y-H. G, Oh, Y. P, Mangandi, J.g, Verma, S. b, Zurn, J. D., Lu, Y-T.&, Fan, Z.b, Bassil, N., Peres, N., Whitaker, V. M. and Lee, Sc. 2018. High-throughput marker assays for *FaRPc2*-mediated resistance to Phytophthora crown rot in octoploid strawberry. ***Molecular Breeding*** 38:104.
10. Singh R., Lee, S., Oh, S., Ramu, V. S., Lee, H-K., Kaundal, A., Muthappa, S. K., Rojas, C. Mc. and Mysore, K. S. 2018. Two chloroplast-localized proteins: AtNHR2A and AtNHR2B, contribute to callose deposition during nonhost disease resistance in Arabidopsis. ***Molecular Plant-Microbe Interactions*** doi: 10.1094/MPMI-04-18-0094-R.
11. Kaundal, A., Ramu, V., Oh, S., Lee, S., Pant, B., Lee, H-K., Rojas, C., Muthappa, S-K. and Mysore, K. S. 2017. General control non-repressible-4 (GCN4) destabilizes 14-3-3 and RIN4 complex to regulate stomatal aperture with implications on plant immunity. ***Plant Cell*** 29: 2233-2248.
12. Lee, S., Muthappa, S-K., Kang, M., Rojas, C., Tang, Y., Oh, S., Choudhury, S. R., Lee, H-K., Ishiga, Y., Allen, R. D., Pandey, S. and Mysore, K. S. 2017. The small GTPase, Nucleolar GTP-binding protein 1 (NOG1), has a novel role in plant innate immunity. ***Scientific Report*** 7: 9260.
13. Kang, M., Lee, S., Abdelmageed, H., Reichert, A., Lee, H-K., Fokar, M., Mysore, K. S. and Allen, R. D. 2016. Arabidopsis Stress Associated Protein 9 mediates biotic and abiotic stress responsive ABA signaling via the proteasome pathway. ***Plant, Cell and Environment*** DOI: 10.1111/pce.12892
14. Karlen, S. D., Peck, M. L., Zhang, C., Smith, R. A., Padmakshan, D., Helmich, K. E., Free, H. C. A., Lee, S., Smith, B. G., Lu, F, Sedbrook, J. C., Sibout, R., Grabber, J. H., Runge, T. M., Mysore, K. S., Harris, P. J., Bartley, L. E. and Ralph, J. 2016. Monolignol-ferulate conjugates are naturally incorporated into plant lignins. ***Science Advances*** 2:e1600393.
15. Noh, Y. H., Lee, S., Whitaker, V. M., Cearley, K. R., and Cha, J. 2016. A high-throughput marker-assisted selection system combining rapid DNA extraction and high-resolution melting analysis: strawberry as a model for fruit crops. ***Journal of Berry Research*** 10.3233/JBR-160145
16. Lee, S., Whitaker, V. M. and Hutton, S. 2016. Mini Review: potential applications of nonhost resistance for crop improvement. ***Frontiers in Plant Science*** (*http://dx.doi.org/10.3389/fpls.2016.00997*)
17. Jia, Y., Zhou, E., Lee, S. and Bianco, T. 2016. Coevolutionary dynamics of rice blast resistance gene *Pi-ta* and *Magnaporthe oryzae* avirulence gene *AVR-Pita 1*. ***Phytopathology*** 106(7): 676-683.
18. Roach, J. A., Verma, S., Peres, N. A., Jamieson, A. R., van de Weg, E. W., Bink, M. C.A.M., Bassil, N. V., Lee, S. and Whitaker, V. M. 2016. *FaRXf1*: a locus conferring resistance to angular leaf spot caused by *Xanthomonas fragariae* in octoploid strawberry. ***Theoretical and Applied Genetics*** 129(6):1191-1201.

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EDUCATION

Korea University, Seoul, Republic of Korea	Ph.D.	2010	Plant Biotechnology and Genetic Engineering
Korea University, Seoul, Republic of Korea	M.S.	2005	Plant Biotechnology and Genetic Engineering
Korea University, Seoul, Republic of Korea	B.S.	2003	Agriculture

PROFESSIONAL EXPERIENCE

2018 – present	Graduate Faculty, Department of Plant Molecular and Cellular Biology, University of Florida, FL, USA
2016 – present	Assistant Professor, Horticultural Sciences Department, Gulf Coast Research and Education Center, University of Florida, FL, USA
2010 – 2016	Postdoctoral Research Associate in Bioinformatics and Soybean Genomics, Department of Crop Sciences, University of Illinois at Urbana- Champaign, IL, USA (Advisor: Matthew Hudson)
2010 – 2010	Research Professor, Korea University, Seoul, Republic of Korea 2009
2009	Researcher, Institute of Life Science & Natural Resources, Korea University, Seoul, Republic of Korea

SELECTED PEER-REVIEWED PUBLICATIONS

Hwang, S., T.G. Lee. 2019. Correcting pervasive errors in genotypic datasets to develop genetic maps. Agronomy 9, 196.

Lee, T.G., S.F. Hutton, R. Shekasteband. 2018. Fine mapping of the *brachytic* locus on the tomato genome. Journal of the American Society for Horticultural Science 143, 239- 247.

Lee, T.G., B.W. Diers, M.E. Hudson. 2016. An efficient method for measuring copy number variation applied to improvement of nematode resistance in soybean. The Plant Journal 88, 143–153.

Lee, T.G., I. Kumar, B.W. Diers, M.E. Hudson. 2015. Evolution and selection of *Rhg1*, a copy-number variant nematode-resistance locus. Molecular Ecology 24, 1774–1791.

Cook, D.E.*, T.G. Lee*, X. Guo*, S. Melito, K. Wang, A. Bayless, J. Wang, T.J. Hughes, D.K. Willis, T. Clemente, B.W. Diers, J. Jiang, M.E. Hudson¶, A.F. Bent¶. 2012. Copy number

variation of multiple genes at *Rhg1* mediates nematode resistance in soybean. Science 338, 1206–1209. (*Equal Authorship, ¶Equal Authorship)

Lee, T.G., M.J. Hong, J.W. Johnson, D.E. Bland, D.Y. Kim, Y.W. Seo. 2009. Development and functional assessment of EST-derived 2RL-specific markers for 2BS.2RL translocations. Theoretical and Applied Genetics 119, 663–673.

Lee, T.G., C.S. Jang, J.Y. Kim, D.S. Kim, J.H. Park, D.Y. Kim, Y.W. Seo. 2007. A Myb transcription factor (*TaMyb1*) from wheat roots is expressed during hypoxia: Roles in response to the oxygen concentration in root environment and abiotic stresses. Physiologia Plantarum 129, 375–385.

SELECTED PEER-REVIEWED EXTENSION PUBLICATIONS

Lee, T.G. 2018. CRISPR: A technical breakthrough for tomato research. Univ. Florida, Inst. Food Agr. Sci., Electronic Data Info. Source, HS1314. Feb. 2018. https://edis.ifas.ufl.edu/hs1314

POSTDOCTORAL FELLOWS TRAINED

Man Bo Lee (2017 – present)
Sadal Hwang (2018 – 2019)

GRADUATE STUDENTS TRAINED

Gurleen Kaur (Chair PhD; 2017 – present)
Prashant Bhandari (Chair PhD; 2019 – present)
Doosan Shin (Co-Chair PhD; 2019 – present)

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Assistant Professor, Vegetable Breeding, Genetics and Genomics
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EDUCATION

University of Georgia, Athens, GA, USA

- **Ph.D. Horticulture**, Aug., 2010 - Dec., 2014
  Thesis: **"***Genetic mapping of resistance to Fusarium wilt and seed nutrition traits in watermelon*"
  Project 1: GBS for SNP discovery and QTL mapping of resistance to *Fusarium* wilt in watermelon
  Project 2: Genetic mapping of seed nutrition traits (oil quality/quantity) in watermelon
  Project 3: Breeding for fruit quality traits and disease resistance in watermelon

Kenyatta University and ICRISAT, Nairobi, Kenya

- **M.Sc. Biotechnology**, Jan., 2009 - July, 2010
  Thesis: **"***Genotyping BC3F2 populations of four Ethiopian sorghum varieties for Stay Green QTL through marker assisted selection with SSRs*"
- **B.Sc. Biotechnology**, Aug. 2004 - Dec. 2008

PROFESSIONAL EXPERIENCE

University of Florida, TREC, Homestead, FL, USA

- **Assistant Professor**, Vegetable Crop Genetics, June, 2016- Present
  Research focus: Cucurbit breeding, genetics and genomics

Tennessee State University, Nashville, TN, USA

- **Postdoctoral Research Associate**, Aug., 2015 - June, 2016
  Project 1: QTL mapping and heritability estimates for resistance to powdery mildew in dogwood
  Project 2: Molecular plant-microbe interactions and GFP-tagging in endophyte-plant systems

ICRISAT

- **Research Consultant Jan., 2010- May, 2010**
  Project: DNA fingerprinting of pigeon pea and groundnut accessions

PROFESSIONAL SKILLS

Plant Breeding

- Mating design implementation
- Marker-assisted selection
- Trait evaluation and experimental design (field and greenhouse)
- Line selection for disease resistance
- Field and greenhouse pollinations (selfs, crosses, backcrosses)
- Breeding database maintenance

- Tissue culture: tetraploid induction and micro-propagation

Molecular Biology

- Marker development and assays: SSRs (capillary electrophoresis), SNPs (KASP)
- Genetic map construction and QTL mapping
- Genotyping by Sequencing, DNA cloning and sequencing &DNA finger-printing

Plant Pathology

- Development and optimization of high throughput disease screening assays
- Fungal, bacterial and viral pathogen inoculation
- Identification of biocontrol agents (*in vivo and in vitro*)

Statistical Analysis and Bioinformatics

- Joinmap, QTL Cart., MapChart, Genemapper, Tassel, BLAST, R/SAS, Sequencher, MEGA

PEER REVIEWED PUBLICATIONS

Ramos, A. Fu, Y., Michael, V., and **Meru, G**. QTL-seq for identification of genetic loci associated with resistance to *Phytophthora* crown rot in squash (*under review*)

Meru, G., Leyva, D., Michael, V., Dorval, M. Mainviel, R. and Fu, Y. 2019. Genetic variation among *Cucurbita pepo* accessions varying in seed nutrition and seed size. Amer. J. Plant Sci. (*in press*).

Michael, V.G, Fu, Y. and **Meru, G**. 2019. Inheritance of resistance to *Phytophthora* crown rot in *Cucurbita pepo*. HortScience 54:1156-1158.

Michael, V., Moon, P., Fu, Y. and **Meru, G**. 2019. Genetic diversity among accessions of *Cucurbita pepo* resistant to *Phytophthora* crown rot. HortScience 54:17-22.

Moon P. and **Meru G.** 2018. Embryo rescue of aged *Cucurbita pepo* seeds in squash rescue medium (J. Hort. Sci. Res. 2:62-69.

Meru, G., Fu, Y., Leyva, D., Sarnoski, P. and Yagiz, Y. 2018. Phenotypic relationships among oil, protein, fatty acid composition and seed size traits in *Cucurbita pepo* Sc. Hort. 233: 47-53.

Parikh L., Mmbaga M, **Meru**, G. et al. 2017. Parikh L., Quantitative trait loci associated with resistance to powdery mildew in Cornus florida. Sci. Horticulturae 226: 322-326.

Porterfield, R. and **Meru**, G. 2017. Candidate Susceptibility Genes for Powdery and Downy Mildew in Watermelon and Squash. J Phylogenetics Evol Biol. 5:2.

Meru G. and Cecilia M. 2016. Genotyping by sequencing for SNP discovery and genetic mapping of resistance to race 1 of *Fusarium oxysporum* in watermelon. Sci. Hort. 209:31-40.

Meru G. and Cecilia M. 2016. Genetic loci associated with resistance to *Fusarium oxysporum* f. sp. niveum race 2 in Citrullus lanatus type watermelon. J. Amer. Soc. Hort. Sci. 141(6):617–622.

Parikh L., Mmbaga M. S. Kodati, M. Blair, D. Hui and **Meru G.** 2016. Broad-sense heritability and genetic gain for powdery mildew resistance in multiple pseudo-F2 (F1) populations of flowering dogwoods (*Cornus florida* L.). Sci. Hort. 213-216-221.

Meru G. and Cecilia M. 2014. Quantitative trait loci and candidate genes associated with fatty acid content of watermelon seed. J. Amer. Soc. Hort. Sci. 139(4):433-441

Meru G. and Cecilia M. 2013. Genetic mapping of seed traits correlated with seed oil percentage in watermelon. HortScience. 48 (8):955-959.

Meru G., D. McDowell, V. Waters, A. Seibel, J. Davis and C. McGregor. 2013. A non- destructive genotyping system from a single seed for marker-assisted selection in watermelon. Genet. Mol. Res. 12 (1):702-709.

BOOK CHAPTERS

- **Meru G**. 2012. Polyploidy. In: C. Brummer and C. McGregor (eds.), Plant Breeding in the 21st Century. PBGG, University of Georgia, Athens (http://plantbreeding.coe.uga.edu/index.php?title=5.Polyploidy)

- McGregor C., **G. Meru** and V. Waters. 2012. Breeding methods for specific crops: watermelon. In: C. Brummer and C. McGregor (eds.), Plant Breeding in the 21st Century. PBGG, University of Georgia, Athens http://plantbreeding.coe.uga.edu/index.php?title=20.6_Watermelon)

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University of Florida, Institute of Food and Agricultural Sciences
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EDUCATION

Postdoc Associate	Forest Genomic Lab.	University of Florida	Jan 2012-June 2013
Ph.D.	Molecular Breeding	University of Florida	Jan 2010-Nov 2012
M.Sc.	Quantitative Genetics	University of Florida	Aug 2007-Dec 2009
B.Sc.	Forestry Engineering (Honors)	Universidad Católica de Temuco	Mar 1998-Oct 2004

PROFESSIONAL EXPERIENCE

Feb 2017-Present — **Assistant Professor Blueberry Breeding and Genomics.** Horticultural Science Department, University of Florida, Gainesville, FL. Develop of improved blueberry cultivars. Leader of UF's Blueberry Breeding program. Research and mentor students on breeding, quantitative genetics, genetics and genomics. Teaching courses in Plant Breeding related topics.

July 2013-Jan 2017 — **Assistant Professor Forage Breeding and Genomics.** Agronomy Department, University of Florida, Gainesville, FL. Research on Forage breeding, genetics and genomics. Leader of UF's alfalfa, bermudagrass and clovers Breeding program. Mentor students on the area of breeding, quantitative genetics and genomics. Development of improved forage cultivars for the Southern US. Teaching courses Field Plot Techniques and Advanced Plant Breeding.

April 2013 — **Quantitative genetic consultant**. Texas A&M AgriLife Research-Dallas. Quantitative support in project "Plant genetics and genomics to improve drought and salinity tolerance for sustainable turfgrass production in the southern United States".

Feb 2013 — **Scientific advisory board assistant**, Technology Innovation Group (TIG), Inc. Austin, TX, USA. Support TIG the "Citrus Research Development Foundation, Inc." Scientific Advisory Board.

2012-2013 — **Quantitative genetic consultant**. GreenWood Resources, Portland, Oregon, USA. Trained four breeders in the use of ASReml software. Analyzed poplar clonal trials data to rank genotypes for selection, estimate genotype-by-environment and genotype-by-year interaction, among others.

April 2012-Nov 2012 — **Statistic consultant**, Turfgrass Breeding Program, Agronomy Dept. University of

	Florida. Gainesville, FL. Analyzed turfgrass breeding experiments for selection based on quality and disease/drought resistance lines. Studied the level of genotype-by-environment, and age-age correlation to define frequency and age to selection.
Jun 2010-2012	**Instructor/Consultant**, VSN International, Hemel Hempstead, United Kingdom. Organize and teach workshops on use of ASReml software, breeding and quantitative genetic theory. Classes are based on lectures and practical examples.
Sep 2010-2012	**Quantitative genetics/Breeding consultant**. TRI-GEN Fish Ltd. British Columbia, Canada. Analysis of Salmon progeny trials, including full-sib, genotype x environment interaction, ranking for genotype selection andgenetic correlations. Recommended breeding strategies and design of experiments.
Aug 2012	**Quantitative genetic consultant**. Fast Genetics, Saskatchewan, Canada. Analyzed sow and swine progeny data: estimated variance component;
direct	genetic effect, permanent environment effect and common environment for litter size, fat content, lean content, weight, feed conversion rate and
number	of born.
Dec 2011	**Quantitative genetic consultant**. Nidera Argentina S.A., Venado Tuerto, Argentina. Trained 13 breeders in use of ASReml software and Genomic Selection. Analyzed corn trial data: augmented designs, genotype-by-environment and genotype-by-year interactions and spatial analysis. Recommendations on experimental design
Jan 2010-Dec 2012	**Research assistant**, Plant Molecular and Cellular Biology. University of Florida. Analysis of Genomic data; Genomic selection, QTL analysis, Linkage Mapping. Analysis of Pine progeny trials; multivariate analysis for genetic correlations and clonal trials.
Aug 2007-Dec 2009	**Research assistant**, Cooperative Forest Genetics Research Program, University of Florida. Establishment and measure of growth, morphological, phenological and disease traits in field and greenhouse experiments. QTL analysis, Linkage Mapping.
Jan 2008-Dec 2009	**Quantitative genetic consultant**. Forestal Mininco S.A., Los Angeles, Chile. Analyzed pine and Eucalyptus progeny trials with half-sib, full-sib and clonal data, Study longitudinal, categorical, multisite and multiage for genotype-by-environment interaction, genetic correlations and genotypes for selection.
Sep 2005-Jul 2007	**Genetic improvement research assistant**, Forestal Mininco S.A., Los Angeles, Chile. Analyzed pine progeny trials data, including half-sib, full-sib, clonal, longitudinal, genotype by environment interaction, genotype by age interaction, genetic correlations, ranking for genotype selection and categorical data. Supported experimental design and supervised progeny trial installation and maintenance. Assist in selection of genotypes for next breeding cycle and for operational use.

Sep 2004-Nov 2004 **Grant proposal assistant**, Universidad Catolica de Temuco, Chile. Revised and formatted university-wide grant projects for national competition.

GRANTS, AWARDS AND FELLOWSHIPS

2017 **University of Florida.** Richard L. Jones Outstanding New Faculty Research Award.

2017 Bermudagrass (Cynodon dactylon L.) A potential host and reservoir of new viruses. **Co-PI**

2017 **Florida Cattle Enhancement Board**. Development of Improved Forage Cultivars and Management Systems for Florida Conditions. $56,000 PI.

2016 on **University of Florida.** Excellence Award for Assistant Professors, given to only 10 faculty the entire UF campus annually.

2016 **NSF-IOS.** Genetic and physiological mechanisms of local climatic adaptation in a widespread perennial plant species. Collaborative. Collaborative-PI. $248,210 ($ 1.17 Million)

2016 **USDA-Sustainable Agriculture Research & Education**. Cover Crop Diversity through Evaluation and Increase from Breeder Stocks and Germplasm Repositories. Co-PI. $25,594 ($201,248).

2015 **USDA-NIFA.** Persistence, Survival, and Recovery of Warm-Season Turfgrass Selections for Sustainable Urban Landscapes Under Limited Irrigation and Long-Term Drought. Co-PI. $224,055 ($4.44 Million).

2015 **Milk Check-Off.** A High Manure Uptake Bermudagrass/Stargrass for Dairy Production. PI. $17,160.

2015 **UF-Plant Breeding Working Group**. Development of improved forages for Florida. PI. $26,255.

2015 **UF-IFAS Early Career Seed Funds**. Discovery of the molecular mechanism for 2,4-D herbicide resistance. PI. $49,380.

2015 **UF-Agronomy**. Improving Cold Units for Forage and Small Grain Seed Storage. Co-PI. $4,134.

2014 USDA. Improving breeding efficiency in autotetraploid with genome-wide prediction. PI. $500,000.

2014 **Sustainable Agriculture Research & Education (SARE).** Evaluation of clovers as cover crop to decrease nematode populations on peanut production. PI. $11,000.

2014 **Milk Check-Off.** Developing Improved Alfalfa Cultivars for Florida. PI. $11,300.

2014 UF Plant Breeding Graduate Initiative. Development of cultivars of bermudagrass resistant to stem maggot. PI. $48,000.

2014 **UF-IFAS Equipment and Facilities.** Equipping the Forage Breeding Lab. PI. $16,400.

2013 **UF-Office of Technology Licensing**. Technology Innovator.

2013 **USDA-DOE**. Accelerated development of optimal feedstock for bioenergy and renewable chemicals using genome-wide selection. Co-PI. $225,380 ($1,000,000).

2013 **USDA-NIFA.** Accelerated breeding by improving accuracy and mate allocation using Genome-Wide selection. Co-PI. $211,744 ($500,000).

2012 **Best Graduate Student Dissertation** Plant Molecular and Cellular Biology Program, University of Florida, FL, USA

2011 **USDA, Honor Award for Excellence**: "For collaborative research and outreach approach to successful development and application of genomic-based tree breeding technology that will enhance US competitiveness in the production of forest products"

2010-2012 Plant Molecular Breeding Initiative **Grant Fellowship**, University of Florida, FL, USA

2011 **IUFRO, Best Poster Award** at the Union of Forest Research Organizations: "Award at best poster selected out 200: "Effect of Alternative BLUP-breeding value prediction on the accuracy of genomic selection" Arraial d' Ajuda, Bahia, Brazil.

2011 **SFTIC, Zobel Award for Best Presentation** at the Southern Forest Tree Improvement Conference Biloxi, MS, USA

2004 Universidad Catolica de Temuco, **Double Award for Outstanding Student and Greatest Effort**, Temuco, Chile

2002-2004 Universidad Catolica de Temuco, **Top Honor Student Award**, Temuco, Chile

PUBLICATIONS

I. Peer Reviewed Journal Publications (31) (g=graduate student, u=undergraduate, underline=senior, Postdoc=p, other=&):

31. Xing L. (g), S. Gezan, K. Kenworthy, and **P. Munoz**. Genetic parameters and genotype-by- environment interaction of zoysiagrass in Florida. **Submitted** Euphytica.

30. Figueiredo U.J. (g), J.A. Rodrigues, C.V. Borges, S.C. Barrios, K. Quesenberry, and **P. Munoz**. Evaluating early selection in perennial tropical forages. **Submitted** Plant Breeding.

29. Müller B (g), L. Neves, J. Filho, M. Resende Jr, **P. Muñoz**, P. Santos, E. Filho, M. Kirst, D. Grattapaglia. 2017. Genomic prediction and GWAS in breeding populations of Eucalyptus benthamii and E. pellita using high-density SNP genotyping. **Submitted BMC Genomics**.

28. Klápště J (&), I. Porth, O. Skyba, A. McKown, **P. Munoz**, M. Resende, D. Garrick, R. Guy, C. Douglas, S. Mansfield, Y. El-Kassaby. 2017. Genome-enabled prediction in the context of linkage disequilibrium heterogeneity and multiple environments using unrelated populations. **Submitted Heredity.**

27. Rios E. (g), K. Kenworthy, A. Blount, K. Quesenberry, B. Unruh, J. Erickson, F. Altpeter, and **P. Munoz**. 2017. Breeding Apomictic Bahiagrass (Paspalum notatum Flugge) with Improved Turf Traits. *Plant*

Breeding. **In press**

26. Lopez J. (g), J. Erickson, **P. Munoz**, A. Saballos, T. Felderhoff, and W. Vermerris. 2017. QTL Associated with crown root angle, stomatal conductance, and maturity in sorghum. *The Plant Genome.* **In press (First Look online).**

25. Pereira M. (u), E. Rios (g), K. Kenworthy, K. Quesenberry, A. Blount, J. Erickson, F. Altpeter and **P. Munoz**. 2017. Turf-type bahiagrass (Paspalum notatum Flugge) performance for root and shoot traits under various nitrogen regimes. *International Turfgrass Society Research Journal.* **In press**

24. Amadeu R. (u), C. Cellon (g), J. Olmstead, A. Garcia, M. Resende, **P. Munoz**. 2016. AGHmatrix: R package to construct relationship matrices for autotetraploid and diploid species, a Blueberry Example. *The Plant Genome* 9(3):1-10

23. Inostroza L. (p), H. Acuña, **P. Munoz**, C. Vasquez, J. Ibañez, G. Tapia, M.T. Pino and H. Aguilera. 2016. Using aerial images and canopy spectral reflectance for high-throughput phenotyping of white clover. *Crop Science* 56(5):2629-2637.

22. Hunter S. (g), J. Ferrell, T. Webster, J. Fernandez, P. Dittmar, **P. Munoz** and G. MacDonald**.** 2016. Impact of irrigation volume on PRE herbicide Activity. *Weed Technology* 30(3):793-800.

21. Filho J. (g), J. Rodrigues (g), F. Silva, M.D. Resende, **P. Munoz**, M. Kirst, and M. Resende Jr. 2016. The contribution of dominance to phenotype prediction in a pine breeding and simulated population. *Heredity* 117:33-41.

20. Sasson D. (g), **P. Munoz**, S. Gezan and C. Miller. 2016. Resource quality affects weapon and testis size and the ability of these traits to respond to selection in the leaf-footed cactus bug, *Narnia femorata*. *Ecology and Evolution* 6(7): 2098-2108. doi:10.1002/ece3.2017

19. Silva F. (g), **P. Munoz**, C. Vincent, and A. Pio. 2016. Generating relevant information for breeding Passiflora edulis: genetic parameters and population structure. *Euphytica* 208(3): 609- 619. doi:10.1007/s10681-015-1616-8.

18. Kumar S. (&), C. Molloy, **P. Munoz P**, H. Daetwyler, D. Chagne, and R Volz. 2015. Genome- enabled estimates of additive and non-additive genetic effects and prediction of apple phenotypes across environments. *G3: Genes, Genomes, Genetics* 5: 2711-2718. doi:10.1534/g3.115.021105.

17. Rios E. (g), K. Kenworthy and **P Munoz**. 2015. Association of phenotypic traits with ploidy and genome size in annual ryegrass. Crop Science 55(5): 2078–2090. doi:10.2135/cropsci2015.01.0039.

16. Quesenberry K. (&), A. Blount, **P. Munoz**, J. Ferrell, and J.C. Dubeux. 2015. Registration of 'FL24D', a red clover selected for tolerance to 2,4-D herbicide. Journal of Plant Registrations 9: 288-293. doi:10.3198/jpr2014.11.0081crc

15. Westbrook J. (g), V.E. Chhatre (g), L. Wu, S. Chamala (g), L.G. Neves, **P. Munoz**, P.J. Martinez-Garcia, D.B. Neale, M. Kirst, D.C. Nelson, K. Mockaitis, G.F. Peter, J.M. Davis, and C.S. Echt. 2015. A consensus genetic map for Pinus taeda and Pinus elliottii and extent of linkage disequilibrium in two genotype-phenotype discovery populations of Pinus taeda. G3: Genes, Genomes, Genetics 5(8): 1685-94. doi:10.1534/g3.115.019588.

14. Ferreira C.A. (g), M.D.V. Resende, F.F. Silva, J.M.S. Viana, M.S.V. Ferreira, M.F.R. Resende Jr, and **P. Munoz**. 2015. Ridge, Lasso and Bayesian additive-dominance genomic models. BMC Genetics 16(105): 1-13. doi:10.1186/s12863-015-0264-2

13. Westbrook J. (g), A.R. Walker (p), G.L. Neves, **P. Munoz**, M.F. Resende Jr., D.B. Neale, J.L. Wegrzyn,

D.A. Huber, M. Kirst, J.M. Davis, and G.F Peter. 2015. Discovering candidate genes that regulate resin canal number in Pinus taeda stems by integrating genetic analysis across environments, ages, and populations. New Phytology 205(2): 627-641. doi: 10.1111/nph.13074

12. Chandra A. (&), A.D. Genovesi, B.W. Wherley, S.P. Metz, J.A. Reinert, Y-Z. Wu, P. Skulkaew, M.C. Engelke, D. Hargey, L.R. Nelson, B.M. Schwartz, P.L. Raymer, Y. Q. Wu, D.L. Martin, S.R. Milla-Lewis, G. Miller, K.E. Kenworthy and P. Munoz. 2015. Registration of 'DALSA 0605' St. Augustinegrass. Journal of Plant Registrations 9(1): 27-34. doi:10.3198/jpr2014.05.0036crc

11. **Munoz P.**, M.F. Resende Jr., S. Gezan, M.D. Resende, G. de los Campos, M. Kirst, D. Huber, and G. Peter. 2014. Unraveling additive from non-additive effects using genomic relationship matrices. GENETICS 198: 1759-1768. doi:10.1534/genetics.114.171322

10. **Munoz P.**, M.F. Resende Jr., D. Huber, T. Quesada, M.D. Resende, M. Kirst and G. Peter. 2014. Genomic relationship matrix for correcting pedigree errors in breeding populations: impact on genetic parameters and genomic selection accuracy. Crop Science *54(3):1115-1123. doi:10.2135/cropsci2012.12.0673*

09. Quesenberry K. (&), **P. Munoz**, A. Blount, K. Kenworthy, and W. Crow. 2014. Breeding forages in Florida for resistance to nematodes. Crop & Pasture Science *65: 1192-1198.* doi.org/10.1071/CP13437

08. Quesada T. (p), M.F. Resende Jr. (g), **P. Munoz**, J. Wegrzyn, D. Neale, M. Kirst, G. Peter, S. Gezan, D. Nelson, and J. Davis. 2014. Mapping fusiform rust resistance genes within a complex mating design of Loblolly pine. Forest 5(2): 347-362. doi:10.3390/f5020347

07. Westbrook J. (g), M.F. Resende Jr., **P. Munoz**, A.R. Walker (g), J.L. Wegrzyn, C.D. Nelson, D.B. Neale, M. Kirst, D. Huber, S. Gezan, G.F Peter and J.M. Davis. 2013. Association genetics of oleoresin flow in loblolly pine: discovering genes and predicting phenotype for improved resistance to bark beetles and bioenergy potential. New Phytology. 199: 89-100. doi:10.1111/nph.12240.

06. Flor N. (g), **P. Munoz**, P. Harmon, and K. Kenworthy. 2013. Response of Seashore paspalum genotypes to Dollar Spot Disease. International Turfgrass Society Research Journal. 12: 119-126. ISSN 1817-0641

05. Resende Jr. M.F. (g), **P. Munoz (g)**, M.D. Resende, D.J. Garrick, R.L Fernando, J. Davis, E.J. Jokela, T.A. Martin, G.F. Peter, and M. Kirst. 2012. Accuracy of genomic selection methods in a standard dataset of loblolly pine (Pinus taeda L.). *GENETICS* 190: 1503-1510. doi: 10.1534/genetics.111.137026

04. **Munoz P. (g)**, D. Huber, and T. Martin. 2012. Relative contribution of crown and phenological traits to growth of a pseudo-backcross family (slash x loblolly) x slash) and its pure species progenitors. Tree Genetics and Genomes 8(6): 1281-1292. doi:10.1007/s11295-012-0514-7.

03. Resende Jr. M.F. (g), **P. Muñoz (g)**, J. Acosta, G. Peter, J. Davis, D. Grattapaglia, M.D. Resende, and M. Kirst. 2012. Accelerating the domestication of trees using genomic selection: accuracy of prediction models across ages and environments. New Phytologist 193(3): 617-624. doi:10.1111/j.1469-8137.2011.03895.x.

02. **Munoz P. (g)**, D. Huber, and J. Butnor. 2011. Phenotypic analysis of first-year traits in a pseudo-backcross {(slash x loblolly) x slash} and the open-pollinated families of the pure-species progenitors. Tree Genetics and Genomes 7(1): 183-192. doi:10.1007/s11295-010-0324-8.

01. Resende M.D.V. (&), F.F. Silva, J.M.S. Viana, L.A. Peternelli, M.F. Resende Jr, and **P. Munoz**. 2011. Statistics methods in genomic wide selection (*Original in Portuguese:* "Metodos estatisticos na selecao genomica ampla"). Embrapa Documents 219. Online version. Brazil. ISSN 1980-3958

II. Non-refereed Journal Publications (10) (g=graduate student, u=undergraduate, underline=senior):

10. **Munoz P.**, K. Quesenberry, A. Blount, J.A. Ferrel, and J.C. Dubeux. 2014. A new red clover 2,4- D resistant cultivar to improve broadleaf weed control and elucidate the molecular mechanism of resistance. In: Molecular Breeding of Forage and Turf (Editors: Budak,H and G. Sangenberg). 236 p.
09. Blount A., J. Vendramini, J. Dubeux, A. Babar, K. Kenworthy, **P. Munoz**, and K. Quesenberry. 2014. 2014 Cool-Season Forage Variety Recommendations for Florida. UF EDIS #SS-AGR-84
08. Newman Y, J. Dubeux, **P. Munoz**, and K. Quesenberry. 2014. Winter Forage Legume Guide. UF EDIS #SS-AGR-49.
07. Dubeux J, and **P. Munoz**. 2014. Alfalfa Production in North Florida.Southern Cattle Advisor. Available through internet: http://www.secattleadvisor.com/2014/12/01/alfalfa-production-in-north-florida.
06. Gezan S, M. Kirst, **P. Munoz**, G. Peter, G. Powell, J. Zhang. 2013. Cooperative Forest Genetics Research Program, Fifty-fifth annual progress report. Gainesville, FL
05. Balmant K, S. Gezan, M. Kirst, **P. Munoz**, G. Peter, G. Powell, M. Resende, and J. Zhang. 2012. Cooperative Forest Genetics Research Program, Fifty-fourth annual progress report. Gainesville, FL
04. Gezan S, M. Kirst, **P. Munoz**, G. Peter, and G. Powell. 2011. Cooperative Forest Genetics Research Program, Fifty-third annual progress report. Gainesville, FL
03. Huber D, **P. Munoz**, and G. Powell. 2010. Cooperative Forest Genetics Research Program, Fifty- second annual progress report. Gainesville, FL
02. Huber D, X. Li, **P. Munoz**, G. Peter, and G. Powell. 2009. Cooperative Forest Genetics Research Program,
Fifty-first annual progress report. Gainesville, FL
01. Huber D, **P. Munoz**, and G. Powell. 2008. Cooperative Forest Genetics Research Program, Fiftieth annual progress report. Gainesville, FL

III. Abstracts (35) (g=graduate student, u=undergraduate, underline=senior):

35. E. Rios (g), M. Resende Jr., M. Kirst, M.D. Resende, J. Filho, and **P. Munoz**. 2016. Genome- wide Family Prediction. National Association of Plant Breeders. 15-18 August 2016, Raleigh, North Carolina, USA.
34. **Munoz P.**, E. Rios (g), M. Resende Jr., M. Kirst, M.D. Resende, and J. Filho. 2016. Genome-wide Family Prediction. 5th International Conference of Quantitative Genetics (ICQG) June 2016, Madison, Wisconsin, USA.
33. Bhakta M. (p), L. Inostroza, M. Kirst, M. Resende Jr., J. Endelman, and **P. Munoz**. 2016. Genome-wide Family Prediction. 5th International Conference of Quantitative Genetics (ICQG) June 2016, Madison, Wisconsin, USA.
32. Xing L. (g), K. Kenworthy, S. Gezan, B. Unruh, and **P. Munoz**. 2016. Post-hoc blocking and genotype-by- environment interaction in zoysiagrass. 5th International Conference of Quantitative Genetics (ICQG) June 2016, Madison, Wisconsin, USA.
31. Santos R. (g), B. Moraes (g), A. Missiagia, A. Aguiar, B. Lima, D. Dias, G. Resende, F. Gonzalves, **M.**

Resende Jr., P. Munoz, and M. Kirst . 2016. Comparing genotypic methods for development of genomic selection models in Eucalyptus. 5th International Conference of Quantitative Genetics (ICQG) June 2016, Madison, Wisconsin, USA.

30. Muller B. (g), L. Neves, J. Filho, M. Resende Jr., A. Fahrenkrog, **P. Munoz,** M. Kirst and D. Grattapaglia. 2016. Impact of relatedness on genomic prediction and GWAS detection in two elite eucalyptus breeding populations. 5th International Conference of Quantitative Genetics (ICQG) June 2016, Madison, Wisconsin, USA.

29. **Munoz P.**, J. Dubeux, B. Anderson, B. Shwartz, J. Vendramini, M. Saha, M. Castillo, S. Milla- Lewis, and A. Rucker (g). 2016. Genomic Progress in Bermudagrass. Plant and Animal Genome (PAG) Jan 2016, San Diego, California, USA.

28. Bhakta M. (p), and **P. Munoz**. Characterizing Genetic Factors Involved in 2,4-D Resistance using the Red Clover. Plant and Animal Genome Jan 2016. San Diego, CA, USA. Poster Presentation

27. Rios, E. (g), K. Kenworthy and **P. Munoz**. 2016. Predictive Ability of Genomic Estimated Family Values (GEFV). Plant and Animal Genome Jan 2016. San Diego, CA, USA. Poster Presentation

26. **P. Munoz**, K. Kenworthy, A. Chandra, Y. Wu, D. Martin, B. Schwartz, P. Raymer, and S. Milla-Lewis. 2015. Effect of Drought on Genotype-by-Environment Interaction on Warm- Season Turfgrasses. ASA, CSSA and SSSA International Annual Meetings. Minneapolis, MN November 15-19.

25. Quesenberry K., **P. Munoz**, and A. Blount. 2015. Breeding Vegetatively Propagated Warm Season Grasses in Florida: Past, Present, and Future. 5th International Symposium of Forage Breeding (ISFB 2015). October 19–21, in Buenos Aires, Argentina.

24. Ibáñez J. (g), H. Acuña, **P. Muñoz**, M. Gonzales, and L. Inostroza. 2015. Genetic structure of a white clover association mapping population. 5th International Symposium of Forage Breeding (ISFB 2015). October 19–21, in Buenos Aires, Argentina.

23. Cellon C. (g), R. Amadeu (u), M. Kirst, **P. Munoz** and J. Olmstead. 2015. Establishing genome-wide selection for *Vaccinium corybosum*. National Association of Plant Breeding (NAPB) July 28-30 2015, Pullman, Washington State, USA.

22. Müller B. (g), L. Neves, M.F. Resende, **P. Munoz**, M. Kirst, P. Santos, E. Paludzyszyn, and D. Grattapaglia. 2015. Genomic Selection for growth traits in Eucalyptus benthamii and E. pellita populations using a genome-wide Eucalyptus 60K SNPs chip. Tree Biotechnology Conference. June 8- 12, Florence, Italy. Poster Presentation

21. Chandra A., K. Kenworthy, B. Schwartz, P. Raymer, Y. Wu, S. Milla-Lewis, L. Nelson, **P. Munoz**, Q. Yu, J. Moss, B. Wherley, G. Miller, D. Martin, F. Waltz, B. Unruh, W. Reynolds, T. Boyer, C. Chung and M. Palma. 2015. Plant Genetics and Genomics to Improve Drought and Salinity Tolerance for Sustainable Turfgrass Production in the Southern United States. ASA, CSSA and SSSA International Annual Meetings. Minneapolis, MN November 15-19.

20. Lopez J. (g), J. Erickson, **P. Muñoz**, A. Saballos, W. Vermerris, T. Felderhoff. 2015. QTLs and Candidate Genes for Root Architecture and Reduced Stomatal Conductance in Sorghum. ASA, CSSA and SSSA International Annual Meetings. Minneapolis, MN November 15-19.

19. Saha M, T. Butler, M. Monteros, M. Tremmell, and **P. Munoz**. 2015. Prospective for Breeding Cover Crop Cultivars for the South. ASA, CSSA and SSSA International Annual Meetings. Minneapolis, MN November 15-19.

18. Rios, E. (g), K. Kenworthy and **P. Munoz**. 2015. Association of Phenotypic Traits with Ploidy and Genome Size in Annual Ryegrass. ASA, CSSA and SSSA International Annual Meetings. Graduate Student Oral Competition. Minneapolis, MN November 15-19.

17. Xing, L. (g), K. Kenworthy and **P. Munoz**. 2015. Improving Selection Accuracy with Post- Hoc Blocking in Turfgrass Breeding. ASA, CSSA and SSSA International Annual Meetings. Graduate Student Competition. Minneapolis, MN November 15-19.

16. Rucker, A. (g), **P. Munoz**, J. Dubeux, J. Vendramini, B. Anderson, B. Shwartz and M. Saha. 2015. Bermudagrass Breeding: What is next? ASA, CSSA and SSSA International Annual Meetings. Graduate Student Poster Competition. Minneapolis, MN November 15-19.

15. Rios, E. (g), K. Kenworthy, A. Blount, K. Quesenberry, B. Unruh, F. Altpeter and **P. Munoz**. 2014. Novel Turf-type Bahiagrass. ASA, CSSA and SSSA International Annual Meetings. Division C5: Graduate Student Oral Competition. Long Beach, CA, November 1-5.

14. Almeida J (g), J. Rodrigues (g), M.F. Resende, R. Santos (g), **P. Muñoz**, and M. Kirst. 2015. Including Dominance Effects in Genomic Selection Regression Models with Different Priors – Pinus taeda. Plant and Animal Genome XXI (PAG) January 10-14 2015, San Diego, California, USA.

13. Rodrigues J (g), J. Almeida (g), R. Santos (g), M.F. Resende, **P. Muñoz**, and M. Kirst. 2015. Inclusion of Dominance and GxE Effects in genomic Selection Models to Improve Predictive Ability. Plant and Animal Genome XXI (PAG) January 10-14 2015, San Diego, California, USA.

12. Olmstead J., C. Cellon(g), R. Amadeu (u), and **P. Munoz**. 2015. Toward Genomic Selection in Blueberry. Plant and Animal Genome XXI (PAG) January 10-14 2015, San Diego, California, USA.

11. **Munoz P**. A new red clover 2,4-D resistant cultivar to improve broadleaf weed control and elucidate the molecular mechanism of resistance. 8th International Symposium on Molecular Breeding of Forage and Turf. June 2014 Istanbul, Turkey. Oral Presentation

10. **Munoz P**. 2013. Maximize the use of molecular information in breeding. International IUFRO Tree Biotechnology Conference. May 26-June 01, Asheville, NC, USA. Oral Presentation

09. Resende Jr. M (g), M.D. Resende, **P. Munoz**, E. Takahashi, C. Petroli, C. Sansaloni, M. Kirst, and D. Grattapaglia. 2013. Increase in Efficiency of Genomic Selection Using Epistatic Interactions and Detection of Candidate Genes for Rust Resistance in Eucalyptus. Plant and Animal Genome XXI (PAG) January 12-16 2013, San Diego, California, USA.

08. **Munoz P**, M.F. Resende, M.D. Resende, S. Gezan, M. Kirst, and G. Peter. 2012. The Re- discovery of the Dominance Variation by Using the Observed Relationship Matrix and its implications in breeding. Fourth International Conference of Quantitative Genetics (ICQG) June 17-22 2013. Edinburgh, Scotland, UK. Poster Presentation

07. **Munoz P**, M.F. Resende, S. Gezan, M.D. Resende, M. Kirst, D. Huber, G. Campos, and G. Peter. Re-discovering non-additive effects with genomic relationship matrices and implications in breeding. Plant and Animal Genome Jan 2012. San Diego, CA, USA. Poster Presentation

06. **Munoz P**, M.F. Resende, M.D. Resende, D. Garrick, R. Fernando, G. Peter, and M. Kirst. 2012. "Benchmarking genomic prediction in forestry – what works and what doesn't for some growth, disease and resistance and developmental traits". Plant and Animal Genome XX (PAG) January 2012, San Diego, California, USA. Poster Presentation

05. **Munoz P.,** M.F. Resende, D. Huber, T. Quesada, M.D. Resende, M. Kirst and G. Peter. 2011 "Effect of

Alternative BLUP-breeding value prediction on the accuracy of genomic selection". 31th Southern Forest Tree Improvement Conference (SFTIC) June 13-16 2011, Biloxi Mississippi, USA.

04. Kirst M, **P. Munoz** and M.F. Resende. 2011 "Hyper-Accelerating Breeding and Adaptation of loblolly pine uning genomic selection". 31th Southern Forest Tree Improvement Conference (SFTIC) June 13-16 2011, Biloxi Mississippi, USA.

03. **Munoz P**, M.F. Resende, G. Peter, D. Huber, M. Kirst, and T. Quesada 2011. Effect of BLUP prediction on genomic selection: Practical considerations to achieve greater accuracy in genomic selection. BMC proceedings 5(Suppl 7): P49

02. Resende M, **P. Muñoz**, J. Acosta, M.D. Resende, D. Grattapaglia, and M. Kirst. 2011. Stability of genomic selection prediction models across ages and environments. BMC proceedings 5(Suppl 7): O14

01. Kirst M, M.F. Resende, **P. Munoz**, and L. Neves. 2011. Capturing and genotyping the genome- wide genetic diversity of trees for association mapping and genomic selection. BMC proceedings 5(Suppl 7): I49

PRESENTATIONS AT CONFERENCES, SCIENTIFIC MEETINGS AND SEMINARS (28)

I. International (14)

14. **Munoz P.**, L. Xing, L. Inostroza, and M. Bhakta. 2016. Phenotyping in the Genomic Era. International Symposium of Genetics and Plant Breeding. Phenomics: a New Era of Biometrics. July 27-28 2016, Universidad Federal of Lavras, Lavras, Brazil. **Invited Speaker**

13. **Munoz P**., E. Rios (g), M. Resende Jr., M. Kirst, M.D. Resende, and J. Filho. Genome-wide Family Prediction. 5th International Conference of Quantitative Genetics (ICQG) June **2016**, Madison, Wisconsin, USA. **Poster Presentation**

12. **Munoz P**., J. Dubeux, B. Anderson, B. Shwartz, J. Vendramini, M. Saha, M. Castillo, S. Milla-Lewis, and A. Rucker. 2016. Genomic Progress in Bermudagrass. Plant and Animal Genome (PAG) Jan **2016**, San Diego, California, USA. **Invited Speaker**

11. **Munoz P.**, K. Kenworthy, A. Chandra, Y. Wu, D. Martin, B. Schwartz, P. Raymer, S. Milla-Lewis. Effect of Drought on Genotype-by-Environment Interaction on Warm-Season Turf Grasses. ASA, CSSA and SSSA International Annual Meetings. November 15-19 **2015**. Minneapolis, MN. **Invited Speaker**

10. **Munoz P.** A new red clover 2,4-D resistant cultivar to improve broadleaf weed control and elucidate the molecular mechanism of resistance. 8th International Symposium on Molecular Breeding of Forage and Turf. June 9-12 **2014** Istanbul, Turkey. **Selected Speaker**

09. **Munoz P.** Forage Breeding and Genomics. Instituto de Investigacion Agropecuaria (INIA). May 15 **2014** Chillan, Chile. **Invited Speaker and Instructor.**

08. **Munoz P,** Resende M, Kirst M and L. Neves**.** Applications of genomic data in breeding. Embrapa. July **2013** Brasilia Brazil. **Invited Instructor.**

07. **Munoz P.** Use of molecular data in breeding. University of Talca. July **2013** Talca Chile. **Invited Speaker**

06. **Munoz P.** Maximize the use of molecular information in breeding. Chilean Fruit Consortium. July **2013** Santiago Chile. **Invited Speaker**

05. **Munoz P.** Maximize the use of molecular information in breeding. Forestal Mininco S.A. July **2013**. Temuco, Chile. **Invited Speaker**

04. **Munoz P.** Maximize the use of molecular information in breeding. IUFRO Tree Biotechnology. May 26th-June 1st **2013** Asheville, NC, USA. **Invited Speaker**

03. **Munoz P.** Quantitative Genetics and Genomic Selection Forestry Workshop. Plant and Animal Genome XXI (PAG). January 12-16 **2012** San Diego, California, USA. **Moderator**

02. **Muñoz P**, Resende M, Resende MD, Gezan S, Kirst M, Peter GF. **2012**. The Re-discovery of the Dominance Variation by Using the Observed Relationship Matrix and its implications in breeding. Fourth International Conference of Quantitative Genetics (ICQG) June 17-22 2012. Edinburgh, Scotland, UK. **Poster Presentation**

01. **Muñoz P**, Resende M, Resende MD, Garrick DJ, Fernando RL, Peter GF, Kirst M. **2012**. "Benchmarking genomic prediction in forestry – what works and what doesn't for some growth, disease and resistance and developmental traits". Plant and Animal Genome XX (PAG) January 14-18 2012, San Diego, California, USA. **Poster Presentation**

II. National (09)

09. **Munoz P.**, and L. Inostroza. How are we impacting the roots when selecting for persistence and nitrogen content. Root Biology Workshop. The Samuel Roberts Noble Foundation. November 05 **2015**. Ardmore, OK, USA. **Invited Speaker**

08. **Munoz P**. Uptades on New Forages for Florida. Central Florida Pasture Management Conference. October 1-2 **2015**. Brevard County FL. **Invited Speaker**

07. **Munoz P.** Forage Breeding and Genomic Lab. Plant Molecular and Cellular Biology Retreat. May 8- 9, **2015** Daytona, FL. **Selected Speaker**

06. **Munoz P.** Genomic Prediction for Breeding. Seminar for Plant Breeding. Oct 03 **2014** Raleigh, NC, USA. **Invited Speaker**

05. **Munoz P.** Forage Breeding and Genomics. Seminar for Crops Science. Oct 02 **2014** Raleigh, NC, USA. **Invited Speaker**

04. **Munoz P.** Breeding and Genomics. Institute of Plant Breeding, Genetics and Genomics (IPBGG). May 19-20 **2014** Tifton, GA, USA. **Invited Speaker**

03. **Munoz P.** Maximize the use of genomic information in breeding. National Association of Plant Breeders (NAPB). June 2-5 **2013** Tampa, FL, USA. **Invited Speaker**

02. **Munoz Del Valle PR**, Resende MF, Huber D, Quesada T, Resende MD, Kirst M and Peter G. "Effect of Alternative BLUP-breeding value prediction on the accuracy of genomic selection". 31th Southern Forest Tree Improvement Conference (SFTIC) June 13-16 **2011**, Biloxi Mississippi, USA. **Selected Speaker**

01. **Munoz Del Valle PR**, Huber D, Butnor J. "Introgression of Loblolly Pine Genes into Slash Pine". 30th Southern Tree Improvement Conference (SFTIC) May 31- June 03 **2009**, Blacksburg, VA, USA. **Selected Speaker**

III. Local (06)

06. **Munoz P.** Genotypic Prediction Using Family Bulks. UF Animal Science Seminars Series. March

08 **2016**, Gainesville, FL. **Invited Speaker**

05. **Munoz P.** Breeding and Genomic. Corn Metabolomics Grant Project Meeting. May 18 **2015**. Gainesville, FL. **Invited Speaker**

04. **Munoz P,** Kirst M and Resende M**.** Phenotypic prediction using genomic data. UF Genetic Institute. Aug 11 **2014** Gainesville, FL, USA. **Organizer and Moderator**

03. **Munoz P.** Updates on Bermudagrass and Alfalfa Breeding. Florida Seed Association. June 25 **2014** Citra, FL, USA. **Invited Speaker**

02. **Munoz P.** Update in Alfalfa Breeding and Cultivar Testing. Corn Silage Field Day. May 29 **2014** Citra, FL, USA. **Invited Speaker**

01. **Munoz P,** and Resende M**.** Phenotypic prediction using genomic data. UF Genetic Institute. Aug 19 **2013** Gainesville, FL, USA. **Organizer and Moderator**

TEACHING:

I. Teaching Context: I currently teach two graduate level courses, Field Plot Techniques (AGR 5266C) and Advanced Plant Breeding (AGR6322). Both courses were developed in fall 2014. Field Plot Techniques is relevant for graduate students in IFAS because it reviews the most common statistical designs in biological sciences for field, greenhouse and laboratory experiments. The objective of this course is to expose students to these different designs and to provide hands- on experience in designing and analyzing experimental data. Advanced Plant Breeding is very relevant for plant breeding graduate students. The objective of this course is to expose students to advanced methods of breeding that require a higher level of knowledge of genetics and genomics.

II. Teaching Evaluation: My "overall rating of instructor" given by my students is higher than departmental and college averages for both years I have taught (Table 1 below). In addition, a 2015 peer auditing of my class has 7 out 10 outstanding scores, while the remainder 3 are in the satisfactory category and almost no changes were recommended (Table 2 below).

Table 1. Overall student evaluation rating of instructor.

Course	Term	Number of Students	Req Y/N	Team Taught	Response Rate	Overall Rating of Instructor		
						Instructor	Department	College
AGR5266C	F16	23	Yes	87.5	83%	4.89	4.47	4.53
AGR5266C	F15	18	Yes	No	89%	4.56	4.53	4.53
AGR5266C	F14	24	Yes	No	75%	4.56	4.34	4.47
AGR4932	F16	1	No	No	100%	5.00	3.94	4.44
AGR6932	F16	2	Yes	No	100%	3.50	4.47	4.53
AGR6322	F16	17	Yes	No	82%	4.93	4.47	4.53
AGR6322	F14	6	Yes	No	100%	4.33	4.34	4.47
PCB7922	F13	9	Yes	50%	78%	4.86	4.49	4.50

Rating Scale: 1 = Poor, 2 = Below Average, 3 = Average, 4 = Above Average, 5 = Excellent

Table 2. Peer review evaluation of AGR5266C, Fall 2015.

	In need of Improvement	Satisfactory	Outstanding
Course content			x
Course organization			x
Syllabus		x	
Other handouts		x	
Quizzes, exams, other course requirements			x
Instructor enthusiasm			x
Classroom technique			x
Innovations			x
Student involvement/participation		x	
Overall course rating			**x**

Operational Definitions: Outstanding- performance far surpasses the expected level for such activities in most respects. Satisfactory- performance meets expected level for such activities in most, if not all, respects. In need of improvement- performance fails to meet expected levels for such activities in several key respects.

III. Teaching courses, Invited lectures and workshops

Graduate Course Instructor. AGR6322 - Advanced Plant Breeding. University of Florida, Gainesville, FL, USA. Since Fall 2014. Fall even-years.

Graduate Course Instructor. AGR5266C – Field Plot Techniques. University of Florida, Gainesville, FL, USA. Since Fall 2014. Fall every year.

Invited Guest Lecturer: Genomic Selection. In course "Molecular Markers for Breeder". University of Florida, Gainesville, FL, USA. November 2014

Graduate Course Instructor. PCB7922 – Journal Colloquium on Molecular Breeding. University of Florida, Gainesville, FL, USA. Fall 2013

Invited Guest Lecturer: Genomic Selection. In course "Molecular Markers for Breeder". University of Florida, Gainesville, FL, USA. November 2012

Workshop Instructor: Analysis of Experiments Using ASReml, including Genomic Selection. VSN International, Atlanta, GA, USA. Oct 15-16 2012

Invited Guest Lecturer: Analysis of Genetic Data for Breeding. In course "Advanced Plant Breeding". University of Florida, Gainesville, FL, USA. April 2012

Workshop Instructor: Analysis of Experiments Using ASReml (with emphasis on Breeding Trials). VSN International, Gainesville, FL, USA. Feb. 23-24 2012

Workshop Instructor: Analysis of Experiments Using ASReml (with emphasis on Breeding Trials). VSN International, Venado Tuerto, Argentina. Dec. 13-15 2011 (Private)

Invited Guest Lecturer: An Overview of Genomic Selection in Plant Breeding. In course "Molecular Markers for Breeders". University of Florida, Gainesville, FL, USA. November 2011

Workshop Instructor: Analysis of Experiments Using ASReml (with emphasis on Breeding Trials). VSN International, Savannah, GA, USA. Sept. 30- Oct 01 2010.

Workshop Instructor: Analysis of Experiments Using ASReml (with emphasis on Breeding Trials). VSN International, Chicago, IL, USA. June 11-12 2010.

Teaching Assistant: Formulation and Projects Evaluation 2003-2004; Accountancy and Finances 2003; Mathematical Methods 2001-2002; System Analysis 2002. Universidad Catolica de Temuco, Chile.

MENTORING

I. Graduate Students and Post-docs

Graduate students and post-docs in my lab have been successful at obtaining two research grants, eighteen national, state and local awards, and have presented their work twelve times at national and international conferences.

Name	Role	Year	Student	Area of Work
Catherine Cellon	Co-Chair	2015	MSc	Blueberry Breeding
Esteban Rios	Chair	2016	PhD	Ryegrass Breeding
Alexandra Rucker	Chair	2016	MSc	Bermudagrass Breeding
Lin Xing	Co-Chair	2017*	PhD	Complex Trait Analytic
Doug Phillips	Chair	2017*	MSc	Blueberry Anthracnose
Mehul Bhakta	Mentor	2015-2016	Post-Doc	Genomics Polyploids
Luis Inostroza	Mentor	2015-2017*	Post-Doc	Breeding and Genomics

*Expected

Committee member on ten more UF graduate student committees from the departments of agronomy, animal science, genetics and genomics, plant molecular and cellular biology and horticultural sciences.

II. Interns

I have had three undergraduate and five graduate interns in my lab since 2013. Undergraduates performed an independent project supported by one of my graduate students, while visiting graduate students worked in an independent project under my supervision as part of their dissertations. Most of these projects resulted in scientific products: three national and international poster presentations in scientific meetings, five scientific manuscripts accepted, submitted or in the final stage of preparation, and one software program uploaded to the web:

Rodrigo Amadeu	BSc Student	University of Florida/University of Sao Paulo, Brazil
Mateus Pereira	BSc Student	University of Florida/University of Sao Paulo, Brazil
Gustavo Alves	BSc Student	Federal University of Vicosa, Brazil
Ulisses Figueiredo	PhD. Student	Federal University of Lavras, Brazil
Hugo Ematne	PhD. Student	Federal University of Lavras, Brazil
Fernando Silva	PhD. Student	Universidad Estadual do Norte Fluminense, Brazil
Braulio Moraes	PhD. Student	Federal University of Lavras, Brazil
Paulo Santos	PhD. Student	Universidad Estadual do Norte Fluminense, Brazil

SPECIALIZED TRAINING

May 2012 Programing and computer algorithms with focus on genomic selection in animal breeding. University of Georgia, Athens, Georgia, USA.

Oct 2011	Statistical learning methods for DNA-based prediction of complex traits. Wageningen, The Netherlands.
Sep 2009	Generation of experimental designs with CycDesign. University of Florida, Gainesville, Florida, USA
Mar 2006	Genetics and forest biotechnology. Universidad de Concepcion and NCSU. Concepcion, Chile.

SKILLS AND LANGUAGES

Software: ASReml, R, SAS, CYCDESIGN, ARCVIEW, PERL, JMP, QTL Cartographer and JoinMap

Languages: Spanish (Native Tongue), English (bilingual proficiency) and Portuguese (basic)

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EDUCATION

University of Chicago	Biology	A.B.	1983
University of California, Los Angeles	Plant Biochemistry	Ph.D.	1988

RESEARCH & PROFESSIONAL EXPERIENCE

2011 –present	Professor, School of Forest Resources and Conservation, University of Florida
2011 –present	Co-director, Cooperative Forest Genetics Research Program, School of Forest Resources and Conservation, University of Florida
2007 –present	Co-director, Forest Biology Research Cooperative, School of Forest Resources and Conservation, University of Florida
2007-2011	Graduate Coordinator & Director, Plant Molecular & Cellular Biology Program, University of Florida
2002-2011	Associate Professor, School of Forest Resources and Conservation, University of Florida
2001-2002	Associate Professor of Forest Biology, Institute of Paper Science and Technology
1996-2001	Assistant Professor, Institute of Paper Science and Technology
1991-1996	Postdoctoral Fellow, Dept. of Plant Biology, University of California Berkeley with Ian Sussex
1988-1991	Postdoctoral Fellow, USDA-Plant Gene Expression Center, UC Berkeley with Athanasios Theologis

HONORS & AWARDS

University of Florida Research Foundation Professorship, University of Florida, 2015-2018

USDA/NIFA Partnership Award, Integration of Research, Education, Extension, University of Florida, 2016

William S. Fuller Best Paper Award, Raw Materials Committee TAPPI, 2008

University of Florida Research Foundation Professorship, University of Florida, 2008-2011

President's Award Scientific Team Advancement, Institute of Paper Science and Technology, 1998-19999

TAPPI Foundation Research Award, Department of Plant Biology, Univ. of California Berkeley, 1995-1996

USDA Individual Award, Department of Plant Biology, University of California Berkeley, 1991-1993

NSF Plant Biology Postdoctoral Fellowship, USDA/ARS Plant Gene Expression Center, Univ. of California Berkeley, 1988-1991

Distinguished Scholar Award, Department of Biology, University of California Los Angeles, 1986-1987

LEADERSHIP ACTIVITIES

Chair, Organizing Committee, IEG40 Conference, 2018

Chair, Science Advisory Board, DOE- The Center for Bioenergy Innovation, 2017-2025

Research Oversight Committee – SpruceUp, Genome Canada, 2017-2021
Chair, Organizing Committee, Southern Forest Tree Improvement Conference, 2017
Chair, Institute of Food and Agricultural Systems, Faculty Research Goal Setting Committee, University of Florida, 2015
Director, Biology Major Undergraduate Program, University of Florida, 2013-14
Chair, Faculty Advisory Committee, School of Forest Resources and Conservation, University of Florida, 2013
Science Advisory Board, DOE-BioEnergy Sciences Center, Oakridge National Lab, 2012- 2017
Director, Plant Molecular and Cellular Biology (PMCB) Graduate Program, University of Florida, 2009-2011
Graduate Programs Coordinator, PMCB Graduate Program, University of Florida, 2007-2009
Chair, Curriculum Committee, PMCB Graduate Program, University of Florida, 2006-2008
Chair, Organizing Committee, IEG40, 2005-06
Chair of Faculty, Institute of Paper Science and Technology, 2002
Chair, Admissions Committee, Institute of Paper Science and Technology, 1999-2002
Chair, Graduate Programs Reaccreditation Committee, Institute of Paper Science and Technology, 2001-2002
TAPPI/AF&PA Technology Summit Participant, 2001 & 2004
Chair, Safety Committee, Institute of Paper Science and Technology, 1998-2000
Secretary, TAPPI Fiber Supply Committee, 1997-2000

CURRENT RESEARCH PROJECTS

Commercial Production of Terpene Biofuels in Pine

- The genetics of constitutive and inducible oleoresin synthesis are being studied and multiple genetic approaches are being pursed to increase the terpene biosynthetic and storage capacity of loblolly pine. The goal is to make more significantly more terpenes in the wood of young trees.

PINEMAP

- An integrated approach is being pursued to develop regionwide understanding of loblolly pine productivity with changes in climate, with the goal of increasing planted pine forests to mitigate carbon, adapt to climate change and transfer this knowledge to land owners to increase forest resilience.

Cooperative Forest Genetics Research Program

- Long-term breeding programs in slash and loblolly pine are being conducted with traditional and molecular methods to increase growth and disease resistance. Slash pine is in its 3rd cycle of tree improvement, and many high oleoresin producers are in the program. Loblolly pine is in its 2nd cycle of tree improvement.

Forest Biology Research Cooperative/Center for Advanced Forestry Systems

- Long-term field based production ecology research is being conducted to understand the biological mechanisms that control forest productivity, sustainability and health.

PROFESSIONAL SERVICE

Panel: DOE/SDA Plant Feedstocks 2014, DOE Plant Systems Biology 2012, Triennial SFA Review 2015
ARPA-E TERRA workshop, 2014 and Biosequestration workshop 2015 Reviewer

PUBLICATIONS

Books

1. Peter, G.F. *Developments in Biological Fibre Treatment*, Pira International, Surrey, UK 2007 pp. 89.

Patents

1. Pullman, G.S. and Peter, G.F. 2002. Methods of Initiating Embryogenic Cultures in Plants US Patent # 6,492,174

Refereed Journal Articles

1. Zhang, J., Bliznyuk, N., Gezan, S.A., Jokela, E.J., Martin, T.A., Peter, G.F. 2019. Consistent genetic and environmental effects from early to mid-rotation on two-parameter Weibull distribution for loblolly and slash pine. *In preparation*.
2. Zhang, J., Peter, G.F., Gezan, S.A., Jokela, E.J., Martin, T.A., Bliznyuk, N., 2019. Loblolly and slash pine genotype x environment interactions are detected early and remain consistent through mid-rotation. *In preparation*.
3. Mewalal, R., Jones, P.C., Abraham, P.E., Annamraju, A., Weighill, D., Gunter, L.E., Pattathil, S., Jacobson, D., Tschaplinski, T.J., Peter, G.F., Tuskan, G.A., 2019. Molecular dissection of the secretory cells lining the specialized oil glands of *Eucalyptus*. *Plant Journal submitted*
4. Ramalho De Oliveira, L., Lassiter, H.A., Wilkinson, B., Whitely, T., Ifju, P., Logan, S., Peter, G.F., Vogel, J., Martin, T.A., 2019. Moving to automated tree inventory: comparison of UAS-derived lidar and photogrammetric data with manual ground estimates. *Remote Sensing* submitted
5. Peter, G.F., 2018. Breeding and engineering trees to accumulate high levels of terpene metabolites for plant defense and renewable chemicals. *Frontiers in Plant Science* 9: 1672 doi: 10.3389/fpls.2018.01672
6. Mramba, L.K., Peter, G.F., Whitaker, V.M., Gezan, S.A., 2018. Generating improved experimental designs with spatially and genetically correlated observations using mixed models. *Agronomy* 8:40. doi.org/10.3390/agronomy8040040
7. Quesada, T., Parisi, L.M., Huber, D.A., Gezan, S.A., Martin, T.A., Davis, J.M., Peter, G.F., 2017. Genetic control of growth and shoot phenology in loblolly pine (*Pinus taeda* L.) clonal trials during the second and sixth growing season. *Tree Genes and Genomes* 13: 1-15.
8. Harman-Ware, A.E., Davis, M., Peter, G.F., Sykes, R. 2017. Estimation of terpenoid content in pine biomass using hybrid fast-GC and pyrolysis-molecular beam mass spectrometry. *J. Analytical and Applied Pyrolysis* 124: 343-348.
9. Papa, G., Kirby, J., Konda, M., Tran, K., Singh, S., Keasling, J.D., Peter, G.F., Simmons, B.A., 2017. Development of an integrated approach for □-pinene recovery and sugar production from loblolly pine using ionic liquids. *Green Chemistry* 19: 1117
10. Mewalal, R., Rai, D.K., Kainer, D., Chen, F., Kulheim, C., Peter, G.F., Tuskan, G.A. 2017. Plant-derived terpenes: A feedstock for specialty biofuels. *Trends in Biotech*. 35: 227-40
11. Harman-Ware, A.E., Sykes, R. Peter, G.F., Davis, M., 2016. Determination of terpenoid content in pine by organic solvent extraction and fast-GC analysis. *Frontiers in Energy Research* 4:2 doi: 10.3389/fenrg.2016.00002.
12. Hacisalihoglu, G., Gustin, J., Louisma, J., Armstrong, P., Peter, G., Walker, A., Settles A.M. 2016. Enhanced Single Seed Trait Predictions in Soybean (*Glycine max*) and Robust Calibration Model Transfer with Near-Infrared Reflectance Spectroscopy. *Journal of Agricultural and Food Chemistry*. 64: 1079-1086.
13. Swamy, P.S., Hu, H., Pattathil, S., Maloney, V.J., Xiao, H., Xue, L-J., Chung, J-D., Johnson, V.E., Zhu, Y., Peter, G.F., Hahn, M.G., Mansfield, S.D., Harding, S.A., Tsai, C-J., 2015. Tubulin perturbation affects cell wall pectin networks, leaf expansion and stomatal behavior in *Populus*. *Journal Experimental Botany*. 20: 6507-6518.
14. Westbrook, J.W., V.E. Chhatre, L.S. Wu, S. Chamala, L.G. Neves, P. Muñoz, P.J. Martínez-García, D.B. Neale, M. Kirst, K. Mockaitis, C.D. Nelson, G.F. Peter, J.M. Davis and C.S. Echt. 2015. A consensus genetic map for *Pinus taeda* and *Pinus elliottii* and extent of linkage disequilibrium in two genotype-phenotype discovery populations of *Pinus taeda*. G3 5:1685-1694.

15. Zhang, J., Gezan, S.A., Peter, G.F., Powell, G.L., White, T.L. 2015. Comparison of breeding values estimated between single-tree and multi-tree plots for a slash pine population. *Tree Genetics Genomes*. 11: 48 DOI 10.1007/s11295-015-0870-1
16. Gonzales-Benecke, C.A, Riveros-Walker, A., Martin, T.A., Peter, G.F., 2015. Automated quantification of false rings using microdensity profiles of mature *Pinus taeda* in a replicated irrigation experiment. *Trees* 29: 185-197.
17. Westbrook, J.W., Walker, A.R., Neves, L.G., Munoz, P., Resende Jr., M.F.R., Neale, D.B., Wegrzyn, J.L., Huber, D.A., Kirst, M., Davis, J.M., Peter, G.F., 2015. Discovering candidate genes that regulate resin canal number in *Pinus* stems by integrating association genetics and QTL analysis across environments, ages, and populations. *New Phytologist* 205: 627-641.
18. Muñoz, P.; Resende Jr., M.F.R., Gezan, S.A., Resende, M.D.V., de los Campos, G., Kirst, M., Huber, D, Peter, G.F., 2014. Unraveling additive from non-additive effects using genomic relationship matrices. *Genetics* 198: 1759-1768.
19. Suseata, A., Peter, G.F., Hodges, A.W., Carter, D.R., 2014. Oleoresin tapping of planted slash pine (*Pinus elliottii Engelm*. var. *elliottii*) adds value and management flexibility to landowners in the southern United States. *Biomass and Bioenergy* 68: 55-61.
20. Muñoz, P., Resende Jr., M.F.R.., Huber, D.R., Quesada, T., Resende, M.D.V., Neale, D.B., Wegerzyn, J., Kirst, M., Peter, G.F., 2014. Impact of pedigree errors on traditional BLUP and genomic selection accuracy. *Crop Science* 54: 1115-1123.
21. Zhang, J., Novaes, E., Kirst, M., Peter, G.F. 2014. Comparison of pyrolysis mass spectrometry and near infrared spectroscopy for genetic analysis of lignocellulose composition in *Populus*. *Forests* 5: 466-481.
22. Quesada, T., Resende Jr., M.F.R., Muñoz, P. Gezan, S.A., Wegrzyn, J.L., Neale, D.B., Kirst, M., Peter, G.F., Davis, J.M., 2014. Genetic mapping of fusiform rust resistance in loblolly pine after genomic selection and association testing. *Forests* 5: 347-362; doi 10.3390/f5020347
23. White, T.L., Davis, J.M, Gezan, S., Hulcr, J., Jokela, E., Kirst, M., Martin, T.A., Peter, G.F., Powell, G., Smith, J. 2014. Breeding for value in a changing world: past achievements and future prospects. *New Forests* 45: 301-309
24. Gustin, J., Jackson, S., Williams, C., Patel, A., Baier, J., Armstrong, P., Edwards, J.W., Peter, G.F., Settles, A.M., 2013. Analysis of maize (*Zea mays*) kernel density and volume using x-ray micro-computed tomography and single-kernel near infrared spectroscopy. *Agriculture and Food Chemistry* 61: 10872-10880.
25. Häggman, H., Raybould, A., Borem, A., Fox, T., Handley, L., Hertzberg, M., Lu, M., Macdonald, P., Oguchi, T., Pasquali, G., Pearson, L. Peter, G.F., Quemada, H., Seguin, A., Tattersall, K., Ulian, E., Walter, C., McLean, M. 2013. Genetically engineered trees for plantation forests: key considerations for environmental risk assessment *Plant Biotechnology* 11: 785-98.
26. Fedenko, J.R., Erickson, J.E., Woodard, K.R., Sollenberger, L.E., Vendramini, J.M.B., Gilbert, R.A., Helsel, Z.R., Peter, G.F., 2013. Biomass production and composition of perennial grasses grown for bioenergy in a subtropical climate across Florida, USA. *Bioenergy Research* 6: 1082-1093.
27. Westbrook, J.W., Resende, M.F.R., Munoz, P., Walker, A.R., Kirst, M., Huber, D.A., Gezan, S.A., Peter, G.F., Davis, J.M. 2013. Association genetics of oleoresin flow in loblolly pine: discovering genes and predicting phenotype for improved resistance to bark beetles and bioenergy potential. *New Phytologist* 199: 89-100.
28. Resende, M.F.R.,Jr., Muñoz, P., Resende, M.D.V., Garrick, D.J., Fernando, R.L., Davis, J.M., Jokela, E.J., Martin, T.A., Peter, G.F., Kirst, M. 2012. Accuracy of genomic selection methods in a standard dataset of loblolly pine (*Pinus taeda* L.). *Genetics* 190: 1503-10.
29. Resende, M.F.R., Jr., Muñoz, P., Acosta, J.J., Peter, G.F., Davis, J.M., Grattapaglia, D., Resende, M.D.V., Kirst, M. 2012. Accelerating the domestication of trees using genomic selection: accuracy of prediction models across ages and environments. *New Phytologist* 193: 617-624.

30. Hunter, C.T., Kirienko, D.H., Sylvester, A.W., Peter, G.F., McCarty, D.R., Koch, K.E. 2012. Cellulose synthase-Like D1 is integral to normal cell division, expansion and leaf development in maize. *Plant Physiology* 158: 708-724.
31. McDonough, T.J., Courchene, C.E., White, D.E., Schimleck, L., Peter, G.F. 2012. Effects of Loblolly Pine Tree Age and Wood Properties on Linerboard Grade Pulp Yield and Sheet Properties. Part 2: Effects on Sheet Properties. *TAPPI Journal* 11: 41-50.
32. Westbrook, J.W., Resende, M.F.R., Munoz, P., Walker, A.R., Kirst, M., Huber, D.A., Gezan, S.A., Peter, G.F., Davis, J.M. 2013. Association genetics of oleoresin flow in loblolly pine: discovering genes and predicting phenotype for improved resistance to bark beetles and bioenergy potential. *New Phytologist*. 199: 89-100.
33. Resende, M.F.R.,Jr., Muñoz, P., Resende, M.D.V., Garrick, D.J., Fernando, R.L., Davis, J.M., Jokela, E.J., Martin, T.A., Peter, G.F., Kirst, M., 2012. Accuracy of Genomic Selection Methods in a Standard Dataset of Loblolly Pine (*Pinus taeda* L.). *Genetics* 190: 1503-10.
34. Resende, M.F.R., Jr., Muñoz, P., Acosta, J.J., Peter, G.F., Davis, J.M., Grattapaglia, D., Resende, M.D.V., Kirst, M. 2012. Accelerating the domestication of trees using genomic selection: accuracy of prediction models across ages and environments. *New Phytologist* 193: 617-624.
35. Hunter, C.T., Kirienko, D.H., Sylvester, A.W., Peter, G.F., McCarty, D.R., Koch, K.E. 2012. Cellulose synthase-Like D1 is integral to normal cell division, expansion and leaf development in maize. *Plant Physiology*. 158: 708-724.
36. Lunsford, K-A., Peter, G.F., Yost R., 2011. Direct matrix-assisted laser desorption ionization mass spectrometric imaging of cellulose and hemicelluloses in *Populus*. *Analytical Chemistry* 83: 6722-6730.
37. McDonough, T.J., Courchene, C.E., White, D.E., Schimleck, L., Peter, G.F., 2011. Effects of Loblolly Pine Tree Age and Wood Properties on Linerboard Grade Pulp Yield and Sheet Properties. Part 1: Effects on Pulp Yield. *TAPPI Journal* Sept. 2011: 45-53.
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40. Gonzales-Benecke, C.B., Martin, T.A., Clark III, A., Peter, G.F., 2010. Water Availability and Genetic Effects on Growth, Wood Density and Stiffness of Loblolly Pine (*Pinus taeda* L.) Stands. *Canadian Journal of Forest Research* 40: 2265-2277.
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44. White D.E., Courchene C., McDonough T., Schimleck L., Jones D., Peter G.F., Purnell R., Goyal G. 2009. Effects of Specific Gravity and Wood Chemical Content on the Pulp Yield of Loblolly Pine. *TAPPI Journal.* 8: 31-36.
45. Liu, X., Lee, S-C., Casella, G., Peter, G.F., 2008. Assessing Agreement of Clustering Methods with Gene Expression Microarray Data. *Computational Statistics and Data Analysis*. 52: 5356-5366.
46. Li, X., Huber, D.A., Powell, G.L., White, T.L., Peter, G.F., 2007. Breeding for Improved Growth and Juvenile Corewood Stiffness in Slash Pine. *Canadian J. Forest Research.* 37: 1886-1893.
47. Roth, B.E., Li, X., Huber, D.A., Peter, G.F., 2007. Effects of Management Intensity, Genetics and Planting Density on Wood Stiffness in a Plantation of Juvenile Loblolly Pine in the Southeastern USA. *Forest Ecology and Management.* 246: 155-162.

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66. Peter, G.F., Benton, D.M., Bennett, K., 2003. A Simple, Direct Method for Measurement of Microfibril Angle in Single Fibers Using Differential Interference Contrast Microscopy. *Journal of Pulp and Paper Science*. 29/8: 274 - 280
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70. Priess, S., Peter, G.F., Anandan, S., Thornber, J.P., 1993. The Multiple Pigment-proteins of the Photosystem I Antenna. *Photochemistry Photobiology*. 57: 152 – 157.
71. Peter, G.F., Thornber, J.P., 1991. Biochemical Evidence that the Higher Plant Photosystem II Core Complex is Organized as a Dimer. *Plant and Cell Physiology*. 32: 1237 – 1250.
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75. Ferguson, L., Halloran, E., Hawthornthwaite, A.M., Cogdell, R., Kerfeld, C., Peter, G.F., Thornber, J.P., 1991. The Use of Nondenaturing Deriphat-Polyacrylamide Gel-Electrophoresis to Fractionate Pigment-Protein Complexes of Purple Bacteria. *Photosynthesis Research*. 30: 139 – 143.
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Non-refereed Publications

1. Nelson, C.D., Peter, G.F., McKeand, S.E., Jokela, E.J., Rummer, R.B., Groom, L.H., Johnsen, K.H., 2013, Pines in *Biofuel Crops: Production, Physiology and Genetics*, Editor B.P.Singh, CAB International. P. 427-459.
2. Sykes, R., Yung, M. Novaes, E., Kirst, M., Peter, G.F., Davis, M., *Biofuels: Methods and Protocols*, *Methods in Molecular Biology.* High-throughput Screening of Plant Cell-wall Composition Using Pyrolysis Molecular Beam Mass Spectrometry, Editor: Mielenz J.R., Humana Press, 2009. Vol. 581 169-183.
3. Peter, G.F., *Genetic Improvement of Bioenergy Crops.* Southern Pines: A Resource for Bioenergy, Editor: Vermerris, W., Springer Press, 2008. 397-414.
4. McDonough, T.J., Courchene, C.E., White, D.E., Schimleck, L. Peter, G.F., *Effects of loblolly pine tree age and wood properties on linerboard grade pulp yield and sheet properties. Part 2: Effects on Paper Properties.* 2011. Tappi PEERS Conference. CD-ROM
5. McDonough, T.J., Courchene, C.E., White, D.E., Schimleck, L. Peter, G.F., *Effects of loblolly pine tree age and wood properties on linerboard grade pulp yield and sheet properties. Part 1: Effects on Pulp Yield.* 2010. Tappi PEERS Conference. CD-ROM
6. White, D., Courchene, C., McDonough, T., Schimleck, L., Jones, D., Peter, G.F., Purnell, R., Goyal, G., *Effects of specific gravity and lignin content on the paper properties of loblolly pine*. 2008. Tappi Engineering, Pulping and Environmental Conference. CD-ROM
7. White, D., Courchene, C., McDonough, T., Schimleck, L., Jones, D., Peter, G.F., Purnell, R., Goyal, G., *Effects of specific gravity and lignin content on the pulp yield of loblolly pine*. 2007. Tappi Engineering, Pulping and Environmental Conference. CD-ROM
8. Evans, M.A., White, D., Peter, G.F., Trends in digital printing papers: Reliability and print quality are key factors in purchase decision. 2007. *Paper360º* May 2007: 10-12.

FUNDED GRANTS & CONTRACTS

M. Kirst, **G. Peter,** P. Munoz, 2013-16

- Accelerated development of optimal pine feedstocks for bioenergy and renewable chemicals using genome-wide selection.- *USDA/DOE*

G.F. Peter, A. Hodges, 2013-2015

- Commercial production of terpene biofuels from existing slash pine plantations - *FDACS-Office of Energy*

G.F. Peter, J. Davis, M. Davis, M. Hinchee, J. Keasling, 2012-2015

- Commercial Production of Terpene Biofuels in Pine – *DOE-ARPAe*

T. Martin, **G.F. Peter**, E. Jokela, + 50 other coPIs, 2011 – 2016

- Integrating research, education and extension for enhancing southern pine climate change mitigation and adaptation – *USDA/NIFA Climate Change*

G.F. Peter, M. Kirst, G. Powell, 2011 – 2016

- Cooperative Forest Genetics Research Program - *Forest Industry*

M. Kirst, **G.F. Peter**, J.M. Davis, D. Huber, 2009 – 2013,

- Advanced Pine Breeding through Association Genetics and Biotechnology - *USDA-AFRI*

E. Jokela, **G.F. Peter**, T. Martin, J. Davis, 2009 – 2014,

- Center for Advanced Forestry Systems - *National Science Foundation University Cooperative Research Centers Program*

M. Kirst, **G.F. Peter**, 2009 – 2012,

- Mechanism of Carbon Partitioning Regulation by cpg13 in the Bioenergy Woody Crop Poplar - *DOE-USDA Plantfeed Stocks*

Y. Chen, **G.F. Peter**, 2008 – 2011,

- Towards Multiscale Mechanical Design of Hierarchical Cellular Materials - *National Science Foundation*

G.F. Peter, S. Blackband, L. Ingram, R. Yost, 2007- 2011

- Integrated Nondestructive Spatial and Chemical Analysis of Lignocellulosic Materials during Pretreatment and Bioconversion to Ethanol – *DOE Analytical Imaging*

J. Davis, E. Jokela, T. Martin, **G.F. Peter**, 2007 -present

- Forest Biology Research Cooperative – *Forest Industry*

C. Langley, D.B. Neale- UC Davis, **G.F. Peter**, J.M. Davis, M. Kirst, G. Casella, D.A. Huber, C. Loopstra, T. Byram-TAMU, B. Goldfard, B. Li- NCSU, 2005- 2010

- Association Genetics and Natural Genetic Variation of Complex Traits in Pine- *NSF Plant Genome*

INVITED SEMINARS

1. Peter, G.F., Conifer Terpenes: Manipulating an Ancient Plant Defense Pathway for Production of Renewable Chemicals and Biofuels, Southern Forest Tree Improvement Conference, Melbourne, FL, 2017
2. Peter, G.F., Conifer Terpenes: Manipulating an Ancient Plant Defense Pathway for Production of Renewable Chemicals and Biofuels, Southern Forest Tree Improvement Conference, North Carolina State University, 2016
3. Peter, G.F., Conifer Terpenes: Manipulating an Ancient Plant Defense Pathway for Production of Renewable Chemicals and Biofuels, Southern Forest Tree Improvement Conference, North Carolina State University, 2016
4. Peter, G.F., PINEMAP Overview and Update, Southern Forest Tree Improvement Conference, Hot Springs, AR, 2015
5. Peter, G.F., Conifer Terpenes: Manipulating an Ancient Plant Defense Pathway for Production of Renewable Chemicals and Biofuels, Centre for Agricultural Genomics, Spain, 2014
6. Peter, G.F., Introgression of Loblolly Pine Alleles into Slash Pine: QTL Analysis for Crown, Growth and Growth Efficiency in a Pseudo-backcross ((Slash X Loblolly) X Slash) Family IUFRO Mexican and Tropical Pines, Jacksonville, FL, 2013
7. Peter, G.F., Southern Pines: The Renewable Chemicals & Bioenergy Star. Society for In Vitro Biology, Providence, RI, 2013
8. Peter, G.F., Innovation in the Transportation Landscape, BioEnergy Science Center, Chattanooga, TN, 2013
9. Peter, G.F, Planted Forest Value: Tree Breeders Can Enable New Markets. Southern Forest Tree Improvement Conference, Clemson, SC, 2013
10. Peter, G.F., Conifer Terpenes: Manipulating an Ancient Plant Defense Pathway for Production of Renewable Chemicals and Biofuels. Florida Genetics, Gainesville, FL, 2013
11. Peter, G.F., Past, Present and Future of Breeding for Rust Resistance in Slash Pine., IEG 40 Workshop – Integrating Fusiform Rust Research, Screening and Breeding, Asheville, NC, 2012
12. Peter, G.F., Opportunities and Challenges Associated with Genetically Engineered Southern Pines, 9th Biennial Short Rotation Woody Crops Operations Working Group Conference, Oak Ridge, TN, 2012
13. Peter, G.F., Regulation of Genetically Engineered Trees, ICMBO, St. Louis, MO, 2012

14. Peter, G.F., High Terpene Pines: Transforming and Enabling New Forest Biorefineries, Frontiers in Biorefining: Chemicals and Products from Renewable Carbon, St. Simons Island, GA, 2012
15. Peter, G.F., Past, Present and Future of Breeding for Rust Resistance in Slash Pine., IEG 40 Workshop – Integrating Fusiform Rust Research, Screening and Breeding, Asheville, NC, 2012
16. Peter G.F., PINEMAP: An Integrated Research, Education and Extension Project. Sustainable Corn Annual Meeting, Chicago, Il, 2011
17. Peter, G.F., Quantitative and Association Genetics of Wood Properties in Loblolly Pine. University of Malaga, Spain 2011
18. Peter, G.F., Association and Conservation Genetics of Loblolly Pine Seville, Estacion Biologica de Donana, CSIC, Spain 2011
19. Peter, G.F., Quantitative and Association Genetics of Wood Properties in Loblolly Pine. Auburn University, Auburn, AL, 2011
20. Peter, G.F., Phenotype to Genotype: Genetics of Wood Chemistry, Bioenergy Science Center Workshop on Biomass Characterization, Golden, CO, 2011
21. Peter, G.F., Munoz, P., Huber, D.A., Martin, T.A. Introgression of Loblolly Pine Alleles into Slash Pine: QTL Analysis for Crown, Growth and Growth Efficiency in a Pseudo-backcross ((Slash x Loblolly) x Slash) Family SFTIC, Biloxi, MS, 2011
22. Peter, G.F., Characterization of woody biofeedstocks for biofuel production, National Renewable Energy Laboratory, Golden, CO, 2011
23. Peter, G.F., Integrated Nondestructive Spatial and Chemical Analysis of Lignocellulosic Materials during Pretreatment and Bioconversion to Ethanol, Bioenergy Science Center Workshop on Biomass Characterization, Riverside, CA, 2010
24. Peter, G.F., Genetic Architecture of Growth, Disease, and Wood Quality Traits in Southern Pines, Annual Meeting, NSF-IUCRC-CAFS, Indianapolis, IN, 2010
25. Peter, G.F., Quantitative and Association Genetics of Wood Properties in Loblolly Pine, IUFRO Tree Biotechnology, Whistler Mountain, Canada, 2009
26. Peter, G.F., Association Genetics to Identify Genes Controlling Wood Properties in Loblolly Pine, Southern Forest Tree Improvement Conference, Blacksburg, VA, 2009
27. Peter, G.F. Quantitative and Association Genetics of Wood Properties in Loblolly Pine, INRA Bordeaux, France 2009
28. Peter, G.F., Forest Biomass and Bioenergy, Florida State Horticultural Society & The Soil and Crop Science Society of Florida Annual Meeting, Jacksonville, FL, 2009
29. Peter, G.F., Genetic Control of Hydraulic Conductivity and Water Relations in *Populus*, Dept. of Wood Science, University of British Columbia, Vancouver, 2008
30. Peter, G.F., Genetic and Environmental Control of Juvenile Corewood Stiffness in Southern Pine, INIA, Madrid, Spain, 2007
31. Peter, G.F., Genetic Control of Xylem Hydraulics and Linkages with Growth and Water Relations in Populus, Department of Forestry and Natural Resources, Purdue University, West Lafayette, IN, 2007
32. Peter, G.F., The Value of Forest Biotechnology: A Cost Modeling Study with Loblolly Pine and Kraft Linerboard in the Southeastern USA, IUFRO Tree Biotechnology-2007, Ponta Delgada, Azores, Portugal, 2007

GRADUATE STUDENTS & POSTDOCTORAL SCHOLARS TRAINED

- **UF Ph.D**.: Derek Drost, 2009; Xiaobo Li, 2009; Patricio Munoz, Alejandro Riveros Walker, current; Jianxing Zhang, current;
- **UF MS**: Brianna Miles, 2007; Anne Mwaniki, 2009
- **Postdoctoral**: Tania Quesada, current; Yongsheng Wang, current

COURSES TAUGHT (Last 5 years)

Plant Molecular Biology and Genomics; Forest Productivity, Sustainability and Health; Forests for the Future, Journal Colloquia

EXTENSION & OUTREACH

Co-Director Cooperative Forest Genetics Research Program: We breed loblolly and slash pine with our members (ArborGen, Florida Forest Service, Four Rivers Land and Timber, Georgia Forestry Commission, International Forest Company, Rayonier, Weyerhaeuser) for development of commercial lines.

Co-Director Forest Biology Research Cooperative: We conduct research on the productivity, health and sustainability of planted loblolly and slash pines.

BALA RATHINASABAPATHI, Ph.D.
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PROFESSIONAL INTERESTS
Metabolic Adaptation of Plants to Environmental Stress. Horticulture Education.

EDUCATION

Univ. of Saskatchewan, Saskatoon, Canada	Biology	Ph.D.	1990
Indian Agricultural Res. Institute, New Delhi	Genetics	M.Sc.	1985
Annamalai University, India	Agriculture	B.Sc.	1983

EMPLOYMENT

2012 – present	Professor, Horticultural Sciences, University of Florida
2014 – 2018	Graduate coordinator, Horticultural Sciences, University of Florida
2003 - 2012	Associate Professor, Horticultural Sciences, University of Florida.
1997 - 2003	Assistant Professor, Horticultural Sciences, University of Florida
1994 – 1997	Research Associate, Horticultural Sciences, University of Florida.
1991 – 1994	Postdoctoral Associate, IRBV., University of Montreal, Montreal.
1990 – 1991	Postdoctoral, DOE-PRL, Michigan State Univ, East Lansing, MI
1985 – 1990	Graduate Assistant, University of Saskatchewan, Saskatoon

PROFESSIONAL ACTIVITIES AND AWARDS
Nominee for College of Agriculture Outstanding Undergraduate Teaching Award (2010, 2012)
Elected to Gamma Sigma Delta, University of Florida (2002)
Outstanding Teacher of the Year, Environ. Horticulture Club, Univ. of Florida (1997-98)
Travel award, American Society of Plant Biologists (1998)
University of Saskatchewan Graduate Scholarship (1985-90)
Fellowship, India Foundation, Pune (1985)
Summer fellow, Tata Institute of Fundamental Research, Bombay (1984)
Indian Council of Agricultural Research Junior Research Fellowship (1983-85)
National Merit Scholarship (1980-83)

PROFESSIONAL AFFILIATIONS
American Society of Plant Biologists (ASPB)
American Society of Horticultural Science (ASHS)
Florida State Horticultural Society (FSHS)

TEACHING
HOS3020 General Horticulture (4 credits)
VEC2100 World Herbs and Vegetables (3 credits)
VEC3221 Vegetable Crop Production (3 credits)
HOS6932 Topics (Food Phytochemicals, Proteomics, Metabolic Engineering) (1 credit)

HOS5711 Phytochemicals in Food and Health (3 credits)
BOT 6935 Plant Biochemistry (4 credits)
HOS5242 Genetics and Breeding of Vegetable Crops (3 credits)
HOS 1014 Vegetable Gardening (1 credit).
Developed a special curriculum in plant breeding and genetics to involve undergraduate students in research- "Building Better Peppers", an on-going project since 2010.

GRADUATE STUDENTS, POST-DOCTORAL AND VISITING SCHOLARS

Current Ph.D. students (4):
Qingyuan Xiang, David Friedman, Jingwei Fu, Caitlin Clarke
Past graduate students (7):
Dr. Newton Kilasi, Dr. Elton Goncalves, Dr. Walid Fouad, Dr. Aparna Krishnamurthy, Dr. Richard Buker (co-advisor), Dr. Piyasa Ghosh (co-advisor), Saul Sotomayor (M.S.)
Past visiting scholars/post-docs (10):
Dr. Jose Francisco, Adeel Shahid Dr. Suresh B. Raman, Dr. Victor Odjeba, Dr. Mohammed Aly, Dr. K. Soorianathasundaram, Dr. S. Sundaram, Dr. M. El-Zohri, Dr. L. Vilarinho, M.L.Grigio.

GRANTS (since 2004 to present): $900,000 in external funding and $ 205,800 in internal funding.

Recent grants are listed below:

Nematode resistant pepper varieties for Florida. FDAC Block Grant. 2018. $81,371.
Improved specialty peppers for Florida's fresh produce market, FDAC,2016. $87,785.
Educational resources for teaching plant breeding. Role: PI. College of Agriculture and Life Sciences, University of Florida, $ 4000. 2011.
Genomics of heat stress tolerance in rice. IFAS Climate change and Florida's Agricultural, Natural Resources and Human Systems Program, Univ of Florida. 2016. $ 121000.
Engineering heat tolerant maize, USDA-SBIR, $ 91,607. Role: Co-PI. 2014-2015.
Engineering glutaredoxins for stress tolerance and yield, Consortium for Plant Biotechnology Research Inc. $189,600. Role: PI. 2009 -2013.
Genetic improvement of tropical vegetables for heat stress tolerance and yield. Role: PI. USDA-TSTAR $91,644. Role: PI. 2005-2007.

REFEREED JOURNAL ARTICLES (Listed 2013-2019) Career total = 96

96. Abid, R., Manzoor, M., De Oliveira, L.M., Da Silva, E., **Rathinasabapathi, B**., Rensing, C., Mahmood, S., Liu, X., Ma, L.Q. (2019) Interactive effects of As, Cd and Zn on their uptake and oxidative stress in As-hperaccumulator *Pteris vittata*. Environmental Pollution 248: 756-762.

95. Manzoor, M., Abid, R., **Rathinasabapathi, B**., De Oliveira, L.M., Da Silva, E., Deng, F., Rensing, C., Arshad, M., Gul, I., Ma, L.Q. (2019) Metal tolerance of arsenic-resistant bacteria and their ability to promote plant growth of *Pteris vittata* in Pb-contaminated soil. Science of the Total Environment 660: 18-24.

94. Nascimento, G.O., Souza, D.P., Santos, A.S., Batista, J.F., **Rathinasabapathi, B**., Gagliardi, P.R., Goncalves, J.F.C. (2019) Lipidomic profiles from seed oil of *Carapa guianensis* Aubl. and *Carapa vasquezii*,Kenfact and implications for the control of phytopathogenic fungi. Industrial Crops and Products 129: 67-73.

93. Khan, N., Bano, A.,Rahman, M.A., Rathinasabapathi, B., Babar, M.A. (2019) UPLC-HRMS-based untargeted metabolic profiling reveals changes in chickpea (*Cicer arietinum*) metabolome following long-term drought stress. Plant, Cell & Environment 42: 115-132.

92. Shahid, M.A., Balal, R.M., Khan, N., Rossi, L., **Rathinasabapathi, B**., Liu, G., Khan, J., Camara-Zapata, J.M., Martinez-Nicolas, J.J., Garcia-Sanchez, F. (2018) Polyamines provide new insights into the biochemical basis of Cr-tolerance in Kinnow mandarin grafted on diploid and double-diploid rootstocks. Environmental and Experimental Botany 156: 248-260.

91. Shahid, M.A., Balal, R.M., Khan, N., Zotarelli, L., Liu, G., Ghazanfar, M.U., **Rathinasabapathi, B**., Mattson, N.S., Martinez-Nicolas, J.J., Garcia-Sanchez, F (2018) Ploidy level of citrus rootstocks affects the carbon and nitrogen metabolism in the leaves of Chromium-stressed Kinnow mandarin plants. Environmental and Experimental Botany 149: 70-80.

90. Kilasi, N., Singh, J., Vallejos, C.E., Ye, C., Jagadish, S.V.K., Kusolwa, P., **Rathinasabapathi, B.** (2018). Heat stress tolerance in rice (*Oryza sativa L.*): Identification of quantitative trait loci and candidate genes for seedling growth under heat stress. Frontiers in Plant Science 9: 1578.

89. Bera, T., McLamore, E.S., Wasik, B., **Rathinasabapathi, B**., Liu, G (2018) Identification of a maize (*Zea mays* L.) inbred line adapated to low-P conditions via analyses of phosphorus utilization, root acidification and calcium influx. Journal of Plant Nutrition and Soil Science 181: 275-286.

88. Han, Y.H., Liu, X., **Rathinasabapathi, B**., Li, H.B., Chen, Y., Ma, L.Q.(2017) Mechanisms of efficient As solubilization in soils and As accumulation by As-hyperaccumulator *Pteris vittata.* Environmental Pollution 227: 569-577.

87. Chen, Y., Hua, C., Jia, M., Fu, Y., Liu, Y., **Rathinasabapathi, B**., Cao, Y., Ma, L.Q. (2017) Heterologous expression of *Pteris vittata* arsenite antiporter PvACR3;1 reduces arsenic accumulation in plant shoots. Environmental Science and Technology 51: 10387-10395.

86. Fu, J., Xue, L., Han, Y., Mei, H., Cao, Y., De Oliveira, L.M., Liu, Y., **Rathinasabapathi, B**., Chen, Y., Ma, L.Q. (2017) Arsenic hyperaccumulator *Pteris vittata* efficiently solubilized phosphate rock to sustain plant growth and As uptake. J Hazardous Materials 330: 68-75.

85. Chen, Y., Han, Y., Cao, Y., Zhu, Y., **Rathinasabapathi, B**., Ma, L.Q. (2017) Arsenic transport in rice and biological solutions to reduce arsenic risk from rice. Frontiers in Plant Science 8.

84. De Oliveira, L.M., Das, S., Gress, J., **Rathinasabapathi, B**., Chen, Y., Ma, L.Q. (2017) Arsenic uptake by lettuce from As-contaminated soil remediated with *Pteris vittata* and organic amendment. Chemosphere 176: 249-254.

83. Grigio, M., Chagas, E.A., **Rathinasabapathi, B.,** Chagas, P.C., Da Silva, A.R.V., Sobral, S.T., De Oliveira, R.R. (2017) Qualitative evaluation and biocompounds present in different parts of Camu-camu (*Myrciaria dubia*) fruit. African Journal of Food Science 11: 124-129.

82. Han, YH., Liu, X., **Rathinasabapathi, B**., Li, H.B., Chen, Y., Ma, L.Q. (2017) Mechanisms of efficient As solubilization in soils and As accumulation by As-hyperaccumulator *Pteris vittata*. Environmental Pollution 227: 569-577.

81. Balal, R.M., Shahid, M.A., Vincent, C., Zotarelli, L., Liu, G., Mattson, N.S., **Rathinasabapathi, B**., Martinez-Nicolas, J.J., Garcia-Sanchez, F. (2017) Kinnow mandarin plants grafted on tetraploid rootstocks are more tolerant to Cr-toxicity than those grafted on its diploid one. Environmental and Experimental Botany 140: 8-18.

80. Chen, Y., Hua, C., Jia, M., Fu, Y., Liu, Y., **Rathinasabapathi, B**., Cao, Y., Ma, L.Q. (2017) Heterologous expression of Pteris vittata arsenite antiporter PvACR3;1 reduces arsenic accumulation in plant shoots. Environmental Science and Technology (in press).

79. Han YH, Fu JW, Xiang P, Cao Y, **Rathinasabapathi B**, Chen Y, Ma LQ (2017) Arsenic and phosphate rock impacted the abundance and diversity of bacterial arsenic oxidase and reductase genes in rhizosphere of As-hyperaccumulator *Pteris vittata*. Journal of Hazardous Materials 321: 146-153.

78. Liu X, Fu JW, Da Silva E, Shi XX, Cao Y, **Rathinasabapathi B**, Chen Y, Ma LQ (2017) Microbial siderophores and root exudates enhanced goethite dissolution and Fe/As uptake by As-hyperaccumulator Pteris vittata. Environmental Pollution 16: 32459-9.

77. Chen Y, Fu JW, Han YH, **Rathinasabapathi B**, Ma LQ (2016) High As exposure induced substantial arsenite efflux in As-hyperaccumulator *Pteris vittata*. Chemosphere 144: 2189-2194.

76. Han YH, Fu JW, Chen Y, **Rathinasabapathi B**, Ma LQ (2016) Arsenic uptake, arsenite efflux and plant growth in hyperaccumulator *Pteris vittata*: Role of arsenic-resistant bacteria. Chemosphere 144: 1937-1942.

75. De Oliveira LM, Gress J, De J, **Rathinasabapathi B**, Marchi G, Chen Y, Ma, LQ (2016) Sulfate and chromate increased each other's uptake and translocation in As-hyperaccumulator *Pteris vittata*. Chemosphere 147: 36-43.

74. Goncalves, EC, Wilkie, AC, Kirst M, **Rathinasabapathi, B** (2016) Metabolic regulation of triacylglycerol accumulation in the green algae: identification of potential targets for engineering to improve oil yield. Plant Biotechnol J. 14: 1649-1660.

73. Goncalves, EC, Koh, J., Zhu N, Yoo MJ, Chen S, Matsuo, T, Johnson JV, **Rathinasabapathi, B** (2016) Nitrogen starvation-induced accumulation of triacylglycerol in the green algae: Evidence for a role for ROC40, a transcription factor involved in circadian rhythm. Plant Journal 85: 743-757.

72. Ghosh, P., **Rathinasabapathi, B**., Ma, L.Q. (2015) Phosphorus solubilization and plant growth enhancement by arsenic-resistant bacteria. Chemosphere 134: 1-6.

71. Ghosh, P., **Rathinasabapathi, B**., Teplitski, M., Ma L.Q. (2015) Bacterial ability in AsIII oxidation and AsV reduction: Relation to arsenic tolerance, P uptake, and siderophore production. Chemosphere 138 : 995-1000.

70. El-Zohri, M., Odjegba, V., Ma, L., **Rathinasabapathi, B** (2015) Sulfate influx transporters in Arabidopsis thaliana are not involved in arsenate uptake but critical for tissue nutrient status and arsenate tolerance. Planta 241: 1109-1118.

69. Lessl, J.T., Guan, D.X., Sessa, E., **Rathinasabapathi, B**., Ma, L.Q. (2015) Transfer of arsenic and phosphorus from soils to the fronds and spores of arsenic hyperaccumulator Pteris vittata and three non-hyperaccumulators. Plant Soil 390: 49-60.
68. Wang, X., Peng, B., Tan, C., Ma, L., **Rathinasabapathi, B**. (2015) Recent advances in arsenic bioavailability, transport and speciation in rice. Environ Sci Pollut Res 22: 5742-5750.

67. Chen YS, Han YH, Rathinasabapathi B, Ma LQ (2015) Naming and function of ACR2, arsenate reductase, and ACR3 arsenite efflux transporter in plants. Environ. Int. 81: 98-99.

66. Sun, H.J., **Rathinasabapathi, B**., Wu, B., Luo, J, Pu, L.P., Ma, L.Q. (2014) Arsenic and selenium toxicity and their interactive effects in humans. Environ. Int. 69: 148-158.

65. Zhu L.J., Guan, D.X., Luo, J., **Rathinasabapathi, B**., Ma, L.Q. (2014) Characterization of arsenic-resistant endophytic bacteria from hyperaccumulators *Pteris vittata* and *Pteris multifida*. Chemosphere 113: 9-16.

64. Tisarum, R., Lessl, J., Dong, X., de Oliverria LM, **Rathinasabapathi, B**., Ma, L.Q. (2014) Antimony uptake, efflux and speciation in arsenic hyperaccumulator *Pteris vittata*. Environmental Pollution 186: 110-114.

63. Goncalves, E., **Rathinasabapathi, B** (2013) Nitrogen starvation in biofuel green algae: Recycling of membrane lipid acyl groups to triacylglycerol and the formation of lipid bodies at early and late time points. Planta 238: 895-906.

62. Krishnamurthy, A., **Rathinasabapathi, B** (2013) Oxidative stress tolerance in plants: Novel interplay between auixn and reactive oxygen species signaling. Plant Signaling and Behavior doi 10.4161/psb.25761.

61. Krishnamurthy, A., **Rathinasabapathi, B** (2013) Auxin and its transport play a role in plant tolerance to oxidative stress from arsenite, high temperature stress and salinity in *Arabidopsis thaliana*. Plant Cell, & Environment 36: 1838 - 1849.

60. Lessl, J.T., Ma, L.Q., **Rathinasabapathi, B**, Guy C (2013) A novel phytase from *Pteris vittata* resistant to arsenate, high temperature, and soil inactivation. Environmental Science and Technology 47: 2204-2211.

BOOK CHAPTERS (Listed 2011-2019) Career total = 12

12. **Rathinasabapathi, B** (2019) Improving vegetable Capsicums for fruit yield, quality and tolerance to biotic and abiotic stress. In: Genome Designing of Climate-Smart Vegetable Crops, C. Kole (ed.), Springer-Nature.

11. **Rathinasabapathi, B**. Liu, X., Cao, Y., Ma, L.Q. (2018) Phosphate solubilizing Pseudomonads for improving crop plant nutrition and agricultural productivity. In: 'Crop Improvement through Microbial Biotechnology" Edited by Prasad, R., Gill, S.S. and N. Tuteja, Elsevier.

10. **Rathinasabapathi, B**. (2011) Functional genomics of drought tolerance in crops: Engineering transcriptional regulators and pathways. In: 'Improving Crop Resistance to Abiotic Stress" Edited by N. Tuteja, A.F. Tiburcio, S. S. Gill and R. Tuteja, Wiley-Blackwell, Wiley-VCH Verlag .

PATENTS Career total = 4

4. **Rathinasabapathi, B**., Fouad, W (2014) Increased stress tolerance and enhanced yield in plants. U.S. Patent No. 8,748,696.

3. **Rathinasabapathi, B**., Sundaram S (2013) Increased stress tolerance, yield, and quality via glutaredoxin overexpression. U.S. Patent No. 8,519,226.

2. **Rathinasabapathi, B**., Raman SB (2007) Beta-alanine *N* methyltransferase. U.S. Patent No. 7,202,084.

1. Hanson, AD., **Rathinasabapathi, B**., Burnet M. (2001) Polynucleotide encoding choline monooxygenase and plants transformed therewith. U.S. Patent No. 6,310,271.

MÁRCIO FERNANDO RIBEIRO DE RESENDE JR., Ph.D.
Assistant Professor, Corn Breeding and Genomics
University of Florida, Institute of Food and Agricultural Sciences
Horticultural Sciences Department, Plant Molecular and Cellular Biology Program
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https://www.resendelab.com/

EDUCATION

2010 – 2014 Ph.D. in Genetics and Genomics - University of Florida, Gainesville, USA
2008 – 2010 M.Sc. in Genetics and Plant Breeding - Federal University of Vicosa, Brazil
2004 – 2008 B.S. in Forest Engineering (Honors) - Federal University of Vicosa, Brazil

PROFESSIONAL EXPERIENCE

2017 Assistant Professor, Sweet Corn Breeding and Genetics – University of Florida (**Current**)
2015 Chief Executive Officer, RAPiD Genomics, LLC, Gainesville, FL.
2013 Consultant Quantitative Genetics, Beck's Hybrids, Indiana.
2013 VP of Science Operations, RAPiD Genomics, LLC., Gainesville, FL.
2013 Invited Instructor ASReml, VSN International, Hemel Hempstead, United Kingdom.
2011 Board of directors' member, RAPiD Genomics LLC., Gainesville, FL.
2010 Research Assistant, University of Florida / Arborgen.
2009 Consultant Quantitative Genetics, AcelorMittal, Brazil.
2008 Quantitative Genetics Research Assistant, Federal University of Viçosa, Brazil.
2007 Plant Breeding Research Assistant, Federal University of Viçosa, Brazil.

GRANTS

1. Resende M.F.R. (PI) *et al.* – UF-PBGI, **$120,000.00**
2. Settles, Resende M.F.R. (co-PI) *et al.* – USDA-SCRI (#2018-51181-28419), **$7,382,441.00**
3. Kirst, Resende M.F.R. (co-PI) *et al.* – NSF-PGRP (#1444543), **$1,956,424.00**
4. Kirst, Resende M.F.R. (co-PI) *et al.* – NSF-I-Corp (#1742833), **$50,000.00**
5. Sandoya, Resende M.F.R. (co-PI) *et al.* – UF-PBGI, **$120,000.00**
6. Rios, Resende M.F.R. (co-PI) *et al.* – UF-PBGI, **$120,000.00**

PUBLICATIONS

Total: **36** Citations: **1244** H-index: **18** I10-index: **22** Patents**: 4**

Selected publications:

1. Ferrão L.F.V, Marinho C., Munoz P., **RESENDE M.F.R.**, **Integration of Dominance and Marker x Environment Interactions into Maize Genomic Prediction Models.** bioRxiv, 2018.

2. Sousa T.V., Caixeta E.T., Alkimim E.R., Oliveira A.C.B., Pereira A.A., Sakiyama N.S., **RESENDE M.F.R**., Zambolim L. **Population structure and genetic diversity of coffee progenies revealed by genome-wide SNP marker.** *Tree Genetics and Genomics* 13:124. 2017.

3. Muller, B., Neves, L.G., Filho, J.A., **RESENDE M.F.R.**, *et. al.* **Genomic prediction of growth traits in breeding populations of Eucalyptus benthamii and E. pellita and a contrast to genome-wide association in explaining heritable variation.** *BMC genomics 18 (1), 524.* 2017.

4. Tieman, D.M., Zhu, G., **RESENDE M.F.R.**, Nguyen, C., Bies, D., Rambla, J.L., Beltran, K.S.O, Taylor, M., Zhang, B., Ikeda, H., Liu, Z., Fisher, J., Monforte, A., Zamir, D., Granell, A., Kirst, M., Huang, S., Klee, H.J. **A genetic roadmap to improved tomato flavor.** *Science* 355 (6323), 391-394. 201

5. Fahrenkrog, A.M., Neves, L.G., **RESENDE M.F.R.**, Vazquez, A.I., de los Campos, G., Dervinis, C., Sykes, R., Davis, M., Davenport, R., Barbazuk, W., Kirst, M. **Genome-wide association study reveals putative regulators of bioenergy traits in Populus deltoides.** DOI: 10.1111/nph.14154. *New Phytologist*, 2017.

6. Amadeu, R., Cellon, C., Olmstead J., Garcia, A., **RESENDE M.F.R.,** Munoz, P. AGHmatrix: **R package to construct relationship matrices for autotetraploid and diploid species, a Blueberry Example.** DOI: 103835/plantgenome2016.01.0009. *The Plant Genome*, 2016.

7. Song, J., Yang, X., **RESENDE M.F.R.**, Neves, L.G., Todd, J., Zhang, J., Comstock, J., Wang, J. **Natural allelic variation in the germplasm of highly polyploid sugarcane.** DOI: 10.3389/fpls.2016.00804. *Frontiers in Plant Science*, 2016.

8. Vazquez, A., Veturi, Y., Behring, M., Shrestha, S., Kirst, M., **RESENDE M.F.R.**, de los Campos, G. **Increased Proportion of Variance Explained and Prediction Accuracy of Survival of Breast Cancer Patients with use of Whole-Genome Multi-Omic Profiles.** DOI: 10.1534/genetics.115.185181, *Genetics*, 2016.

9. Raposo F.A., Neves L.G., **RESENDE M.F.R.**, Mobili F., Miyaki C.Y., Pellegrino K.C.M., Biondo C. **Ultraconserved elements sequencing as a low-cost source of complete mitochondrial genomes and microsatellite markers in non-model amniotes.** *PLoS ONE* 10: e0138446, 2015.

10. **RESENDE M.F.R.**, Munoz P., Resende M.D.V., Garrick D.J., Fernando R.L., Davis J.M., Jokela E.J., Martin T.A., Peter G.F., Kirst M. **Accuracy of genomic selection methods in a standard data set of loblolly pine (*Pinus taeda* L.).** *Genetics,* 190: 1503–1510, 2012.

OTHER ACTIVITIES OF DISTINCTION

1. Chair/organizer of the symposium "Phenotype prediction using genomic data" (2013-2019) that happens annually at University of Florida with over 500 attendees every year

2. Co-leading the efforts to establish a Ph.D. program in Plant Breeding at UF
3. Faculty advisor of the Plant Science Council – graduate student organization.
4. Associate editor – Crop Science Journal
5. Young Entrepreneur: Award granted by the State of Florida and Governor Rick Scott.
6. Utility patent recognition: 9th Annual UF/IFAS FAES Awards Ceremony.

7. Currently mentoring 3 UF graduate students, 4 visiting Ph.D. student, 2 post-docs and 1 undergrad
8. Carrying extension work with multiple sweet corn growers in Florida
9. Invited to sit on 2 grant review panels (DOE and USDA-AFRI).
10. Invited to give talks in multiple meetings including international conferences.

ESTEBAN FERNANDO RIOS, Ph.D.
Assistant Professor, Forage Breeding and Genetics
Agronomy Department
University of Florida, Institute of Food and Agricultural Sciences
2005 SW 23rd Street, Bldg 350, Gainesville, FL 32608
352-301-2244, estebanrios@ufl.edu

EDUCATION

Ph.D. 2016. Agronomy, University of Florida (UF). Area: Forage Breeding.

M.S. 2013. Agronomy, UF. Area: Forage and Turfgrass Breeding.

B.S. 2010. Agronomy Engineer, Universidad Nacional del Nordeste (UNNE), Argentina.

RESEARCH PORTFOLIO *(*undergraduate and ^graduate student under my supervision)*

Refereed publications

1. ^Minski da Motta E., et al., and E. Rios. Nutritive value and forage production in *Paspalum* interspecific hybrids. *Under review: Chilean J. Agri. Res.*

2. Rios, E., et al. Genetic Parameters for Agronomic and Morphological Traits in Annual Ryegrass (*Lolium multiflorum* Lam.). 2019. *Crop Sci. doi:10.2135/cropsci2019.02.0126.*

3. Rios, E., et al. Management Practices for Improving Seed Production in Turf and Forage Type Bahiagrass (*Paspalum notatum* Flügge). *Under review: Crop Sci.*

4. *Pereira, M., E. Rios, et al. 2017. Comparisons of Turf-Type Bahiagrass for Root and Shoot Parameters Under Various Nitrogen Regimes. *Int. Turfgrass Soc. Res. J. 13:1–11.*

5. Rios, E., K. et al. 2017. Breeding Apomictic Bahiagrass (*Paspalum notatum* Flügge) with Improved Turf Traits. *Plant Breeding 136:253–260.*

6. Rios, E., K. Kenworthy and P. Munoz. 2015. Association of Phenotypic Traits with Ploidy and Genome Size in Annual Ryegrass. *Crop Sci.* 55:2078-2090.

7. Rios, E., et al. 2015. Ergot resistant tetraploid bahiagrass and fungicide effects on seed yield and quality. *Plant Health Progress* 16, 56-62.

8. Zilli, A.L., E.A. Brugnoli, F. Marcón, M.B. Billa, E.F. Rios, et al. Acuña 2015. Heterosis and Expressivity of Apospory in Tetraploid Bahiagrass Hybrids. *Crop Sci*. 55:1189–1201.

9. Rios E.; Blount A.; Kenworthy K.; Acuña C.; Quesenberry K. 2013. Seasonal expression of apospory in bahiagrass. *Tropical Grasslands–Forrajes Tropicales* 1:116–118.

10. Rios, E., et al. 2013. Root and Shoot Characterization of Mutant Turf-Type Bahiagrass. *Int. Turfgrass Soc. Res. J.* Volume 12.

Book chapter

1. Sollenberger, L., et al., and **E. F. Rios**. 2019. Warm-Season Grasses for Humid Areas. Forages: The Science of Grassland Agriculture (7th Edition). *In press*.

Most recent oral presentations *(*invited speaker)*

1. *X Brazilian Plant Breeding Congress, July 2019, Aguas de Lindoia, Sao Paulo, Brazil.
2. International Forage and Turf Breeding Conference. March 24-27 2019, Orlando, FL, USA.
3. *XXII Int. Symposium in Genetics and Plant Breeding, November 2018, Lavras, Brazil.
4. *INERA, June 2018, Bobo-Diulasso, Burkina Faso.
5. North America Alfalfa Improvement Conference, June 2018, Logan, UT.
6. *Instituto de Botanica del Nordeste, February 2017, Corrientes, Argentina.
7. *Universidad Autonoma de Chapingo, 2017, Texcoco, Mexico.

GRANTS

1. Bill & Melinda Gates Foundation/UF LSIL. Investigator, 2018-2022. ($8,742,893).
2. USAID-AREA Project. Co-PI, 2017-2019 ($45,579.24, out of $7,510,829).
3. USDA-AFRP. Co-PI, 2017-2019 ($34,000, out of $250,000).
4. USDA-SARE. Co-PI, 2017-2019 ($19,695, out of $205,138).
5. Corteva. UF Plant Science Symposia 2016 to 2019 ($32,000).
6. Florida Cattle Enhancement Board. PI, 2016-2020 ($175,000).
7. UF-IFAS Plant Molecular Breeding Initiative. PI, 2019-2022 ($120,000).
8. Florida Milk-Checkoff Program. PI, 2018-2020 ($42,000).
9. UF-IFAS Office of Research Young Breeder Equipment Funds. PI, 2017 ($35,901).
10. UF-IFAS Office of Research. PI, 2017 ($31,153).

AWARDS AND HONORS *(*undergraduate under my supervision)*

- *Best poster presentation: Maryjo Valle. Undergraduate research competition at the Southern Branch ASA Annual Meeting, February 2018, Jacksonville, Florida.
- 2016-17 Best dissertation Award, Agronomy Department, UF (Jan 2017).
- Jimmy G. Cheek Medal of Excellence (2016).
- UF Outstanding Graduate Student Award, UF Graduate Student Council (2016).
- UF/IFAS – Dean for Research, 2016 High Impact Research Publication.

LEADERSHIP, INVOLVEMENT AND PROFESSIONAL SERVICE

- Faculty advisor: Agronomy Graduate Student Association and the UF Plant Science Council.
- Crop Science Society of America C6 division session moderator: R.F. Barnes Ph.D. Oral Contest

and Graduate Student Poster Session during the 2017 Annual Meeting, Tampa, FL.

- Associate Editor of the Brazilian Journal of Animal Science.
- Ad hoc reviewer for Crop Science, Agronomy Journal, Theoretical and Applied Genetics, Industrial Crops and Products, Canadian Journal of Plant Science.

TEACHING AND MENTORING

I teach three graduate-level courses and I have mentored 26 students. My areas of expertise and instruction are genetics, plant breeding and experimental designs.

Average teaching evaluation scores across all classes and sections (*3 classes, 7 sections*)

	Question	Fall_2017	Spring_2018	Fall_2018	**Mean**
1	Description of course objectives and assignments	4.73	4.93	4.31	**4.66**
2	Communication of ideas and information	4.45	4.86	4.37	**4.56**
3	Expression of expectations for performance in this class	4.64	4.93	4.41	**4.66**
4	Availability to assist students in or out of class	5.00	5.00	4.60	**4.87**
5	Respect and concern for students	5.00	4.93	4.94	**4.96**
6	Stimulation of interest in course	4.82	4.93	4.69	**4.81**
7	Facilitation of learning	4.73	4.93	4.34	**4.67**
8	Enthusiasm for the subject	4.82	5.00	4.84	**4.89**
9	Encouragement of independent, creative, & critical thinking	4.82	4.86	4.84	**4.84**
10	**Overall rating of the instructor**	**4.73**	**5.00**	**4.69**	**4.81**

Number of students and mentees (*numbers in parenthesis indicate degree completion*)

Role	**Degree and number of students**
Chair	PhD: 1; MS: 3 (2)
Co-Chair	PhD: 1; MS 2
Committee member	PhD: 2; MS: 5 (2)
Mentor	Postdoctoral researcher: 2; Visiting students: 9 (1); Undergraduates: 5

HARDEV S. SANDHU, Ph.D.
Assistant Professor
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Phone: 561-993-1567, Fax: 561-993-1582
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EDUCATION

2002 B. Sc., Agriculture, Punjab Agricultural University, Ludhiana, India
2005 M. Sc., Entomology, Punjab Agricultural University, Ludhiana, India
2010 Ph.D., Entomology, University of Florida, Gainesville, FL

PROFESSIONAL EXPERIENCE

2014-present Assistant Professor, Agronomy Department, EREC, UF-IFAS, Belle Glade, FL
2010-2014 Post-Doctoral Research Associate, Agronomy, EREC, UF-IFAS, Belle Glade, FL
2006-2010 Graduate Research Assistant, EREC, UF-IFAS, Belle Glade, FL

SELECTED AWARDS

- 2017 American Society of Agronomy (ASA) Early Career Award - This award is presented annually by ASA to recognize individuals who have made an outstanding contribution in agronomy within seven years of completing their final degree.
- 2017 Seymour Webber Extension Award –UF-IFAS award for outstanding contribution in extension.

SELECTED GRANTS

PI/Co-PI	Funding agency	Total amount (2014-2019)	Title of the project
PI	Florida Sugarcane League	$711,000	Genetic improvement and agronomic evaluation of sugarcane
Co-PI	DOE	$195,049	Discovering the desirable alleles contributing to the lignocellulosic biomass traits in *Saccharum* germplasm collections for energy cane improvement
PI	BP Biofuels LLC	$382,395	*Saccharum* Breeding, Evaluation, and Development of Energy Cane for Bio-Fuel Production

SUMMARY OF RESEARCH ACCOMPLISHMENTS

Book chapters	1
Refereed research publications	71
Published abstracts	40
Non-refereed publications/Trade journal articles	60
Graduate students-Chair	7 (4 Ph.D., 3 Masters)
Sugarcane cultivar released	34

SELECTED REFEREED PUBLICATIONS: [g]=Graduate student

1. **Sandhu, H.S.**, M.P. Singh and M. Vuyyuru[g]. 2019. Minimum or no-tillage improves sugarcane ratoon yield on Florida Histosol. *Agron. J.* 111: 1516-1523.
2. Vuyyuru, M[g]., **H.S. Sandhu,** J. M. McCray and R.N. Raid**.** 2018. Effects of soil fungicides on sugarcane root and shoot growth, rhizosphere microbial communities and nutrient uptake. *Agronomy*, DOI: 10.3390/agronomy8100223 (online).
3. Migneault, A.[g], **H.S. Sandhu**, P. McCord, D. Zhao, and J. Erickson. 2018. Albinism in sugarcane: Significance, research gaps and potential future research developments. *Sugar Tech.* DOI 10.1007/s12355-018-0668-1 (online)
4. Zhang, J., P. Wang, X. Wang, **H.S. Sandhu**, and Y. Wang. 2018. Enhancement of sucrose metabolism in Clostridium *saccharoperbutylacetonicum* N1-4 through metabolic engineering for improved acetone–butanol–ethanol (ABE) fermentation. *Biores. Technol.* 270: 430-438.
5. **Sandhu, H.S.**, P. McCord, D. Zhao, J. Comstock, et al. 2018. Registration of 'CP 09-1822' Sugarcane. *J. Plant Reg.* 12: 333-339.
6. Karounos, M.[g], R. Cherry, **H. Sandhu**, and C. Odero. 2018. Feeding behavior of wireworms, *Melanotus communis* (Coleopltera: Elateridae) in southern Florida sugarcane. *J. Entomol. Sci.* 53: 242-250.
7. **Sandhu, H.S**., M.P. Singh, R.A. Gilbert, et al. 2017. Harvest management effects on sugarcane ratoon growth, yield and nutrient cycling in Florida and Costa Rica. *Field Crops Res.* 214: 253-260.
8. **Sandhu, H.S.**, P. McCord, J.C. Comstock, et al. 2016. Registration of 'CP 07-2137' Sugarcane. *J. Plant. Reg.* 10: 265-270.
9. Shi, P., **H.S. Sandhu**, and G.P. Reddy. 2016. Dispersal distance determines the exponent of the spatial Taylor's power law. *Ecol Modell.* 335: 48-53.
10. **Sandhu, H. S.**, R. A. Gilbert, J. C. Comstock, et al. 2015. Registration of 'UFCP 74-1010' sugarcane. *J. Plant. Reg.* 9: 179-184.
11. **Sandhu, H. S.,** B. S. Glaz, S. J. Edmé, et al. 2014. Registration of 'CPCL 02-6848' sugarcane. *J. Plant. Reg.* 8: 155-161.
12. **Sandhu, H. S.**, R. A. Gilbert, G. Kingston, et al. 2013. Effects of sugarcane harvest method on microclimate in Florida and Costa Rica. *Agr. Forest Meteorol.* 177: 101-109.
13. **Sandhu, H. S.**, G. S. Nuessly, R. H. Cherry, et al. 2011. Effects of *Elasmopalpus lignosellus* (Lepidopter: Pyralidae) damage on sugarcane yield. *J. Econ. Entomol.* 104: 474-483.
14. **Sandhu, H. S.**, G. S. Nuessly, R. H. Cherry, et al. 2011. Effects of harvest residue and tillage on lesser cornstalk borer (Lepidoptera: Pyralidae) damage to sugarcane. *J. Econ. Entomol.* 104: 155-163.
15. **Sandhu, H. S.**, G. S. Nuessly, S. E. Webb, et al. 2010. Temperature-dependent development of *Elasmopalpus lignosellus* (Lepidoptera: Pyralidae) on sugarcane under laboratory conditions. *Environ. Entomol*. 39: 1012-1020.

SELECTED PROFESSIONAL ACTIVITIES

- Associate Editor, Agronomy Journal (2019-2022)
- Leader, Bioenergy Systems Community, Annual meetings of ASA, CSSA and SSSA, 2016, Phoenix.
- Program Chair, Joint American Society of Sugar Cane Technologists (ASSCT) meeting, June-2016, St. Petersburgh, FL.
- Committee member, Agronomy section of the Agriculture Commission, International Society of Sugar Cane Technologists (ISSCT), 2015-present.
- Member, IFAS Cultivar Release Advisory Committee, 2014-present.
- Member, UF Sustainability Committee, 2017-2019.

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EDUCATION AND PROFESSIONAL EXPERIENCE

University of California, Davis. The Genome Center and Department of Plant Science	Assistant Project Scientist IV	11/2013 – 09/2016 Dr. Richard Michelmore, advisor
University of California, Davis. The Genome Center and Department of Plant Science	Postdoctoral Research	11/2011 – 10/2013 Dr. Richard Michelmore, advisor
The Pennsylvania State University	Postdoctoral Scholar	01/2011 – 10/2011 Dr. Marcia Buanafina, advisor
The Pennsylvania State University	Postdoctoral Scholar	11/2008 – 12/2010 Dr. Dawn Luthe, advisor
University of Vigo, CSIC	Ph.D. degree	06/2004 – 05/2008 Drs. Rosa Malvar and Ana Butron
Mediterranean Agronomic Institute of Saragossa - CIHEAM	Master of Science degree	09/2002 – 05/2004 Drs. Amando Ordas and Rosa Malvar

APPOINTMENTS

October 2016-Present: Assistant Professor in Lettuce Breeding and Genetics, Everglades Research and Education Center/ Horticultural Sciences Department, University of Florida, Gainesville, FL

FIVE SELECT RECENT PUBLICATIONS

G. Sandoya , B. Maisoneuve, M.J. Truco, C. T. Bull, I. Simko, M. Trent, R.J. Hayes, R.W. Michelmore. 2019. Genetic analysis of resistance to bacterial leaf spot in the heirloom lettuce cultivar Reine des Glaces. Molecular Breeding (in press)

Hayes, R. **G. Sandoya**, B. Mou, I. Simko, K. Subbarao. 2018. Release of three iceberg lettuce populations with combined resistance to two soil borne diseases. HortScience 53:247-250.

Sandoya, G., K.V. Subbarao, R.J. Hayes. 2017. Delayed wilt symptoms caused by *Verticillium dahliae* as a resistance characteristic in iceberg lettuce (*Lactuca sativa*). HortScience 52: 513-519.

Sandoya, G., S. Gurunj, D. Short, K.V., Subbarao, R. Michelmore, R.J. Hayes. 2017. Genetics of resistance in lettuce to races 1 and 2 of *Verticillium dahliae* from different host species. Euphytica 21: 3-20.

Lafta A., T. Turini, **G. Sandoya,** B. Mou. 2017. Field evaluation of green and red leaf lettuce genotypes in the Imperial, San Joaquin, and Salinas Valleys of California for heat tolerance and extension of the growing seasons. HortScience 52:40-48.

FIVE ADDITIONAL PUBLICATIONS OF NOTE

Gurung, S., D. Short, X. P. Hu, **G.V. Sandoya**, R.J. Hayes, K.V. Subbarao. 2015. Screening of cultivated and wild *Capsicum* germplasm reveals new sources of Verticillium wilt resistance. Plant Disease 99: 1404-1409.

Hu, X. P., S. Gurung, D.P.G. Short, W. Shang, **G.V. Sandoya**, K.V. Subbarao. 2015. Defoliating and non-defoliating strains of *Verticillium dahliae* from cotton show high affinity with races 1 and 2 from lettuce. Plant Disease 99:1173-1720.

Gurung, S., D.P.G. Short, **G.V. Sandoya**, R.J. Hayes, S. Koike, K. V. Subbarao. 2015. Host range of *Verticillium isaacii* and *V. klebahnii* from spinach and lettuce. Plant Disease 99: 933-938.

Short, D.P.G., **G. Sandoya**, G.E. Vallad, B. Wu, S. Gurung, C. Xiao, S.T. Koike, R.J. Hayes, K.V. Subbarao. 2015. Dynamics of *Verticillium dahliae* microesclerotia following flooding, fumigation, and different crop patterns. Phytopathology 105: 638-645.

Novakazi, F., P. Inderbitzin, **G. Sandoya**, R.J. Hayes, A. von. Tiedemann, K.V. Subbarao. 2015. The three lineages of the diploid hybrid *Verticillium longisporum* differ in virulence and pathogenicity. Phytopathology 105: 662-673.

AWARDS AND HONORS

2017. Early Career Grant Dean of Research. University of Florida, IFAS

SYNERGISTIC ACTIVITIES

1. Graduate & Postdoc Mentoring. I have mentored one postdoc and three graduate students which two are Ph.D.'s and one masters. I also supervise undergraduate, high school and international visiting scholars' students.

2. Communications. I talk at different stakeholder venues such as the Florida Seed Association, Florida Foundation for Seed Producers, the Florida Lettuce Advisory Committee among others.

3. Community Building. I was one of two main coordinators of the Strawberry Genome Sequencing Consortium that published the genome in 2011. I was elected Chair of the Rosaceae Genetics Genomics and Breeding Executive Committee in 2007 and was elected to the committee from 2005-2008; 2010-2013. My position as a Department Chairman (2012-2018) allowed many opportunities to connect researchers, students, growers and industry statewide.

4. Outreach. I host local high school students in Palma Beach County and offer mentoring in projects for these students nationwide when asked.

5. Service to Discipline. Reviewer for Journals such as HortScience, Journal of Horticulture, Theoretical and Applied Genetics and Euphytica.

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EDUCATION

1994	**Ph.D.**,	Louisiana State University, Baton Rouge, LA
1991	**M.S.**,	Louisiana State University, Baton Rouge, LA
1986	**B.S.**,	Auburn University, Auburn, AL

ACADEMIC/PROFESSIONAL APPOINTMENTS

7/1- present **Professor -** (75% Research, 15% Extension); North Florida Research and Education Center, Agronomy Department, University of Florida

3/17-present **Assistant Center Director-** (10% administrative) North Florida Research and Education Center, Agronomy Department, University of Florida

7/10-6/18 **Associate Professor- Peanut Breeding and Genetics** (80% Research, 20% Extension); North Florida Research and Education Center, Agronomy Department, University of Florida

2/04- 6/10 **Assistant Professor- Peanut Breeding and Genetics** (75% Research, 20% Extension; North Florida Research and Education Center, Agronomy Department, University of Florida

06/97-02/04 **Hybrid Rice Breeder- 2-Line Program Leader** (100% Research); RiceTec, Inc., Alvin, Texas

03/95-06-97 **Assistant Research Scientist** (100% Research); Beaumont Research and Education Center, Department of Soil and Crop Sciences, Texas A&M University

PUBLICATIONS AND INTELLECUTAL PROPERTY

UNITED STATES PATENTS

Tillman, Barry L. and Daniel W. Gorbet. May 15, 2012. Peanut Cultivar UFT113. United States Patent 8178752.

Sarreal, Eugenio S., Tillman, Barry L., and Ibrahim, Yahia Hassan. January 5, 2010. Rice hybrid XL729. United States Patent 07642435.

Sarreal, Eugenio S. and Tillman, Barry L. February 3, 2009. Rice hybrid XP316M. United States Patent 7485784.

Sarreal, Eugenio S. and Tillman, Barry L. April 1, 2008. Inbred rice line 053002. United States Patent 7351891.

Sarreal, Eugenio S. and Tillman, Barry L. April 1, 2008. Inbred rice line 054001. United States Patent Application 7351892.

Sarreal, Eugenio S. and Tillman, Barry L. April 1, 2008. Inbred rice line 053001. United States Patent Application 7351893.

Sarreal, Eugenio S. and Tillman, Barry L. December 4, 2007. Rice hybrid XL723. United States Patent 7304223.

Sarreal, Eugenio S. and Tillman, Barry L. November 27, 2007. Rice hybrid XL730. United States Patent 7301083.

Tillman, Barry L. and Sarreal, Eugenio S. April 26, 2005. Rice hybrid RH101. United States Patent 6884931.

Tillman, Barry L. and Sarreal, Eugenio S. June 3, 2004. Rice hybrid RH102. United States Patent 7005567.

Tillman, Barry L. September 30, 2003. Rice hybrid RH103. United States Patent 6953881.

CULTIVAR RELEASES AND PLANT VARIETY PROTECTION CERTIFICATES

Release of peanut cultivar- Walton (2018), Developer, Joint release with Dr. Maria Balota, Virginia Tech University.

Release of peanut cultivar- FloRun™ '331' (2016), Developer, (PVP pending- 201700120)

Release of peanut cultivar- FloRun™ '157' (2015), Developer, (PVP pending)

Release of peanut cultivar- TUFRunner™ '297' (2014), Developer, (PVP 201500201)

Release of peanut cultivar- TUFRunner™ '511' (2013), Co-developer, (PVP 201400249)

Release of peanut cultivar- Spain (2012), Co-developer, (PVP 201200394)

Release of peanut cultivar- Florida EP™ '113' (2011), Co-developer, (Patented)

Release of peanut cultivar- TUFRunner™ '727' (2011), Co-developer, (PVP 201300199)

Release of peanut cultivar- FlorRun™ '107' (2010), Co-developer. (PVP 201100459)

Release of peanut cultivar- Florida Fancy (2007), Co-developer. (PVP 200800231)

Release of peanut cultivar- AP-4 (2007), Co-developer. (PVP 200800158)

Release of peanut cultivar- York (2006), Co-developer. (PVP 200800186)

Release of peanut cultivar- McCloud (2006), Co-developer. (PVP pending)

Release of peanut cultivar- Florida-07 (2006), Co-developer. (PVP 200800069)

PUBLICATIONS

Racette, K.A., D.L. Rowland, B.L., Tillman, J. Erickson, P. Munoz, W. Vermeris. 2019. Transgenerational stress memory in seed and seedling vigor of peanut (Arachis hypogaea L.) varies by genotype. Environmental and Experimental Botany 162:541-549.

Power, I.L., Tillman, B.L., Brenneman, T.B., Kemerait, R.C., Stevenson, K., and Culbreath, A.K. 2019. Field resistance and components of peanut rust resistance of newly developed breeding lines. *Peanut Science* 46:22-36.

Tillman, B.L. and J.L. McKinney. 2018. Relationships among symptoms of spotted wilt disease of peanut (Arachis hypogaea L.) and their potential impact on crop productivity and resistance breeding. Plant Breeding 137:757-762.

Tseng, Y-C., B.L. Tillman, S.A. Gezan, J. Wang, and D.L. Rowland. 2018. Heritability of spotted wilt resistance in a Florida-EP™ '113' derived peanut (*Arachis hypogaea*) population. Plant Breeding. 137:614–620. DOI: 10.1111/pbr.12610

Zurweller, B.A., A. Xavier, B.L. Tillman, J.R. Mahan, P.R. Payton, N. Puppala, and D.L. Rowland. 2018. Pod yield performance and stability of peanut genotypes under differing soil water and regional conditions, Journal of Crop Improvement, DOI: 10.1080/15427528.2018.1458674.

Colvin, B.C., Yu-Chien Tseng, B.L. Tillman, D.L. Rowland, J.E. Erickson, A.K. Culbreath, and J.A. Ferrell. 2018. Consideration of peg strength and disease severity in the decision to harvest peanut in southeastern USA. Journal of Crop Improvement. 32:287-304. DOI: 10.1080/15427528.2017.1422073.

Tillman, B.L. 2017. Registration of TUFRunnerTM '297'. J. of Plant Reg. DOI:10.3198/jpr2017.02.0007crc.

Carter, E.T., Rowland, D.L., Tillman, B.L., Erickson, J.E., Grey, T.L., Gillett-Kaufman, J.L., Clark, M.W. 2017. Pod Maturity in the Shelling Process. Peanut Science. 44:26–34.

Tillman, B.L. and D.W. Gorbet. 2017. Registration of TUFRunnerTM '511'. J. of Plant Reg. 11:235–239. doi:10.3198/jpr2016.11.0064crc.

McKinney, J.L. and B.L. Tillman. 2017. Spotted wilt in peanut (Arachis hypogaea L.) as impacted by genotype resistance, planting date and plant population. Crop Sci. 57:1-7. doi: 10.2135/cropsci2016.05.0368.

Tseng, YC, B.L. Tillman, Z. Peng, and J.P. Wang. 2016. Identification of major QTLs underlying tomato spotted wilt virus resistance in peanut cultivar Florida-EP (TM) '113'. BMC Genetics 17:128. DOI 10.1186/s12863-016-0435-9.

Culbreath, A.K., A.C. Selph, B.W. Williams, R.C. Kemerait Jr., R. Srinivasan, M.R. Abney, B.L. Tillman, C.C. Holbrook, and W.D. Branch. 2016. Effects of new field resistant cultivars and in-furrow applications of phorate insecticide on tomato spotted wilt of peanut. Crop Protection 81:70-75.

Ze, Peng, M. Gallo, B.L. Tillman, D. Rowland, and J. Wang. 2015. Molecular marker development from transcript sequences and germplasm evaluation for cultivated peanut (Arachis hypogaea L.). MGAG 291:363-381.

Leon, R.G. and B.L. Tillman. 2015. Postemergence herbicide tolerance variation in peanut germplasm. Weed Science 63:546-554.

Tillman, B.L. and D.W. Gorbet. 2015. Registration of FloRun™ '107'. Journal of Plant Registrations 9(2):162-167.

Thornton, S.T., M. Gallo, and B.L. Tillman. 2015. Genotypic variability in calcium concentration of peanut (Arachis hypogaea L.) seeds. Crop Science 55: 211-218. doi:10.2135/cropsci2014.04.0302.

Chamberlin, K., N.L. Barkley, B.L. Tillman, J. Dillwith, R. Madden, M. Payton, and R. Bennett. 2014. A comparison of methods used to determine the oleic/linoleic acid ratio in cultivated peanut (Arachis hypogaea L.). Agricultural Sciences 5(3):227-237.

Phan-Thien, K.Y., G.C. Wright, B.L. Tillman, and N.A Lee. 2014. Peanut Antioxidants: Part 1. Genotypic Variation and Genotype-by-Environment Interaction in Antioxidant Capacity of Raw Kernels. LWT - Food Science and Technology 57:306-311.

Narh, S., K.J. Boote, J.B. Naab, M.Abudulai, Z.M. Bertin, P. Sankara, M.D. Burow, B.L. Tillman, R.L. Brandenburg, and D.L. Jordan. 2014. Environment Analyses of Peanut Cultivars in Multilocation Trials in West Africa. Crop Sci. 54:2413–2422.

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EDUCATION

Ph.D. (2009) Plant Breeding and Molecular Genetics, Univ. of Minnesota, St. Paul, MN
M.S. (2006) Plant Breeding and Molecular Genetics, Univ. of Minnesota, St. Paul, MN
B.S. (2003) Horticultural Science, North Carolina State University, Raleigh, NC
B.S. (2003) Agricultural Economics, North Carolina State University, Raleigh, NC

PROFESSIONAL APPOINTMENTS

June 2015 to Present. Associate Professor, University of Florida, Institute of Food and Agricultural Sciences, Gulf Coast Research and Education Center, Balm, FL. I direct the strawberry breeding program at UF which is focused on genetic improvement of strawberries for annual production systems, release and commercialization of cultivars, and extension of knowledge and resources to growers (80% research, 20% extension).

August 2009 to June 2015. Assistant Professor, University of Florida, Gulf Coast Research and Education Center, Balm, FL.

April 2009 to August 2009. Post-doctoral Research Fellow, Department of Horticultural Science, University of Minnesota, St. Paul, MN. Inheritance and molecular marker analyses of race-specific black spot resistances in tetraploid rose.

SYNERGISTIC PROFESSIONAL ACTIVITIES

Member, RosEXEC: Committee for Coordination of Rosaceae Genetics and Genomics in U.S. (elected)
Executive Committee Member and Statistical Genetics Team Lead, USDA/NIFA RosBREED SCRI CAP
8th International Strawberry Symposium Scientific Committee
7th International Rosaceae Genomics Conference Scientific Committee
Past-President, Fruit Breeding Working Group, American Society for Horticultural Science
Florida representative to the USDA/CSREES Regional Project NCCC 212: Small Fruit Research
Member, USDA Crop Germplasm Committee for Small Fruits
Secretary, UF/IFAS Plant Breeders Working Group and Member, UF/IFAS Tomato and Blueberry Cultivar Release Advisory Committees

HONORS AND AWARDS

UF/IFAS Richard Jones Outstanding New Researcher Award (2013)
UF Term Professorship (2018-2020)

PATENTS AWARDED AND PENDING

'Florida Brilliance' Strawberry (Released 2017, U.S. Plant Patent Pending)
'Florida Beauty' Strawberry (Released 2016, U.S. Plant Patent Pending)
Sweet Sensation® 'Florida127' Strawberry (U.S. PP25,574 P3)
Compositions and methods for modifying perceptions of sweet taste (U.S. Patent 20130280400)

GRADUATE STUDENTS ADVISED

Degree	Role	Students	Total
PhD	Chair	Kennedy (‘13), Mangandi (‘15), Salinas* (‘19), Fan* (’22)	4
	Co-Chair	Chambers (‘14), Torres (‘16), Barbey (‘18), Tapia (’21), Kim (’22)	5
MS	Chair	Perez (‘13), Roach (‘15), Nelson (’18)	3
	Co-Chair	Anciro (’17)	1
		TOTAL	**13**

*Awarded graduate school fellowships

Publications and Abstracts Key: Senior/Corresponding Author(s) = underline; Graduate Student = g; Biological Scientist = b; Postdoc = p; Research Coordinator = r; Visiting Scholar = vs

REFEREED JOURNAL PUBLICATIONS

Noh, Y.H., Y. Oh, J. Mangandi[g], S. Verma[b], J.D. Zurn, Y.T. Lu, Z. Fan, N. Bassil, N. Peres, G. Cole, C. Acharya, R. Famula, S. Knapp, **V.M. Whitaker** and S. Lee. 2018. High-throughput marker assays for FaRPc2-mediated resistance to Phytophthora crown rot in octoploid strawberry. Molecular Breeding 38:104.

Anciro, A.[g], J. Mangandi [g], S. Verma[b], N. Peres, **V.M. Whitaker** and S. Lee. 2018. *FaRCg1*: a quantitative trait locus conferring resistance to Colletotrichum crown rot caused by *Colletotrichum gloeosporioides* in octoploid strawberry. Theoretical and Applied Genetics https://doi.org/10.1007/s00122-018-3145-z

Mramba, L., G.F. Peter, **V.M. Whitaker** and S. Gezan. 2018. Generating improved experimental designs with spatially and genetically correlated observations using mixed models. Agronomy 8:40.

Mangandi, J.[g], S. Verma[b], L. Osorio[b], N.A. Peres, E. van de Weg and **V.M. Whitaker**. 2017. Pedigree-based analysis in a multiparental population of octoploid strawberry reveals QTL alleles conferring resistance to *Phytophthora cactorum*. G3:Genes, Genomes, Genetics 7:1707-1719.

Gezan, S., L.F. Osorio[b], S. Verma[b] and **V.M. Whitaker**. 2017. An experimental validation of genomic selection in octoploid strawberry. Horticulture Research 4:16070 doi:10.1038/hortres.2016.70.

Pillet, J., A.H. Chambers, C. Barbey, Z. Bao, A. Plotto, J. Bai, M. Schwieterman, T. Johnson, B. Harrison, **V.M. Whitaker**, T.A. Colquhoun and K.M. Folta. 2017. Identification of a methyltransferase catalyzing the final step of methyl anthranilate synthesis in cultivated strawberry. BMC Plant Biology 17:147.

Verma, S[b], J.D. Zurn, N. Salinas[g], M.M. Mathey, B. Denoyes, J.F. Hancock, C.E. Finn, N.V. Bassil and **V.M. Whitaker**. 2017. Clarifying sub-genomic positions of QTLs for flowering habit and fruit quality in U.S. strawberry (*Fragaria* x *ananassa*) breeding populations using pedigree-based QTL analysis. Horticulture Research 4:17062.

Whitaker, V.M., L.F. Osorio[b], N.A Peres, Z. Fan[b], M. Herrington, M. Cecilia do Nascimento Nunes, A. Plotto and C. Sims. 2017. ‘Florida Beauty’ Strawberry. HortScience 52:1443-1447.

Noh, Y., S. Lee, **V.M. Whitaker**, K.R. Cearley[b] and J.S. Cha. 2017. A high-throughput marker-assisted selection system combining rapid DNA extraction, high-resolution melting and simple sequence repeat analysis: Strawberry as a model for fruit crops. Journal of Berry Research 7:23-31.

Mathey, M., S. Mookerjee, L. Mahoney, K. Gunduz, U. Rosarya, J.F. Hancock, P.J. Stewart, **V.M. Whitaker**, N.V. Bassil, T. Davis and C.E. Finn. 2017. Genotype by environment interactions and combining ability for strawberry families grown in diverse environments. Euphytica 213:112.

Roach, J.[g], S. Verma[b], N.A. Peres, A.R. Jamieson, W.E. van de Weg, M.C.A.M. Bink, N.V. Bassil, S. Lee and **V.M. Whitaker**. 2016. *FaRXf1*: a locus conferring resistance to angular leaf spot caused by *Xanthomonas fragariae* in octoploid strawberry. Theoretical and Applied Genetics 129:1191-1201.

Kelly, K.[g], **V.M. Whitaker** and C. Nunes. 2016. Physiochemical characterization and postharvest performance of the new Sensation® 'Florida127' strawberry compared to commercial standards. Scientia Horticulturae 211:283-294.

Lee, S., **V.M. Whitaker** and S.F. Hutton. 2016. Potential applications of non-host resistance for crop improvement. Frontiers in Plant Science 7:997.

Perez, Y[g], S. Sargent, C. Nunes and **V.M. Whitaker**. 2016. Composition of commercial strawberry cultivars and advanced selections as affected by season, harvest and postharvest storage. HortScience 51:1134-1143.

Thekke-Veetil, T., T. Ho, C. Moyer[b], **V.M. Whitaker** and I.E. Tzanetakis. 2016. Detection of strawberry necrotic shock virus using conventional and TaqMan® quantitative RT-PCR. Journal of Virological Methods 235:176-181.

Zuzek, K., D. Zlesak, **V.M. Whitaker**, S. McNamara and S.C. Hokanson. 2016. Northern Accents® 'Lena', 'Ole', 'Sigrid', and 'Sven': four cold-hardy polyantha rose cultivars from the University of Minnesota Woody Landscape Plant Breeding Program. HortScience 51:296-299.

Wu, F., Z. Guan and **V.M. Whitaker**. 2015. Optimizing yield distribution under economic and biological constraints: Florida strawberries as a model for perishable commodities. Agricultural Systems 141:113-120.

Whitaker, V.M., C.K. Chandler, N.A. Peres, M.C.N. Nunes, A. Plotto and C. Sims. 2015. Sensation™ 'Florida127' Strawberry. HortScience 7:1088-1091.

Torres-Quezada, E.A.[g], L. Zotarelli, **V.M. Whitaker**, B.M. Santos and I. Hernandez-Ochoa. 2015. Initial crown diameter of strawberry bare-root transplants affects early and total fruit yield. Hort Technology 25:203-208.

Mangandi, J.[g], N.A. Peres and **V.M. Whitaker**. 2015. Identifying resistance to crown rot caused by *Colletotrichum gloeosporioides*. Plant Disease 99:954-961.

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ABSTRACTS

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EDITORIAL ADVISORY BOARDS

Horticulture Research (Nature Publishing Group) – Associate Editor

INVITED LECTURES

"Breeding for a Complex of Quality Traits in a Complex Fruit Crop". University of Minnesota Plant Sciences Symposium, St. Paul, Minnesota, 2018.

"Advances in Strawberry Breeding at the University of Florida". 8th International Strawberry Symposium. Quebec City, Quebec, Canada. August, 2016.

"Breeding blueberry and strawberry cultivars with resiliency and wide adaptability". International Horticulture Congress. Brisbane, Australia. August 2014.

"Sensory-Assisted Strawberry Breeding". Annual Meeting of the American Society for Horticultural Science, Orlando, FL. July, 2014.

"46 Years of strawberry breeding in Florida." Southeast Strawberry Expo, Pinehurst, NC. November, 2014.

"Consumer-Assisted Breeding in Strawberry". Annual Meeting of the National Association of Plant Breeders, Tampa, FL. June, 2013.

"Consumer-Assisted Strawberry Breeding". University Industry Consortium, Gainesville, FL. April, 2013.

"Genomewide Selection in Strawberry". USDA/NIFA RosBREED Strawberry Workshop, Corvallis, OR. January, 2013.

"Trends in Public and Private Strawberry Breeding Programs". 7th North American Strawberry Symposium. Tampa, FL. February 2011.

"Strawberry breeding at the University of Florida: Strengths, weaknesses, and opportunities". Southern Region American Society for Horticultural Science, Orlando, FL. February 2010.

"New advances in strawberry breeding at UF". Ekland International Strawberry Conference. Tampa, FL. January 2010.

"NBS and LRR profiling for marker development and RGA discovery in rose". Plant and Animal Genome XVII Conference. San Diego, CA. January 2009.

APPENDIX D. External consultants' reports, as requested by Dr. Elaine Turner, Dean of the College of Agricultural and Life Sciences (CALS). The four consultants are listed below, and their reports follow consecutively.

1. **Dr. William Tracy**, Professor of Agronomy at the University of Wisconsin-Madison, former Department Chair. Dr. Tracy is a member of the graduate faculty of the interdepartmental graduate training program in Plant Breeding and Genetics, which is very similar in design and objectives to our proposed program.

2. **Dr. Wayne Smith**, Professor of Cotton Breeding and Associate Department Head, Department of Soil and Crop Sciences at Texas A&M University, and Vice-Chair of the Plant Breeding Coordinating Committee (PBCC) Executive Committee.

3. **Dr. B. Todd Campbell**, Research Geneticist, USDA-ARS, Coastal Plains Soil, Water, and Plant Research Center and former President of the National Association of Plant Breeders (NAPB).

4. **Dr. Rex Bernardo**, Professor and Endowed Chair of corn breeding at the University of Minnesota, and former Associate Director of Graduate Studies and former Director of Graduate Studies in Applied Plant Sciences at the University of Minnesota.

From:	Turner,R Elaine
To:	Kampf,Eliana; Whitaker,Vance M
Cc:	Brendemuhl,Joel H
Subject:	FW: External review of Plant Breeding PhD Program Proposal
Date:	Sunday, January 12, 2020 9:46:01 PM
Attachments:	Florida PB review Tracy.pdf

Another review received.

From: William Tracy <wftracy@wisc.edu>
Sent: Sunday, January 12, 2020 8:28 PM
To: Turner,R Elaine <returner@ufl.edu>
Subject: Re: External review of Plant Breeding PhD Program Proposal

[External Email]
Dr. Turner,

Please see that attached file.

I hope this is useful. I strongly endorse this effort.

Bill

William F. Tracy
Professor of Agronomy
Clif Bar and Organic Valley Chair in Plant Breeding for Organic Agriculture
University of Wisconsin-Madison
364c Moore Hall, 1575 Linden Dr. Madison, Wisconsin 53706
(608) 262-2587

And pray what more can a reasonable man desire, in peaceful times, in ordinary noons, than a sufficient number of ears of green sweet corn boiled, with the addition of salt.

Henry David Thoreau, Walden

This was typed by me so please forgive all snorts of errors.

12 January 2020

Dr. R. Elaine Turner, Dean
College of Agricultural and Life Sciences
University of Florida
Email: returner@ufl.edu

Dean Turner

Thank you for the opportunity to provide an external review of the proposed Plant Breeding Ph.D. program in the College of Agricultural and Life Sciences at the University of Florida. I am currently a professor of agronomy at the University of Wisconsin-Madison, I chaired the department for 14 years with the exception of 14 months when I served as interim dean of the College of Agricultural and Life Sciences. For 35 years I have been a member of the graduate faculty of the interdepartmental graduate training program in Plant Breeding and Plant Genetics, which is very similar in design and objectives to the proposed Plant Breeding Ph.D. program.

In your letter you suggested I address the topics below:

- Overall merit of the proposed program
    - The overall merit is very strong. The proposal is well written and explains needs, reasons, and benefits for the proposed program. UF has a very strong group of plant breeders working in diverse crops in diverse ecoregions. The fundamental and agricultural sciences that are needed to support the degree program are also strong at UF. I believe students would benefit from this environment and be well trained.
- Demand for Ph.D. plant breeders in the Southeast region, the United States and the world.
    - Despite the consolidation of the seed industry the demand for plant breeders remains strong, in fact the consolidation will increase the need especially in the Southeast. As companies consolidate they leave entire regions and crops creating gaps that new companies (that will hire breeders) strive to fill. This is especially true in the highly specialized agriculture of Florida. Another reason demand for new Ph.D.s in plant

breeding will be high is many states are downsizing their colleges of agriculture and this has affected plant breeding training programs. It is my perception that Florida's powerful specialty ag industry keeps the ag programs in your college strong.

- Importance of such a program in the Southeast region, the United States and the world.
    - There are other strong programs in the Southeast such as NC State and Georgia, but nowhere else offers the potential to study breeding of subtropical and tropical crops and the adaptation of temperate crops such as blueberries and strawberries to those conditions. In addition to this unique role, as I said above, this new program has the opportunity to supply breeders nationally and internationally as traditionally strong programs downsize. The ability to train students in tropical breeding and germplasm management is an enormous opportunity, currently entirely unmet.
- Potential of the program to provide the educational needs of future plant breeders
    - As someone who has studied USA public plant breeding both in terms of cultivar development and graduate training I have long felt that UF was missing a great opportunity to be one of the leading Ph.D. plant breeding Ph.D. programs. UF has, perhaps, the strongest public cultivar development program in the US, with a very strong and deeply knowledgeable faculty. Mobilizing this group toward graduate training will quickly move UF into the top five programs if not the top three.
- Ability of plant breeding faculty and administration at UF to build a successful program.
    - See above.

- Financial and other resources available.
    - Potential resources exceed those of any other institution I know of, except, perhaps, TAMU.
- Advice for achieving program success based on your experiences at your institution.
    - For the greatest success I strongly recommend that the faculty work to develop and support a strong cohort and community approach. Having each incoming cohort take an introductory seminar together or perhaps tour that orients them to the unique programs and faculty. It is very hard for students at Gainesville to gain a sense of the massive operation they are a part of. They need to be made aware. Then have seminars and journal clubs that all Ph.D. candidates (and faculty) are required to attend.

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College of Agricultural and Life Sciences
University of Wisconsin-Madison 1575 Linden Dr. Madison, Wisconsin 53706
608/262-1390 Fax: 608/262-5217 http://agronomy.wisc.edu/

This of course means that the faculty must work to maintain these opportunities at an engaging level of content.

I hope this evaluation is useful.

Respectfully yours,

William F. Tracy
Professor of Agronomy
Clif Bar and Organic Valley Chair in Plant Breeding for Organic Agriculture
wftracy@wisc.edu

From: Smith, C W <cwsmith@tamu.edu>
Sent: Tuesday, December 24, 2019 12:12 PM
To: Turner,R Elaine <returner@ufl.edu>
Subject: Re: External review of Plant Breeding PhD Program Proposal

[External Email]
Elaine,

Thank you for the opportunity to review your proposed IDP in Plant Breeding at the UFL. It is an excellent program and a well written proposal. I believe that you have the breadth of plant breeding programs and plant breeders for a highly successful program. I made a few comments on the attached pdf proposal and addressed your suggested comments below.

- Overall merit of the proposed program

The proposed program is well designed to meet the needs of the state of Florida and the nation for well-trained plant breeders. It will expand the impact of the UFL in this critical area of STEM education and research.

- Demand for Ph.D. plant breeders in the Southeast region, the United States and the world

The proposed program will add to the number of well-trained PhD plant breeders in the U.S. and globally. Demand for PhD plant breeders has been strong since the 1970 PVP act and especially since the 1994 PVP act and the advent of patented genetic products and procedures since 1985.

- Importance of such a program in the Southeast region, the United States and the world

Plant breeding is recognized as a cornerstone of modern agriculture. However, rates of genetic gain have decreased over the past 20 years while global population growth demands improved cultivars to meet caloric and nutritional needs. This situation requires extensive training of future plant breeders with the education and training to lead diverse teams of scientists to meet this challenge. Florida is well positioned to remain a major player and to enhance its footprint in this arena given their environment suitable to numerous crops. The proposed program will be an important effort to meet the demands for additional plant breeders in the Southeast, the U.S., and globally.

- Potential of the program to provide the educational needs of future plant breeders

The proposed program has been vetted through UFL faculty and administrators and will produce well-trained plant breeders to meet societal needs. I would question the number of graded courses proposed since current BS-MS-PhD students, at least at my institution, are exposed to 44 graded SCH (24 during their MS and another 20 minimum (by departmental policy) as a PhD candidate). The proposed program (If I'm reading it correctly) would have PhD candidates entering the program with an MS to have more academic experience than a candidate with only a BS degree. I'm a proponent of class room education and of exposing students to an array of subject matter. I have unsuccessfully proposed that our PhD students be required to take at least one people management course and one business course during their degree program because upon employment there's a high probability that they will be managing people and budgets and a little instruction in those areas should be a good expenditure of time.

I also would suggest a bit of clarification on your distance delivery. At A&M, we can only deliver 49% of a degree plan at distance except in our approved Distance Plant Breeding Program where 100% can be distance delivered. If Florida has similar rules then that section of the proposal needs clarification.

- Ability of plant breeding faculty and administration at UF to build a successful program

The proposal addresses the administration of the program extremely well. It is obvious that UFL is a leading LGU in this area with excellent faculty and administrators who will ensure a successful program.

- Financial and other resources available

Well documented.

- Advice for achieving program success based on your experiences at your institution

Our experience suggests that UFL will be successful with this program. There is a need to engage research personnel on RECs in graduate education to take advantage of their vast knowledge and experience in plant breeding research. I believe that this proposal addresses that to a greater degree and any program that I'm aware of. One point that you might need to address is whether or not this program will accept students as cohorts in the fall semester or individually in any semester

Regards,

Wayne

Professor, Cotton Breeding Associate Department Head

979.845.3450

From:	Turner,R Elaine
To:	Kampf,Eliana; Whitaker,Vance M
Cc:	Brendemuhl,Joel H
Subject:	FW: External review of Plant Breeding PhD Program Proposal
Date:	Saturday, January 11, 2020 7:21:18 PM
Attachments:	image001.png image002.png image003.png image004.png image005.png Review of UF Plant Breeding degree proposal.pdf

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Another review received.

From: Campbell, Todd - ARS <todd.campbell@usda.gov>
Sent: Saturday, January 11, 2020 5:32 PM
To: Turner,R Elaine <returner@ufl.edu>
Subject: Re: External review of Plant Breeding PhD Program Proposal

[External Email]

Dear Dr. Turner:

Please find attached my review of the proposed program. Feel free to contact me if you need additional assistance. Good luck with establishing this new and exciting program!

Best regards,

Todd

B. Todd Campbell, Ph.D.
Research Geneticist
USDA-ARS
Coastal Plains Soil, Water, and Plant Research Center
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Florence, SC 29501
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Get more information: www.ars.usda.gov

Original file: Appendix_D_Plant_Breeding_External_Reviewers.pdf

Below are some suggested items which could be addressed in your review:

- *Overall merit of the proposed program*

The program fills a current gap in graduate degree offerings at UF. By leveraging existing faculty expertise and resources, the new interdisciplinary based degree program creates a new and very strong plant breeding degree program with little to no initial investment. The interdisciplinary nature of the program avoids competition among existing departments (Agronomy, Horticulture, etc.) which often times fractures the strength of plant breeding education at a Land Grant institution. The breadth and diversity of the existing plant breeding effort at UF (e.g.-diversity of crops and plants already with plant breeding efforts) is leveraged to build a strong and singular interdisciplinary plant breeding program that offers students unique and diverse educational opportunities.

- *Demand for Ph.D. plant breeders in the Southeast region, the United States and the world*

Private companies represent the primary employer of plant breeders in the future. As such, all indications from private industry note a large need for well trained plant breeders in the future. There are numerous reports of current graduates not meeting the needs of the industry. In the last 10-15 years, we have seen a large, increased investment by private industry to build plant breeding capacity. During this time, plant breeding has evolved and become even more multi-disciplinary in nature to include traditional breeding, agronomy, pathology, entomology, molecular genetics, biochemistry, statistics, genomics, computational biology, computer science, engineering, and data science. States such as Florida and others in the Southeast region that depend upon agriculture and horticulture as a large part of their economies, will need to provide the industry well trained plant breeders in the future. 'Local' plant breeders will work within large domestic and global teams to fulfull their jobs while meeting the needs of consumers.

- *Importance of such a program in the Southeast region, the United States and the world*

Continuing the comments above regarding the demand of plant breeders, the strong program proposed by UF herein should begin filling the employment gap noted very quickly. There are strong plant breeding programs already in the region (NC State University and University of Georgia); however, a new program at UF would complement those and build more capacity for the Southeast. A UF program is complementary because there are a number of crops/plants unique to Florida that are not addressed elsewhere in the region.

- *Potential of the program to provide the educational needs of future plant breeders*

The academic program as outlined is adequate to meet the educational needs of future plant breeders. Two suggestions for additional courses. 1) More advanced statistics course offerings should be considered. 2) A course or combination of 1-hour module courses focused on management (both financial and people) and/or professional development should be considered. In my opinion, one of the weaknesses of many PhD plant breeding degree programs is a lack of education involving these areas.

- *Ability of plant breeding faculty and administration at UF to build a successful program*

By leveraging existing faculty expertise and resources, the new interdisciplinary based degree program creates a new and very strong plant breeding degree program with little to no initial investment. The interdisciplinary nature of the program avoids competition among existing departments (Agronomy, Horticulture, etc.) which often times fractures the strength of plant breeding education at a Land Grant institution. The breadth and diversity of the existing plant breeding effort at UF (e.g.-diversity of crops and plants already with plant breeding efforts) is

leveraged to build a strong and singular interdisciplinary plant breeding program that offers students unique and diverse educational opportunities.

- *Financial and other resources available*

The financial plan proposed seems adequate. Suggest reaching out to the network of private companies involved in plant breeding to provide recurring support.

- *Advice for achieving program success based on your experiences at your institution*

I like the overall scope of this new interdisciplinary program as it appears to balance traditional plant breeding training with training in new areas (e.g. genomics, bioinformatics, etc). In my career, I have seen a number of institutions historically very strong in plant breeding shift the emphases in their degree program to 100% molecular and/or genomic technologies. This has resulted in a significant dilution of traditional breeding skills that still are required for jobs today…these involve experimental design, data analysis, and field based skills. The private industry has commented that recent graduates are usually strong in the basic sciences, but lack traditional breeding skills. I would also like to comment that I strongly feel this new degree program needs a strong leader, especially early in the life of the program. My suggestion would be to hire a new faculty or re-allocate the appointment of an existing faculty member to lead the new program. A revolving leadership track often times results in weak leadership. It will be critical for strong leadership be in place to help this program fulfill its potential. Similarly, it is very important that the new program has the faculty teaching capacity to adequately teach all of the courses in the plan of study. Similar to the dilution of traditional plant breeding skills, I have also seen institutions propose new degree offerings without teaching capacity in place because most currently faculty did not have a teaching component in their job requirement.

From:	Rex Bernardo
To:	Turner,R Elaine
Cc:	Whitaker,Vance M; Kampf,Eliana
Subject:	Re: External review of Plant Breeding PhD Program Proposal
Date:	Saturday, December 21, 2019 12:02:44 PM
Attachments:	UFL Plant breeding proposal review - Bernardo.pdf

[External Email]

Dear Elaine,

Attached is my review of the proposed Plant Breeding Ph.D. program at the University of Florida. It is a strong proposal, and I offer three suggestions to strengthen it further. Please let me know if you have questions or if I can provide any additional input.

Sincerely,

Rex

--
Rex Bernardo
Professor and Endowed Chair in Corn Breeding and Genetics

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December 21, 2019

Dr. R. Elaine Turner
University of Florida
2001 McCarty Hall D, PO Box 110270
Gainesville, FL 32611-0270
Email: returner@ufl.edu

Dear Dean Turner:

Thank you for the opportunity to review the proposal for a Plant Breeding Ph.D. program at the University of Florida. I am providing this review on the basis of my experience as former Associate Director of Graduate Studies (2015–2017) and former Director of Graduate Studies (2005–2007, 2017–2019) in the Applied Plant Sciences (www.appliedplantsciences.umn.edu) program at the University of Minnesota. I am currently Professor and Endowed Chair in corn breeding at Minnesota.

I am pleased to fully support the efforts of your plant breeding faculty to develop a graduate program that provides a unified platform for coordinating teaching efforts, reaching across different disciplines, leveraging developments in different crops, and building community among doctoral students and faculty who are engaged in the genetic improvement of plants for human benefit. The University of Florida is strategically located to play a vital role in U.S. crop improvement, given its research programs on plants that are of economic importance in the southeast U.S. At Minnesota, we pride ourselves in being able to work on row crops, forages, cover crops, fruits, vegetables, flowers, turfgrasses, woody ornamentals, and turfgrasses; on self-pollinated, cross-pollinated, and asexually propagated species; on diploids and polyploids; and annuals and perennials. I can easily see that the same richness of plant species, which enhances the graduate education experience in an interdepartmental program such as ours at Minnesota, is present on the main campus and the outlying research centers at the University of Florida.

You also have a core mass of faculty whose expertise spans the spectrum of crop improvement, from molecular genetics to phenotyping to statistical genetics. Your faculty are very productive in releasing cultivars and in academic research. Overall, I believe the proposed Ph.D. Plant Breeding program will elevate Ph.D. research and education in plant breeding across your campus and will lead to graduates who are well prepared for future contributions in plant improvement.

That being said, the proposal made me wonder whether there was a missed opportunity to evaluate the current set of plant breeding graduate courses and see what changes need to be made. The following statement was given on page 11: "*Because the curriculum of the program relies on current coursework being taught in the involved departments, most faculty will not see a change in their responsibilities, or their time assigned to the new program*." Perhaps I missed it elsewhere in the proposal, but the above statement gave me the impression that the doctoral curriculum is largely an assemblage of current courses rather than the result of identifying what new courses—particularly for emergent fields in plant improvement—are needed. Two new courses (*Journal Colloquium* and

Survey of Breeding Tools and Methods) are proposed. While these courses will be helpful, they do not address the following gaps that I perceive in the proposed curriculum. Please allow me to offer three suggestions for further strengthening the proposed curriculum:

1. Focus more on principles and concepts applicable across species, rather than on individual types of crops. A key issue in planning curricula is the limit on the total number of coursework credits. Given this limit, I think it is better for courses to focus on what is applicable across species, rather than on breeding for specific types of crops. I noticed that the curriculum includes a course on breeding for perennial crops and a course on breeding for vegetable crops. Continuing to offer these courses seems contrary to the goal of the proposal of unifying plant improvement across species. This is not to say that differences in breeding for different types of crops should be ignored. Introductory plant breeding courses should highlight the key differences in breeding different types of plants, e.g., yield in cereals versus "flower power" in roses. Differences in applicable breeding approaches for different species can also be emphasized in the *Plant Breeding Techniques* course.

2. Include more courses in statistics and data science. When I ask seed industry contacts about the main technical skills they seek in our graduates, the most common answer I get is the ability to quickly make breeding decisions from large amounts of data. My audience for this question is skewed towards row crops, but this answer nevertheless underscores that plant breeding will continue to be increasingly data driven. The proposed core curriculum has a statistics course and a field plot techniques course, whereas no statistics courses are included as electives. My opinion is that the list of elective courses should be expanded to include courses in traditional areas such as regression and mixed-model methodology, as well as newer areas such as machine learning. Again, I realize that the total number of credits is limited. But between a field plot techniques course and a regression course, I would recommend the latter because it is more difficult to learn on your own or by experience than field plot techniques.

3. Develop a course on professional skills. Breeding in major companies these days has shifted to a team effort, and the days of a corn breeder largely working alone in some place in, say, central Iowa are over. I believe that modern Ph.D. curricula need to have a formal component devoted to the awareness and development of professional skills. A few years ago, I emailed my former M.S. and Ph.D. students to ask them what they wish we taught them in graduate school but we didn't, and the replies were uniform: dealing with conflict; creating budgets; communicating with non-experts; personality differences; work-life balance; etc. I therefore developed a graduate course called *Professional Skills for Scientists* at Minnesota. We are not deceiving ourselves in thinking that simply taking a course is sufficient, as these are skills learned and honed across a lifelong professional career. Yet it is important for our students to be aware that they will encounter these issues, and for us to begin to teach them basic, soft skills in these areas. I strongly suggest that the proposed Ph.D. curriculum include a component on professional skills.

I hope you find these comments helpful; please ignore what isn't. I wish your plant breeding faculty the very best on this proposal.

Sincerely,

Rex Bernardo

Rex Bernardo
Professor and Endowed Chair in Corn Breeding and Genetics

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352-392-6479 Fax

May 04, 2020

Re: Approval for courses from Horticultural Sciences (HOS), Environmental Horticulture (ENH), Agronomy (AGR) and School of Forest Resources and Conservation (SFRC) to be used in Plant Breeding Ph.D. Major

Dear Drs. Jackie Burns, Dean Kopsell, Diane Rowland, Terrell 'Red' Baker, and Elaine Turner,

During Summer 2019, and with the support of Dean Turner, we presented a proposal and rationale for a new Ph.D. degree with a major in Plant Breeding to the four UF/IFAS departments where plant breeders are housed (HOS, ENH, AGR, and SFRC). All four chairs were fully supportive and approved our proposal. In November 2019 we officially submitted the full proposal to the Academic Tracking System.

After initial approvals by CALS, OIPR and AP for Academic and Faculty Affairs, on March 2020 the Graduate School Tech Review committee asked for curriculum clarifications before the proposal could move forward with full review by the Graduate Council on May 2020. As you are aware, our proposed curriculum includes some of your departmental graduate courses and we were requested to include the signatures of each participating department representative in this revised proposal once more.

In addition, current Graduate School policies dictate that graduate students in this new plant breeding major are restricted from pursuing minors in academic units that contribute major credit toward their specified degree program. This may also be true in reverse since the Graduate School stipulates that if an academic unit contributes more than one course (as specified in the curriculum inventory and/or the Graduate Catalog) to the major, students from that unit would not be eligible to earn said minor. Therefore, Ph.D. graduate students majoring in Plant Breeding are unable to pursue minors in the Ph.D. majors offered by your department and vice-versa. As reference, the PMCB interdisciplinary program, which served as a model to create our new Plant Breeding Interdisciplinary Program has never had a student requesting a minor in any of the other IFAS departments.

Once again, we respectfully request your signature below to indicate you are aware and agree with your departmental courses being used in the Plant Breeding Ph.D. major.

Thank you for your time and support of this crucial and innovative new graduate degree.

Respectfully,

Patricio R. Munoz, Ph.D.
Assistant Professor, Horticultural Sciences Department
University of Florida

Elaine Turner

5/4/2020 | 3:58 PM EDT

Dr. Elaine Turner, Dean
College of Agricultural and Life Sciences

Date

Jacqueline K. Burns

5/4/2020 | 3:38 PM EDT

Dr. Jacqueline Burns, Chair
Horticultural Sciences Department

Date

Dean A. Kopsell

5/5/2020 | 7:18 AM EDT

Dr. Dean Kopsell, Chair
Environmental Horticulture Department

Date

Diane Rowland

5/4/2020 | 7:47 PM EDT

Dr. Diane Rowland, Chair
Agronomy Department

Date

Terrell T. Baker

5/4/2020 | 4:46 PM EDT

Dr. Terrell 'Red' Baker, Director
School of Forest Resources and Conservation

Date

Certificate Of Completion

Envelope Id: 9DCF57887C1842CD8627FEE738BE175C
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Eliana Kampf
971 Elmore Drive, Rm 102
PO Box 115250
Gainesville, FL 32611
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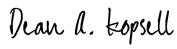
Signer Events	Signature	Timestamp
Dean A. Kopsell dean.kopsell@ufl.edu Ph.D. University of Florida Security Level: Email, Account Authentication (None)	 Signature Adoption: Pre-selected Style Using IP Address: 174.70.80.20	Sent: 5/4/2020 3:11:00 PM Viewed: 5/4/2020 3:36:18 PM Signed: 5/5/2020 7:18:56 AM
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Diane Rowland dlrowland@ufl.edu University of Florida Security Level: Email, Account Authentication (None)	 Signature Adoption: Pre-selected Style Using IP Address: 70.171.37.218	Sent: 5/4/2020 3:11:00 PM Viewed: 5/4/2020 7:46:51 PM Signed: 5/4/2020 7:47:10 PM
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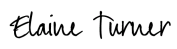
Elaine Turner returner@ufl.edu University of Florida Security Level: Email, Account Authentication (None)	 Signature Adoption: Pre-selected Style Using IP Address: 174.70.71.230	Sent: 5/4/2020 3:11:00 PM Viewed: 5/4/2020 3:57:45 PM Signed: 5/4/2020 3:58:18 PM
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Jacqueline K. Burns jkbu@ufl.edu University of Florida Security Level: Email, Account Authentication (None)	 Signature Adoption: Pre-selected Style Using IP Address: 128.227.155.166	Sent: 5/4/2020 3:10:59 PM Viewed: 5/4/2020 3:38:06 PM Signed: 5/4/2020 3:38:28 PM
Electronic Record and Signature Disclosure:		

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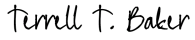
Terrell T. Baker tbakeriii@ufl.edu Director University of Florida SFRC Security Level: Email, Account Authentication (None)	 Signature Adoption: Pre-selected Style Using IP Address: 128.227.192.116	Sent: 5/4/2020 3:11:00 PM Resent: 5/4/2020 4:42:04 PM Viewed: 5/4/2020 4:46:48 PM Signed: 5/4/2020 4:46:55 PM
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Envelope Summary Events	Status	Timestamps
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Signing Complete	Security Checked	5/5/2020 7:18:56 AM
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PDF Reader:	Acrobat® or similar software may be required to view and print PDF files
Screen Resolution:	800 x 600 minimum
Enabled Security Settings:	Allow per session cookies

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MEMO

Date: April 22, 2020

To: Graduate School Tech Review Committee and Graduate Council members

Plant Breeding Working Group - Curriculum Development Committee (Dr. Patricio Munoz, Dr. Marcio Resende, Dr. Kevin Kenworthy, Dr. Vance Whitaker and Eliana Kampf)

RE: Revised Proposal for a New Ph.D. Degree with a Major in Plant Breeding

This document serves as our reply addressing the Word file *"Plant Breeding Notations 04012020.docx"* given to us on April 7, 2020 by Ms. Stacy Wallace. In this file the Graduate School Tech Review committee asked for edits in order for the proposal to move forward for full review by the Graduate Council. As requested, we provide further clarifications, detailed explanations and adjustments to all the points brought up by the review team. In addition, we indicate where edits were made in the full revised proposal, which accompanies this document.

Curriculum:

The curriculum was re-designed after conducting a Qualtrics survey of all 27 plant breeding faculty, where the majority approved the proposed changes. As explained in detail in the revised proposal, the plant breeding doctoral degree requires a minimum of 90 credit hours beyond a bachelor's degree and includes required courses, elective courses and dissertation research. The revised curriculum states that in order to graduate in the program, students are required to have a minimum of 40 credits of coursework toward their major. All students are required to take 20 credits from required courses and choose a minimum of 20 additional credits from the list of elective courses in Table 2 or as determined by the supervisory committee. The list of required courses and elective courses are listed as Table 1 and Table 2, respectively, on page 26 (*VIII. Curriculum B*). We have also adjusted and explained in more detail all references regarding required and elective courses. The Graduate Catalog, appendices and attachments have also been updated to mirror this information and ensure accuracy across all documents. The revised Graduate Catalog copy has been named *Plant_Breeding_Catalog_Final_April_22_2020.docx* .

Students entering the doctoral program with a completed Master's degree may transfer up to 30 hours of graduate credits toward their elective course requirement from a regionally accredited institution or international equivalent, subject to existing UF Graduate School policies.

These changes have been reflected in the full revised proposal (in special on pages 26 to 33) and have been also incorporated in the additional attachment in the online approval system, titled *Plant Breeding Curriculum*. As requested, the *Plant Breeding Curriculum* attachment indicates all required and elective courses contributing to the full Ph.D. program with a major in Plant Breeding. It also lists the prefix, number, name of the course, the amount of credit, and grading scheme for each of the courses. We have made a note that this document will need to be submitted later to the Graduate School with an additional indication that all these courses are intended to count toward major credit. The current Graduate Catalog copy document has also been updated to mirror this information and ensure accuracy across all documents.

Please note that due to recent change of instructors, PCB 6555 Introduction to Quantitative Genetics will be offered fall of even years. This recent change has not been reflected in the Graduate Catalog yet; currently it still shows the course as being offered in spring of odd years.

We were also asked to elaborate on recruitment strategies, especially for those students being recruited directly after completing their B.S. degrees. In the plant breeding STEM field of study it is very common to receive highly competitive applications from baccalaurean students who exhibit exceptional strong research undergraduate experience. To make it clear to the reader, we have considerably expanded section *II. Need and Demand D* (page 9) to explain in details that recruitment for post-baccalaurean will follow a successful strategy used by the interdisciplinary UF/IFAS PMCB program. PMCB has successfully recruited highly qualified candidates, with either Bachelor's or Master's degrees, and for over 30 years has placed these graduates in high-impact positions in research, teaching and industry. The Plant Breeding program will draw on PMCB's experiences in recruiting highly qualified students who exhibit strong research experience.

Curriculum and Major Credit:

As described in the proposal, the proposed Ph.D. degree will be an interdisciplinary graduate program involving four IFAS units (AGR, HOS, ENH and SFRC) whose curriculum relies on existing coursework being offered by plant breeding faculty in their respective departments/school. This interdisciplinary program will unify faculty working in plant breeding and formalize an educational program that is currently underway. The Ph.D. program will increase strong, collaborative research teams involving multiple faculty, Ph.D. students, master's students, and undergraduates. The four participating units agree that some of their current courses will count toward major credit for our requested Ph.D. degree in Plant Breeding.

As requested, we sent each of the three department chairs, namely Dr. Diane Rowling (Agronomy), Dr. Jacqueline Burns (Horticultural Sciences), Dr. Dean Kopsell (Environmental Horticulture) and one school director, Dr. Terrell 'Red' Baker (School of Forest Resources and Conservation) individualized letters which, first, detailed which of their specific courses will be used in our proposed degree curriculum and count toward major credits in the new Ph.D. degree. The letter also explained the potential impact this will have on any students from these units who wish to minor in plant breeding and vice-versa. We summarized these individual letters in one DocuSign document that shows we have full endorsement of not only all the units involved but also from the CALS Dean, Dr. Elaine Turner(see attached file *Chairs_Dean_DocuSign_PlantBreeding_RevisedCurriculum.pdf*).

It is also important to state that the PMCB interdisciplinary graduate program, which served as a model to create this new Plant Breeding Interdisciplinary Program, has never had a student requesting a minor in any of the other IFAS departments.

Faculty Participation and Table 4:

Table 4 (Appendix A) has been amended to list the 27 graduate faculty who will participate in the interdisciplinary PB graduate program and will serve as chairs or members of supervisory committees of students. Also, the proposal under *IX. Faculty Participation A.* has been edited to explain that these faculty will maintain their appointments in their budgeted department (either HOS, ENH, AGR or SFRC); in other words, none of the listed 27 PB graduate faculty will be budgeted in the proposed PB program. Because the curriculum of the program relies on current coursework being taught in the four involved departments, most faculty will not see a change in their responsibilities, or their time assigned to the new program. The proposed program attempts to minimize the effects of the reallocation of teaching resources by re-allocating only 1% per teaching faculty FTE to the new program. The revised list of 27 faculty members have also been updated in the Graduate Catalog and elsewhere in the document and attachments.

We also state in the proposal that students must establish a supervisory committee by the end of the first year, comprised of at least three plant breeding faculty members, including the chair, and one external faculty member. External members of these committees will be chosen from University of Florida graduate faculty members not affiliated with the PB program. We intend to contact Associate Director Jody Slapcinsky of the Graduate School's Data Management Division to request this unique supervisory committee rule be applied to GIMS as this model is different from the more traditional Ph.D. committee template.

Another question raised was whether listing the Department of Environmental Horticulture as one of the departments involved in the proposed PB program was problematic since the department does not offer a graduate degree program per se. This should not be a problem. Even though the Department of Horticultural Sciences and the Department of Environmental Horticulture offer a jointly, combined Doctor of Philosophy degree with concentrations in either Environmental Horticulture or Horticultural Sciences this does not affect the contribution of plant breeding faculty housed in the Environmental Horticulture Department. All four departments listed in the proposal (Horticultural Sciences, Agronomy, School of Forest Resources and Conservation, Environmental Horticulture) have faculty who greatly contribute to this new major and program by teaching and performing research in plant breeding-related areas.

Plant Breeding UF Alumni:

The Tech Review Committee requested clarification about the plant breeding UF alumni statement originally on page 9 (under *III. Budget D*). This statement has been re-written, now on page 14, to explain the plant breeding alumni survey carried out in 2018 by the UF/IFAS Plant Breeding Working Group.

Dissertation Credits:

Students in the Ph.D. degree with a major in Plant Breeding will take dissertation research credits in PLS 7979 Advanced Research before advancing to candidacy and PLS 7980 Research for Doctoral Dissertation after passing their candidacy exam. This has been corrected in the revised proposal and updated consistently in all attachments to reflect the same content across all documents.

Signature below indicates support for the Plant Breeding new degree proposal and commitment of departmental resources.

Christine Chase
_____

Dr. Christine Chase, Interim Chair
Horticultural Sciences Department

11/8/2019 | 9:39 AM EST
_____
Date

Dean A. Kopsell
_____

Dr. Dean Kopsell, Chair
Environmental Horticulture Department

11/8/2019 | 3:31 PM EST
_____
Date

Dr. Terrell Baker
_____

Dr. Terrell "Red" Baker, Director
School of Forest Resources & Conservation

11/10/2019 | 9:43 AM EST
_____
Date

Diane Rowland
_____

Dr. Diane Rowland, Chair
Agronomy Department

11/8/2019 | 11:44 AM EST
_____
Date

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Christine Chase cdchase@ufl.edu University of Florida Security Level: Email, Account Authentication (None)	Christine Chase Signature Adoption: Pre-selected Style Using IP Address: 70.185.100.88	Sent: 11/7/2019 4:40:59 PM Resent: 11/8/2019 9:38:34 AM Viewed: 11/7/2019 11:43:55 PM Signed: 11/8/2019 9:39:34 AM
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Dean A. Kopsell dean.kopsell@ufl.edu Ph.D. University of Florida Security Level: Email, Account Authentication (None)	Dean A. Kopsell Signature Adoption: Pre-selected Style Using IP Address: 128.227.180.157	Sent: 11/8/2019 9:38:21 AM Resent: 11/8/2019 9:38:34 AM Resent: 11/8/2019 10:01:59 AM Viewed: 11/8/2019 3:31:01 PM Signed: 11/8/2019 3:31:15 PM
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Diane Rowland dlrowland@ufl.edu University of Florida Security Level: Email, Account Authentication (None)	Diane Rowland Signature Adoption: Pre-selected Style Using IP Address: 128.227.130.180	Sent: 11/8/2019 9:38:21 AM Resent: 11/8/2019 9:38:35 AM Resent: 11/8/2019 10:01:59 AM Viewed: 11/8/2019 11:44:37 AM Signed: 11/8/2019 11:44:43 AM
Electronic Record and Signature Disclosure: Accepted: 8/6/2018 8:45:11 AM ID: 13f7bb3c-3c2d-4cfa-b78a-ba31ee6b9bdb		
Dr. Terrell Baker tbakeriii@ufl.edu Director University of Florida SFRC Security Level: Email, Account Authentication (None)	Dr. Terrell Baker Signature Adoption: Pre-selected Style Using IP Address: 70.185.108.113 Signed using mobile	Sent: 11/8/2019 9:38:21 AM Resent: 11/8/2019 9:38:35 AM Resent: 11/8/2019 10:01:49 AM Resent: 11/8/2019 10:01:59 AM Viewed: 11/10/2019 9:43:49 AM Signed: 11/10/2019 9:43:59 AM
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Original file: DocuSign_11_10_19_Dept_Chairs_Signatures_Plant_Breeding.pdf

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Envelope Summary Events	Status	Timestamps
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Signing Complete	Security Checked	11/10/2019 9:43:59 AM
Completed	Security Checked	11/10/2019 9:43:59 AM

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- To contact us by email send messages to: UF-DocuSign@ufl.edu
- To contact us by paper mail, please send correspondence to:

  University of Florida Information Technology
  Attn: UFDocuSign Service
  P.O. Box 113359
  Gainesville, FL 32611-3359

To advise UF of your new e-mail address

You agree to promptly update us regarding any change in your email address so that we may send Documents to you electronically, as needed. To let us know of a change in your e-mail address, you must send an email message to us at UF-DocuSign@ufl.edu and in the body of such request state: your previous e-mail address, your new e-mail address. You also agree to promptly update us regarding any change to your other contact information in the same manner described above.

In addition, you must notify UF to arrange for your new email address to be reflected in your UFDocuSign account by following the process for changing e-mail in the UFDocuSign system.

Required hardware and software

Operating Systems:	Windows® 2000, Windows® XP, Windows Vista®; Mac OS® X
Browsers:	Final release versions of Internet Explorer® 6.0 or above (Windows only); Mozilla Firefox 2.0 or above (Windows and Mac); Safari™ 3.0 or above (Mac only)
PDF Reader:	Acrobat® or similar software may be required to view and print PDF files
Screen Resolution:	800 x 600 minimum
Enabled Security Settings:	Allow per session cookies

These minimum requirements are subject to change. If these requirements change, you will be asked to re-accept the disclosure. Pre-release (e.g. beta) versions of operating systems and browsers are not supported.

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To confirm to us that you can access this information electronically, which will be similar to other electronic Documents that we will provide to you, please verify that you were able to read

this DISCLOSURE AND CONSENT TO USE ELECTRONIC DOCUMENTS AND SIGNATURES and that you also were able to print on paper or electronically save this page for your future reference and access or that you were able to e-mail this DISCLOSURE AND CONSENT TO USE ELECTRONIC DOCUMENTS AND SIGNATURES to an address where you will be able to print on paper or save it for your future reference and access.
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Plant Breeding Curriculum

The Plant Breeding Ph.D. degree will require a minimum of 90 post-baccalaureate credit hours and will include required courses, elective courses and dissertation research. To graduate in the program, students are required to have a minimum of 40 credits of coursework toward their major. All students are required to take 20 credits of required courses and must additionally choose a minimum of 20 additional credits from the list of elective courses.

Students must take the following 20 credits of required courses toward the Plant Breeding major:

Required Courses	**Credit Hours**
AGR 5266C Field Plot Techniques	3
AGR 5321C Genetic Improvement of Plants	3
AGR 6325L Plant Breeding Techniques *	1
PCB 6555 Introduction to Quantitative Genetics **	3
HOS 6XXX [1] Journal Colloquium ***	4
HOS 6XXX [2] Survey of Breeding Tools & Methods	3
STA 6093 Introduction to Applied Statistics for Agricultural and Life Sciences	3
Total Required Courses Credits	**20**

* Students can take AGR 6325L any spring semester of odd years in coordination with their supervisory committee.

** Students can take PCB 6555 any fall semester of even years in coordination with their supervisory committee. (*NOTE: due to recent change of instructors, PCB 6555 Introduction to Quantitative Genetics will be offered fall of even years. This recent change has not been reflected in the Graduate Catalog yet; currently it still shows the course as being offered in spring of odd years*).

*** Students can take HOS 6XXX [1]

Journal Colloquium (1 credit) any fall and spring semester to be counted toward the total 4 credits required during their graduate studies.

Students must also choose a minimum of 20 additional credits from the list of elective courses listed below:

Elective Courses	**Credit Hours**	**Gra**
AGR 5307 Molecular Genetics for Crop Improvement	3	Let
AGR 6322 Advanced Plant Breeding	3	Let
AGR 6XXX Plant Chromosomes and Genomes	3	Let
AGR 5444 Ecophysiology of Crop Production	2	Let
BCH 5045 Graduate Survey of Biochemistry	4	Let
NEM 5004C Graduate Survey of Nematology	3	Let
ENY 5006 Graduate Survey of Entomology	2	Let
ENY 5006L Graduate Survey of Entomology Laboratory	1	Let
GMS 6231 Genomics and Bioinformatics	3	Let
HOS 5242 Genetic and Breeding of Vegetable Crops	3	Let
HOS 6201 Breeding Perennial Cultivars	3	Let
HOS 6236 Molecular Marker-Assisted Plant Breeding	3	Let
HOS 6932 Horticultural Physiology	3	Let
PCB 5065 Advanced Genetics	4	Let
PCB 5530 Plant Molecular Biology and Genomics	3	Let
PCB 6685 Population Genetics	4	Let
PLP 5005C General Plant Pathology	4	Let
PLP 6291 Plant Disease Diagnosis	3	Let

Please note that HOS 6XXX
[1]

Journal Colloquium, HOS 6XXX
[2]

Survey of Breeding Tools & Methods and AGR 6XXX Plant Chromosomes and Genomes are currently offered as special topics courses in the Graduate Catalog but are expected to be approved by the Academic Approval Tracking System and have their own prefixes and course numbers assigned before the start of this new graduate degree program.

Students admitted with a M.S. degree may transfer up to 30 credits toward their elective courses requirement from a regionally accredited institution or international equivalent, subject to existing UF Graduate School policies.

The number of dissertation research credits will vary according to the student's field of study and progression toward research and degree.

Dissertation Research	**Credit hours**
PLS 7979 Advanced Research	variable
PLS 7980 Doctoral Research	variable

Notations to be addressed within the proposal for a new Ph.D. degree with a major in Plant Breeding or to be considered before fully moving forward with review by the Graduate Council:

As we discussed earlier, the Graduate School feels you may potentially face resistance from Graduate Council in reference to the way the curriculum has been laid out for the entire program. Please inform us if we are misunderstanding the intent here and also be prepared to answer any questions of this nature that Graduate Council members may also present. It appears to our tech review team that

> The Ph.D. requires a minimum of 90 post-baccalaureate credit hours. Up to 30 credits may be transferred from an M.S. or other appropriate master's program. The doctoral course work will include core courses (15 credits), elective courses (minimum 6 credits), and dissertation research.

Elsewhere in the program, you speak of recruiting post-bac students. If recruited, how will they obtain the appropriate course work for these credits? It currently appears as presented,

> If the full program is 90 hours and there are 15 required core credits, 6 credits of elective lecture courses (totaling 21 credits of content), the rest of the program appears to simply be dissertation research (for almost 70 hours)?

Perhaps the 21 didactic credits are intended to be post master's degree; if that is the case, how will those credits be structured for the post-bac students? The Graduate School and the Graduate Council would likely be uncomfortable with 70 hours of research credits. If it is really more like 40 hours because 30 (mostly didactic) hours were obtained through master's credits, this is generally acceptable but should be stated in the proposal. Additionally, a statement should be added how these credits will be accounted for when recruiting post-bac students. In general, the recommendation of the 90-credit curriculum comes out in an overlapping curriculum of approximately a. 30, mostly coursework hours; b. 30 middle didactic overlapping hours after the master's; and c. 30 Ph.D. Research credits. When a student is coming in with a bachelor's is starting off directly in advanced doctoral research really appropriate in their first term as a graduate student?

In the proposal, address how the curriculum is intended to function for these students and tell the reader more about who and how you are recruiting these bachelor's students?

Online Program:

It appears this program will only be offered fully online; please be aware of the restrictions that may be placed on the program in relation to residential international students due to potential conflicts and international visa issues. Discussions should take place with the UFIC, so you are aware of the potential impact of this decision on potential international enrollment. Fulbright students may have even more restricted options that should be looked into before offering the program. For this reason, after the program establishes itself, you may want to consider opening more of the curriculum to the campus community in order to ensure viable student groups are not seemingly systematically excluded from pursuing the program.

Faculty Listings and Table 4:

In Table 4, the data does not point to the faculty appointment but rather to the degree held by the faculty---is that the intent here?

As far as the committee guidelines, what measures are in place to ensure these guidelines will be followed? What measures are in place addressing how the unit plans to monitor the requirements? We suggest that you contact Associate Director Jody Slapcinsky of the Graduate School's Data Management Division for consultation and in order to submit this information to their office for coding into the Graduate Information Management System (GIMS).

Please also confirm and differentiate the full appointed faculty list from the potential contributing faculty list. The faculty lists provided in the proposals and the attachments for catalog copy do not currently match, and we suspect that this may be the differentiation between these lists, but this needs to be clarified for the Council members.

Plant Breeding UF Alumni:

Pg. 9. Is this statement indicating there are 113 Ph.D. alumni in Plant Breeding?

> Furthermore, a recent study **of all graduates for each plant breeding faculty since the beginning of their career at UF in each of the four departments indicated that the 27 plant breeding faculty are not exclusively focused on preparing students as breeders.** Out of a total of 241 graduate students under plant breeder supervision 113 students (46%) **complete programs focused on plant breeding** while 128 students (54%) focused on other traditional areas of specialization in their respective

while 128 students (54%) focused on other traditional areas of specialization in their respective departments such as agronomy, horticulture, floriculture, pest management, plant physiology, nutrition, weed science, plant management, crop production, molecular and cellular biology, and landscape management.

Please clarify this statement. The Tech Review Committee cannot quite decipher exactly what is being said here. I have bolded some of the things that could be clarified in the above statement.

The following notations can be submitted as addendum items or corrected in existing items within the online approval system---all attachments must be updated consistently to reflect the same content across all documents:

Curriculum Breakdown:

Please ensure course lists are broken down clearly for the students. Please attach an additional attachment in the online approval system, titled *Plant Breeding Curriculum* . On this attachment, avoid the use of the word "core" wherever possible or define exactly what that means. Does this mean they are required for the program? Does it mean these courses will count toward major credit? Please indicate all required courses contributing to the full Ph.D. program with a major in Plant Breeding. List the prefix, number, name of the course, the amount of credit, and grading scheme for each of the courses; then, note the elective courses in this same fashion with the indication of which courses you intend to count toward major credit. Feel free to recast the table from Page 28 in the proposal form as the base for this attachment, by simply adding the grading scheme for the courses. Later this same document will need to be submitted to the Graduate School with an additional indication of whether the courses are intended to then count toward major credit. If all are intended, please note this in the attachment.

Once this document is attached to the online approval system, the current *catalog copy* document submitted with this proposal should also be updated to mirror this information. Update all materials as appropriate to ensure accuracy across all documents.

Dissertation Credits:

Please also be aware that dissertation credits should be clarified in the appendix items, the *catalog copy* , and within the submitted form in the online approval system. Currently, the *catalog copy* attachment indicates these courses will be HOS 7979 and HOS 7980, while other attachments indicate PLS 7979 and PLS 7980 are the required dissertation credits to be taken for the program. Does registration perhaps follow the unit that the chair hails from? If this is the case, please state this fact and list all potential prefixes where 7979 and 7980 for this program may potentially come from. Please clarify on all attachments in the system as appropriate.

Please be aware of the following potential issues and address accordingly with appropriate parties:

Curriculum and Major Credit:

Please provide a list of the courses that you intend to count toward major credit for this degree. Once you do, please also be aware any courses taken from any of the contributing departments to this program will also count toward major credit for your requested degree program (Ph.D. with a major in Plant Breeding) as well. The College of Agriculture and Life Sciences courses will continue to contribute to major credit following standard guidelines.

i. Departmental courses (from all of the contributing units listed on the proposal)
ii. College courses (from the College of Agricultural and Life Sciences)

If the plan is to include courses from outside units within this degree program, not only should permission be obtained from the contributing unit to use the course within your curriculum, precautions should also be considered regarding the potential impact this will have on any students from these units who wish to minor, as they will be blocked from doing so. Please be aware graduate students are restricted from pursuing minors in academic units that contribute major credit toward their specified degree program. Therefore, graduate students majoring in Plant Breeding find themselves potentially unable to pursue minors in Horticultural Sciences, Agronomy, Environmental Horticulture, and programs under the School of Forest Resources and Conservation umbrella, for example. This may also be true in reverse and should first be verified prior to recruiting students from these programs, as current requirements dictate that if an academic unit contributes more than one course (as specified in the curriculum inventory and/or the Graduate Catalog) to the major, students from that unit would not be eligible to earn said minor. Should you have further questions about how these rules are applied, please contact Assistant Director Patricia Van Wert in the Graduate School's Records Office or Associate Director Gann Enholm of the Graduate School's Administration Office for further explanation.

Lastly, please add credit totals in this section of the *catalog copy* :

Six core courses are required (STA6093 Introduction to Applied Statistics for Agriculture & Life Sciences, AGR5266C Field Plot Techniques, AGR5321 Genetic Improvement of Plants, HOS6932 Special Topics – Survey of Breeding Methods, AGR6325 Plant Breeding Techniques, HOS6932 Special Topics - Journal Colloquium) and must be taken during the first fall and spring semesters (with the exception of AGR6325 which can be taken any semester). Additionally, students must take at least two additional courses (minimum of six credits) from a list of elective courses (see below). Additional elective courses may be taken with the approval of the student's supervisory committee.

Plant Breeding (CALS)

College

College of Agricultural and Life Sciences

Department/School

Plant Breeding Graduate Program

Plant Breeding Graduate Program Information

Plant Breeding is an interdisciplinary and interdepartmental graduate program that provides comprehensive training to prepare well-rounded and career-ready plant breeders for academic, industry, non-profit and other sectors . Our integrated curriculum equips students with traditional and contemporary breeding methodologies, including analysis of breeding trials, breeding methods and techniques, bioinformatics, gene editing, genomic prediction and quantitative genetics.

The Plant Breeding Graduate Program offers a Doctor of Philosophy degree that provides students with a strong background in experimental design and analysis during the first semester, and plant breeding theory and methods during the second semester. Our plant breeding faculty work with 50 plant species and represent diverse disciplines including: cell biology, genomics, molecular genetics, plant pathology, quantitative genetics & biometrics. For a complete faculty listing, please see the last page of this document.

To graduate in the program, students are required to have a minimum of 40 credits of coursework toward their major. Students must take all the 7 required courses listed below for a total of 20 credits of required courses and must additionally choose a minimum of 20 additional credits from the list of elective courses.

Minimum requirements for this degree are available in the Graduate Degrees section of this catalog. Successful applicants should have a B.S. or M.S. in agricultural, horticultural, forestry, biological or chemical sciences with desirable advanced undergraduate coursework in genetics, statistics, plant breeding, and biochemistry. However, outstanding students from a broad range of science and engineering disciplines will be considered.

All doctoral students must have at least one first author publication submitted to a peer-reviewed journal in their research field before graduation. Our students are strongly encouraged to publish before graduating.

Contact program coordinator Eliana Kampf at elianak@ufl.edu , Dr. Vance Whitaker at vwhitaker@ufl.edu , or visit the program's website at TBD (*Note: Plant Breeding website under construction*).

Degrees Offered with a Major in Plant Breeding

Doctor of Philosophy

Plant Breeding Courses

Required Courses :

AGR 5266C Field Plot Techniques (3 credits)

AGR 5321C Genetic Improvement of Plants (3 credits)

AGR 6325L Plant Breeding Techniques* (1 credit)

PCB 6555 Introduction to Quantitative Genetics** (3 credits)

HOS 6XXX1 Journal Colloquium*** (4 credits)

HOS 6XXX2 Survey of Breeding Tools & Methods (3 credits)

STA 6093 Introduction to Applied Statistics for Agricultural and Life Sciences (3 credits)

** Students can take AGR 6325L any spring semester of odd years in coordination with their supervisory committee.*

*** Students can take PCB 6555 any fall semester of even years in coordination with their supervisory committee.*

NOTE: due to recent change of instructors, PCB 6555 Introduction to Quantitative Genetics will be offered fall of even years. This recent change has not been reflected in the Graduate Catalog yet; currently it still shows the course as being offered in spring of odd years.

**** Students need to take a total of 4 credits of HOS 6XXX*
1

Journal Colloquium (1 credit) toward the major. HOS 6XXX
1

can be taken any fall and spring semester.

Students must choose a minimum of 20 credits from the list of electives below:

Elective Courses:

AGR 5307 Molecular Genetics for Crop Improvement (3 credits)

AGR 6322 Advanced Plant Breeding (3 credits)

AGR 6XXX Plant Chromosomes and Genomes (3 credits)

AGR 5444 Ecophysiology of Crop Production (2 credits)

BCH 5045 Graduate Survey of Biochemistry (4 credits)

NEM 5004C Graduate Survey of Nematology (3 credits)

ENY 5006 Graduate Survey of Entomology (2 credits)

ENY 5006L Graduate Survey of Entomology Laboratory (1 credit)

GMS 6231 Genomics and Bioinformatics (3 credits)

HOS 5242 Genetic and Breeding of Vegetable Crops (3 credits)

HOS 6201 Breeding Perennial Cultivars (3 credits)

HOS 6236 Molecular Marker-Assisted Plant Breeding (3 credits)

HOS 6932 Horticultural Physiology (3 credits)

PCB 5065 Advanced Genetics (4 credits)

PCB 5530 Plant Molecular Biology and Genomics (3 credits)

PCB 6685 Population Genetics (4 credits)

PLP 5005C General Plant Pathology (4 credits)

PLP 6291 Plant Disease Diagnosis (3 credits)

Dissertation Research:

PLS7979 Advanced Research

PLS7980 Doctoral Research

Plant Breeding Faculty List

Faculty Name (Last, First)	Department	Title	Crop
Altpeter, Fredy	Agronomy	Professor	Elephantgrass, Bahiagrass, Napiergra
Babar, Md Ali	Agronomy	Assistant Professor	Grains (wheat, oats and triticale)
Blount, Ann	Agronomy, NFREC	Professor	Small Grains (Oat, Triticale), Forage (Perennial Peanut
Chambers, Alan	Horticultural Sciences, TREC	Assistant Professor	Tropical Fruits
Chaparro, José X.	Horticultural Sciences	Associate Professor	Stone fruit (Peach, Nectarine, Aprico Avocado
Clark, David G.	Environmental Horticulture	Professor	Ornamentals, Coleus, Basil
			Ornamentals (Caladium, Gerbera, La

Deng, Zhanao	Environmental Horticulture, GCREC	Professor	Ornamentals (Caladium, Gerbera, La Blackberry, Pomegranate, Hops
Dutt, Manjul	Horticultural Sciences, CREC	Research Assistant Scientist	Citrus
Gmitter, Fredrick G.	Horticultural Sciences, CREC	Professor	Citrus
Grosser, Jude	Horticultural Sciences, CREC	Professor	Citrus
Huo, Heqiang (Alfred)	Environmental Horticulture, MREC	Assistant Professor	Tropical Foliage
Hutton, Sam	Horticultural Sciences, GCREC	Associate Professor	Tomato
Kenworthy, Kevin	Agronomy	Professor	Turfgrass, Annual Ryegrass
Kirst, Matias	School of Forest Res. & Cons.	Associate Professor	Forestry (Pine)
Klee, Harry	Horticultural Sciences	Professor	Tomato Genetics
Lee, Seonghee	Horticultural Sciences, GCREC	Assistant Professor	Strawberry Genetics
Lee, Tong Geon	Horticultural Sciences, GCREC	Assistant Professor	Tomato Genetics
Meru, Geoffrey	Horticultural Sciences, TREC	Assistant Professor	Cucurbit, Tropical Pumpkin
Munoz, Patricio	Horticultural Sciences	Assistant Professor	Blueberry
Peter, Gary F.	School of Forest Res. & Cons.	Professor	Forestry (Pine)
Rathinasabapathi, Balasubramanian	Horticultural Sciences	Professor	Peppers
Resende, Márcio F. R.	Horticultural Sciences	Assistant Professor	Sweet Corn
Rios, Esteban F.	Agronomy	Assistant Professor	Forage (Alfalfa, Bermudagrass, Clove
Sandhu, Hardev S.	Agronomy, EREC	Assistant Professor	Sugarcane
Sandoya M., Germán	Horticultural Sciences, EREC	Assistant Professor	Lettuce
Tillman, Barry	Agronomy, NFREC-Marianna	Professor	Peanut
Whitaker, Vance	Horticultural Sciences, GCREC	Associate Professor	Strawberry

Board of Governors, State University System of Florida

Request to Offer a New Degree Program

(Please do not revise this proposal format without prior approval from Board staff)

University of Florida	Fall 2021
University Submitting Proposal	**Proposed Implementation Term**
College of Agricultural and Life Sciences	Horticultural Sciences, Agronomy, School of F Resources and Conservation, Environmental Hc
Name of College(s) or School(s)	**Name of Department(s)/ Division(s)**
Plant Breeding	Doctor of Philosophy
Academic Specialty or Field	**Complete Name of Degree**
01.1104	
Proposed CIP Code	

The submission of this proposal constitutes a commitment by the university that, if the proposal is approved, the necessary financial resources and the criteria for establishing new programs have been met prior to the initiation of the program.

Date Approved by the University Board of Trustees

Signature of Chair, Board of Trustees **Date**

Provide headcount (HC) and full-time equivalent (FTE) student estimates of majors for Years 1 through 5. HC and FTE estimates should be identical to those in Table 1 in Appendix A. Indicate the program costs for the first and the fifth years of implementation as shown in the appropriate columns in Table 2 in Appendix A. Calculate an Educational and General (E&G) cost per FTE for Years 1 and 5 (Total E&G divided by FTE).

Implementation Timeframe	Projected Enrollment (From Table 1)			Projected Program C (From Table 2)		
	HC	FTE		E&G Cost per FTE	E&G Funds	Contract & Grants Funds
Year 1	5	3.5		$34,473	$120,657	$33,278
Year 2	10	7.25				
Year 3	15	11				
Year 4	20	14.5				
Year 5	20	14.5		$23,174	$336,027	$210,063

Note: This outline and the questions pertaining to each section must be reproduced within the body of the proposal to ensure that all sections have been satisfactorily addressed. Tables 1 through 4 are to be included as Appendix A and not reproduced within the body of the proposals because this often causes errors in the automatic calculations.

Introduction

I. Program Description and Relationship to System-Level Goals

A. Briefly describe within a few paragraphs the degree program under consideration, including (a) level; (b) emphases, including majors, concentrations, tracks, or specializations; (c) total number of credit hours; and (d) overall purpose, including examples of employment or education opportunities that may be available to program graduates.

The University of Florida is one of the most active and innovative land-grant universities in plant breeding and variety licensing in the country. The university employs 27 faculty positions, breeding 50 plant species in four academic departments (Agronomy, Horticultural Sciences, Environmental Horticulture, and the School of Forest Resources and Conservation - SFRC) within the Institute of Food and Agricultural Sciences (UF/IFAS). However, we are the largest land-grant university in the country without a formal plant breeding graduate education program. Furthermore, a plant breeding graduate degree program is currently not offered in the state of Florida.

The interdisciplinary Ph.D. degree in Plant Breeding is proposed to fill the demand for breeding research and for educating new plant breeding graduates. The program will create a framework and administrative structure to leverage resources, faculty, courses, and student recruitment, which will attract federal and private funding and increase the number of graduate STEM degrees awarded at UF. It will be administered by the UF/IFAS College of Agricultural and Life Sciences (CALS) to provide a comprehensive plant breeding education. Our integrated curriculum will equip students with traditional and contemporary breeding methodologies, including molecular

curriculum will equip students with traditional and contemporary breeding methodologies, including molecular techniques (e.g. genomic prediction and genome editing), quantitative genetics, and analysis of breeding trials. Our curriculum was developed upon consultation with industry, non-profit, and academic sectors. The CALS plant breeding graduate program will prepare breeders proficient to work in both academia and industry, and thus supply the large demand that exists for plant breeders.

The proposed Ph.D. degree will require a minimum of 90 credit hours beyond the bachelor's degree. The coursework will include core classes (15 credits), to provide a strong foundation in experimentation, data analysis and plant breeding; followed by an array of electives (minimum of 6 credits); and dissertation research credits). Approved elective courses will be drawn both from within CALS as well as existing UF areas of expertise outside of CALS in genetics, statistics, biology, molecular biology, bioinformatics, and genomics.

Over the past 30 years, 113 plant breeding alumni have graduated from CALS graduate degree programs offered by the four departments mentioned above; however, none of them graduated with a formal plant breeding degree. Many of these graduates are now leading or employed in productive and innovative plant breeding programs in the public and private sector in the USA and internationally. Appendix F lists numerous examples of plant breeding graduates successfully employed in academia, industry, government and research institutions nationally and globally.

We expect extensive student interest in this interdisciplinary STEM program. Dozens of inquiries from prospective students are received by each of the 27 UF plant breeders every year, and there is an extraordinary demand from the private sector for highly-qualified, specialized plant breeders (see Appendix E).

B. Please provide the date when the pre-proposal was presented to CAVP (Council of Academic Vice Presidents) Academic Program Coordination review group. Identify any concerns that the CAVP review group raised with the pre-proposed program and provide a brief narrative explaining how each of these concerns has been or is being addressed.

The pre-proposal was presented to the CAVP Academic Program Coordination review group on February 22, 2019. No concerns were raised.

C. If this is a doctoral level program please include the external consultant's report at the end of the proposal as Appendix D. Please provide a few highlights from the report and describe ways in which the report affected the approval process at the university.

In the fall of 2019, four external reviewers who are highly recognized in the discipline of plant breeding were asked by Dr. Elaine Turner, Dean of the College of Agricultural and Life Sciences (CALS), to provide feedback on the Plant Breeding Ph.D. program full proposal. These were:

Reviewer 1: Dr. William Tracy , Professor of Agronomy at the University of Wisconsin-Madison, former Department Chair. Dr. Tracy is a member of the graduate faculty of the interdepartmental graduate training program in Plant Breeding and Genetics, which is very similar in design and objectives to our proposed program.

Reviewer 2: Dr. Wayne Smith , Professor of Cotton Breeding and Associate Department Head, Department of Soil and Crop Sciences at Texas A&M University, and Vice-Chair of the Plant Breeding Coordinating Committee (PBCC) Executive Committee.

Reviewer 3: Dr. B. Todd Campbell , Research Geneticist, USDA-ARS, Coastal Plains Soil, Water, and Plant Research Center and former President of the National Association of Plant Breeders (NAPB).

Reviewer 4: Dr. Rex Bernardo , Professor and Endowed Chair of corn breeding at the University of Minnesota, and former Associate Director of Graduate Studies and former Director of Graduate Studies in Applied Plant Sciences at the University of Minnesota.

The four external reviewer reports are in Appendix D. All reviewers were positive and supportive, strongly endorsing the proposed University of Florida Ph.D. program.

Regarding the overall merit of the proposed program, the reviewers emphasized that UF has, perhaps, the strongest public cultivar development program in the US, with a very strong faculty. Mobilizing this group toward a unified graduate curriculum and program will quickly move UF plant breeding into the top five programs if not the top three in the nation. The reviewers noted that the present lack of a plant breeding graduate program has been a missed opportunity for UF to become one of the leading Ph.D. plant breeding programs at present.

Regarding the demand for Ph.D. plant breeders in the Southeast region, the United States and the world, the reviewers emphasized that " Demand for PhD plant breeders has been strong since the 1970 PVP act (Plant Variety Protection Act) and especially since the 1994 PVP act and the advent of patented genetic products and procedures since 1985." Despite the consolidation of the seed industry, the demand for plant breeders remains strong, and industry may be the primary employer in the future. There are numerous reports of insufficient graduates to fill the needs of the industry. In the last 10-15 years, we have seen a large, increased investment by private industry to build plant breeding capacity. During this time, plant breeding has evolved and become even

more multi-disciplinary in nature, as reflected in the construction of the degree program proposal.

Regarding the importance of such a program in the Southeast region, the United States and the world, reviewers commented that the University of Florida is strategically located to play a vital role in U.S. crop improvement, given its research programs on plants that are of economic importance in the Southeast U.S. One reviewer noted the unique ability to study breeding of subtropical and tropical crops and the adaptation of temperate crops such as blueberries and strawberries to those conditions. Another reviewer emphasized that there are a number of crops/plants unique to Florida that are not addressed elsewhere in the region or country. Thus, the proposed program is not only locally important, but will fill a national and international gap in the plant breeding area.

Regarding the potential of the program to provide the educational needs of future plant breeders, one reviewer emphasized that UF has a strong and knowledgeable group of plant breeding faculty. Another reviewer emphasized that the academic program as outlined is adequate to meet the educational needs of future plant breeders. A few recommendations were suggested by the reviewers which are addressed in the last paragraph of this section. Overall, reviewers agreed that the program will provide a high quality education for future plant breeders.

Regarding the ability of plant breeding faculty and administration at UF to build a successful program, reviewers emphasized that t he proposal addresses the administration of the program extremely well. They emphasized that UF is a leading land-grant university in this area with excellent faculty and administrators who will ensure a successful program. The breadth and diversity of the existing plant breeding effort at UF (e.g.- diversity of crops and plants already with plant breeding efforts) is leveraged to build a strong interdisciplinary plant breeding program that offers students unique and diverse educational opportunities. Reviewers also stressed that UF faculty are very productive in releasing cultivars and in academic research, which are key to the success of the proposed program.

Regarding the financial and other resources available, one reviewer emphasized that potential resources listed in the proposal exceed those of any other institution he knows of, except, perhaps, Texas A&M University. Another reviewer noted that creating this very strong plant breeding degree program requires little to no initial investment. Overall, reviewers thought this section was well explained and documented.

Regarding advice for achieving program success based on experience at their own institution, reviewers were unanimously confident that UF will be successful with this graduate program. One reviewer highly praised the program's interdisciplinary educational approach of balancing traditional plant breeding methods and successfully incorporating modern methods such as genomics and bioinformatics in the curriculum and program. Their suggestions and recommendations were incorporated in the present proposal, more specifically:

- The reviewers emphasize the need to expose students to management, professional development and financial courses, while recognizing the limitations of number of credits courses to achieve the needed training. This proposal is addressing this topic with a special journal club that focuses on management decisions, professional development and financial aspects of being a plant breeder in the public and private sectors.
- The reviewers also recommend t hat the faculty work toward developing and supporting a strong student cohort and community approach which is addressed by offering core classes and journal clubs built in the program with this objective.
- One reviewer suggested a clarification on our distance delivery which is addressed and already incorporated to Section I part F (page 6).
- Additional statistical courses have been added as electives as suggested by one reviewer.
- For the time being, the program will only accept students in the fall semesters.
- One reviewer recommended that courses focus primarily on principles and concepts rather than knowledge specific to crop types or species. In this proposal the core courses, as well as the electives focus on concepts that are broadly applicable. However, the electives "Breeding Perennial Cultivars" and "Genetic and Breeding of Vegetable Crops" are more targeted due to the specific and very different nature of these crops.
- One final recommendation was regarding the leadership of the program, especially in the first years of establishment. This will be addressed with UF administration to ensure the rotation length is not too short for each program director and that the leadership time is recognized for the faculty leading the program.

D. Describe how the proposed program is consistent with the current State University System (SUS) Strategic Planning Goals. Identify which specific goals the program will directly support and which goals the program will indirectly support (see link to the SUS Strategic Plan on the resource page for new program proposal). –

The proposed degree program is consistent with the current State University System's (SUS) 2025 Strategic Planning Goals, which focus on excellence, productivity and strategic priorities for a knowledge economy. Specifically, the proposed degree program directly supports the strategic goals as follows:

I. Excellence. The Board of Governors continues to expect the state universities to provide academic programs of the highest quality, to produce world class, consequential research, and to reach out and engage Florida's communities and businesses in a meaningful and measurable way.

The proposed Plant Breeding (PB) doctoral program will create a new highly renowned STEM program. The new program will strengthen the reputation of the academic programs at the University of Florida and thus the state. Plant Breeding is a well-recognized field both nationally and internationally. A few AAU and land-grant Universities offer a doctoral program in this area, and none are located in the state of Florida. Faculty at UF are well recognized in different sub-areas of plant breeding, and formalizing the PB program will create greater visibility and increase recruitment of top state, national and international students further strengthening the reputation of this UF program and aligning it with state pre-eminence goals. The PB Ph.D. degree will provide a strong basis for conducting research that examines new potential crops for a local need with a global impact, as well as the continued improvement of crops that support Florida's rural economies. UF Plant Breeders, as a part of the land-grant mission, are already engaged with a diverse group of stakeholders and industries ranging from nursery and landscape, fruits and vegetables, and forestry for pulp and lumber. This program will strengthen relationships with Florida stakeholders through increased awareness of our programs and by providing graduates to work in our industries.

II. Productivity. Florida must become more competitive in the national and global economy. To accomplish this, the state must increase the educational attainment levels of its citizens and the state universities must respond by awarding more degrees in specific high demand programs, particularly the STEM disciplines.

Currently all plant breeding faculty are preparing the next generation of doctoral level plant breeders. However, this is done across multiple departments that have different curriculum and graduation requirements. The creation of the new PB Ph.D. program will streamline the requirements for graduation by formalizing the program, ensuring high quality, increasing efficiency and streamlining the degree requirements. A streamlined program will be more attractive to potential students and increase the number of degrees awarded. UF/IFAS plant breeders are inventors of new cultivars with high productivity. In the last 10 years more than 300 new plant varieties have been released. We expect that by formalizing the new program more funding and more highly-qualified Ph.D. students will contribute to increasing the productivity in the development of new plant cultivars, and in engaging Florida's agricultural and natural resources industries.

Through mentorship of CALS graduate students, UF/IFAS plant breeders are already contributing to UF's diversity goal of preparing the next generation, where currently 43% of students are women and 8% are Hispanic/Latino. The new Ph.D. program will boost the cultural, ethnic, gender, and socio-economic diversity by recruiting under-represented students in STEM (including women and returning adults). The PB program will further support faculty in their recruitment of students from around the world, supporting the global impact of our plant breeding programs and highlighting the potential for UF to become a global leader in plant breeding given the unique diversity of crops in Florida.

III. Strategic priorities. The Board of Governors acknowledges that simply producing more with greater efficiencies is not inherently strategic, so this plan also has a focus on Strategic Priorities within each of the tripartite missions that need to be prioritized to better align university outputs with state economic and workforce needs.

UF/IFAS plant breeding research programs have long enjoyed a strong partnership with Florida's agricultural and natural resources industries. By being strategically located in the center of production of their respective crops, breeders located in Gainesville and at UF/IFAS Research and Education Centers (RECs) throughout the state have become integral components of these industries. The agronomic, horticultural, and ornamental varieties they develop are used by farmers, ranchers, and homeowners in Florida, the nation, and the world.

Offering a diverse educational and interdisciplinary program will increase the number of students and faculty engaged in collaborative research and plant breeding efforts worldwide. A Ph.D. program in plant breeding will increase the cultural, ethnic, gender, and socio-economic diversity of students, faculty and staff reflecting the breadth of thought essential for state, national and world preeminence. The Florida Department of Economic Opportunity projects that life scientist jobs will increase by 12.5% in the next eight years. This category includes the occupations of soil and plant scientists (8.4% growth) and biological scientist (9.3% growth). Plant breeders fall into both plant scientist and biological scientist categories.

Additionally, plant breeding faculty have a strong track-record of successful grantsmanship and will continue to attract external funding from federal and private organizations, therefore promoting more collaboration with private industry on research projects. The external support coming from industry through plant breeding royalties has increased by $1 million each year since 2013. The external funding and royalty income are being re-invested to increase fellowships and research, thus increasing the productivity and reputation of UF plant breeding.

E. If the program is to be included in a category within the Programs of Strategic Emphasis as described in the SUS Strategic Plan, please indicate the category and the justification for inclusion.

The Programs of Strategic Emphasis Categories:

1. Critical Workforce:
    - Education
    - Health
    - Gap Analysis
2. Economic Development:

• Global Competitiveness

3. Science, Technology, Engineering, and Math (STEM)

Please see the Programs of Strategic Emphasis (PSE) methodology for additional explanations on program inclusion criteria at the resource page for new program proposal .

The new degree proposed should be included in the Science, Technology, Engineering, and Math (STEM) Program of Strategic Emphasis as described in the SUS Strategic Plan, further classified as STEM CIP (Classification of Instructional Programs) 01.11 Plant Sciences and, more specifically, as 01.1104 Agricultural and Horticultural Plant Breeding.

The proposed program will focus on the application of genetics and genetic engineering to the improvement of agricultural plant health, the development of new plant varieties, and the selective improvement of agricultural plant populations. Doctoral students in this program will be educated in genetics, genetic engineering, population genetics, agronomy, plant protection, and biotechnology as well as biological sciences related to plant reproduction, molecular biology and genetics. This new STEM Ph.D. degree will provide qualified students with core scientific skills necessary for success in plant breeding (as opposed to broader agronomic or horticultural skills), which in turn will strengthen our ability to recruit the top students to UF.

F. Identify any established or planned educational sites at which the program is expected to be offered and indicate whether it will be offered only at sites other than the main campus.

Courses for the plant breeding Ph.D. program will be offered on main campus with the goal of both face-to-face and on-line delivery. The majority of classes will be delivered from main campus but made available to students on and off main campus through on-line technologies that will allow graduate students located at RECs to pursue their studies close to their crop's center of production. This increases opportunities for students to engage with and advance their education combined with a full immersion from stakeholders in the production systems and the associated advantages and challenges of producing food, feed, and fiber for the local, national and global economies.

Institutional and State Level Accountability

II. Need and Demand

A. Need: Describe national, state, and/or local data that support the need for more people to be prepared in this program at this level. Reference national, state, and/or local plans or reports that support the need for this program and requests for the proposed program which have emanated from a perceived need by agencies or industries in your service area. Cite any specific need for research and service that the program would fulfill.

An unmet need for plant breeding skill development in both traditional and genomic methodologies is widely recognized. The need to educate future plant breeders in specialty crops, the integration of molecular tools, and the fact that graduate education has become concentrated in a small number of universities focused on a few major row crops (e.g., corn and soybeans) were highlighted by The National Plant Breeding Coordinating Committee (http://cuke.hort.ncsu.edu/gpb/pr/pbccmain.html) as major issues facing plant breeding nationally and internationally.

In a national survey, Guner and Wehner (2003) indicate that the majority of plant breeders were being trained at the University of Wisconsin-Madison, North Carolina State University, University of Nebraska-Lincoln, Cornell University, University of Minnesota-St. Paul, Iowa State University, and Texas A&M University which focus on a small number of major crops. Their geographic distribution and breeding focus result in an imbalance in graduate student training in western and southeastern regions of the United States. These regions contain unique environments (i.e. southern California and Florida) that produce specialty crops not found in other areas of the U.S. The University of Florida has highly regarded breeding programs for a diversity of crops, including several specialty crops of regional and international importance (e.g., oranges, strawberries, blueberries). This is largely owed to Florida's tropical and subtropical environments which allow breeding and production of specialty crops that cannot be grown in other areas of the U.S. These facts further emphasize the University of Florida's unique situation and bring an enormous opportunity for UF to become a leader in Plant Breeding education among its peer institutions.

We have assessed the needs for more people to be educated in Plant Breeding using different sources and approaches. At a regional level, and according to the Florida Department of Economic Opportunity, it is forecasted that life scientist jobs will increase by 12.5% in the next eight years. This category includes the occupations of soil and plant scientist (8.4% growth) and biological scientist (9.3% growth). Plant breeders fall into both plant scientist and biological scientist categories. Moreover, the Bureau of Labor and Statistics (https://www.bls.gov/home.htm) estimates a national growth of 8.8% in plant science careers, and within this group, a growth of 17.8% in research and development. Following these expected increases in job opportunities, a 2015 survey of private and

U.S. university plant-breeding programs reported that the number of domestic private sector positions for Ph.D.-level plant breeders is one third larger than the number of domestic academic positions. When international plant breeding positions are considered, nearly three times as many private sector positions are available (Sylak-Glassman et al., 2016). When the private sector was asked if they had enough qualified applicants for plant breeding positions, most of the responses indicated that there were not enough well-qualified applicants.

This result is supported by a statement from The National Association of Plant Breeders (https://www.plantbreeding.org/) publicizing a lack of qualified plant breeders, especially in specialty crops like fruits and vegetables. To build on this survey carried out by Sylak-Glassman et al. (2016), we have reached out to industry representatives of different crops nationally and internationally. We collected letters of support from nine companies engaged in the local, national and global production of row crops, fruits and vegetables (see Appendix E). The general consensus is that there is demand for Ph.D. level plant breeders, and they supported the creation of a formal graduate program in plant breeding in CALS. Finally, the USDA Roadmap for Plant Breeding (USDA Plant Breeding Working Group, 2015) emphasizes that stakeholders have continued to call for increased USDA involvement in the preparation of plant breeding professionals.
Altogether, we observe a strong need for more professionals at the regional, national and international level, and an opportunity to position the University of Florida at the forefront of plant breeding education and research. The proposed program will address these issues by increasing the number of Ph.D. degrees in plant breeding awarded at UF and improving UF's visibility at the state, national, and international levels. As a result, UF's plant breeding programs will more easily compete for federal and private funds.

B. Demand: Describe data that support the assumption that students will enroll in the proposed program. Include descriptions of surveys or other communications with prospective students.

We expect extensive student interest in this interdisciplinary STEM program. Dozens of inquiries from prospective students are received by each of the 27 UF plant breeders every year, and there is extraordinary demand from the private sector for high-quality plant breeders. In the last 30 years, 113 plant breeding alumni have graduated from four UF/IFAS departments (Horticultural Sciences, Environmental Horticulture, Agronomy and School of Forest Resources and Conservation). However, none of them graduated with a formal plant breeding degree. No students are currently enrolled in similar programs in the state of Florida.

Moreover, the National Plant Breeding Coordinating Committee (http://cuke.hort.ncsu.edu/gpb/pr/pbccmain.html) points out that education of plant breeders has become concentrated in a small number of universities focused on major row crops. The University of Florida is located in a sub-tropical location with a unique emphasis on specialty crops. The climate of Florida and broad research programs in UF/IFAS position the proposed program to lead plant breeding education and research related to specialty crops both nationally and globally.

We have surveyed current and former University of Florida students as well as AAU land-grant institutions that offer comparable doctoral programs to assess the demand for a Ph.D. in Plant Breeding. Among 34 public and 26 private AAU and land-grant universities only six offer comparable doctoral programs and only one is located in the Southeast.

We surveyed three out of the six universities with similar graduate degrees in plant breeding: University of Wisconsin-Madison, University of California-Davis, Texas A&M University, and Cornell University. While UC-Davis does not have a graduate degree titled "Plant Breeding", we nevertheless include it for comparison, as it is known for training plant breeders and resides in a state with a large specialty crop industry, similar to Florida. In general, the representatives from these institutions all indicated either a stable number of students going into their programs or an increase in interest in their program, given by the number of students applying. Each year, these programs each have 5-8 new students which is similar to the projected number of students in this proposed CALS graduate program. Cornell University indicated they only accept 10% of the applicants, which suggests they receive 50-80 applications per year. The University of Wisconsin-Madison indicated they have graduated 337 students from their program since their founding in 1968 and that the program is still running strong.

In addition, we sent a survey to 49 graduate students enrolled as of June 2018 in graduate programs in four UF/IFAS departments (Agronomy, Horticultural Sciences, School of Forest Resources and Conservation, Environmental Horticulture) pursuing degrees related to plant breeding. The response rate was 86% and students were asked, if given the option, to choose which three Ph.D. degree titles would be more beneficial for their career plans. Forty-eight percent of the students indicated that they would prefer a Ph.D. in Plant Breeding with formal and structured graduate education tailored to all relevant aspects of plant breeding that would prepare career-ready plant breeders. Forty-five percent of the students surveyed indicated they would prefer a Ph.D. in their current major (e.g. Agronomy or Horticultural Sciences) with a concentration in plant breeding while only 7% of the students preferred to keep the same degree title as currently awarded by these four departments.

C. If substantially similar programs (generally at the four-digit CIP Code or 60 percent similar in core courses), either private or public exist in the state, identify the institution(s) and geographic location(s). Summarize the outcome(s) of communication with such programs with regard to the potential impact on their enrollment and opportunities for possible collaboration (instruction and research). In Appendix C, provide data that support the need

for an additional program.

There are no similar programs at either private or public institutions in the state of Florida.

D. Use Table 1 in Appendix A (1-A for undergraduate and 1-B for graduate) to categorize projected student headcount (HC) and Full Time Equivalents (FTE) according to primary sources. Generally undergraduate FTE will be calculated as 30 credit hours per year and graduate FTE will be calculated as 24 credit hours per year. Describe the rationale underlying enrollment projections. If students within the institution are expected to change majors to enroll in the proposed program at its inception, describe the shifts from disciplines that will likely occur.

We anticipate that the majority of our students will register as full-time students, generally taking 24 credits per year (0.75 FTE). We expect that students who graduated from a preceding degree program at other Florida public universities, out-of-state residents and international residents will account for the initial applicants to our doctoral program.

We also anticipate that students who have recently graduated with a master's degree from one of the four departments (Horticultural Sciences, Environmental Horticulture, SFRC and Agronomy) that offer a degree related to plant breeding might apply to our program in this first year. However, we will not allow current Ph.D. students in any of the four UF departments mentioned above to transfer to our proposed plant breeding doctoral program for the first five years of our program.

In addition, we expect that we will attract non-traditional students from state and local industries. This expectation stems from the strong partnerships that UF plant breeding faculty have with Florida's agricultural and natural resources industries.

In years 2 to 4, we expect to focus our recruitment efforts on attracting high-quality students who have completed M.S. degrees in other majors from other Florida or out-of-state universities, with special attention to underrepresented minorities, low-income or first-generation college students. Over time, students from other universities within the state, as well as out-of-state residents and international students and those from industry will be drawn to our program and will account for the majority of our students. We base this on the results of surveys of current and former students, as well as our survey of other comparable programs across the country.

Furthermore, several plant breeding faculty have participated in the interdisciplinary Plant Molecular and Cellular Biology (PMCB) Graduate Program, established 30 years ago and well-recognized nationwide as a center of excellence for plant biology faculty focusing on genetic, molecular, and cellular research. PMCB was in the top 10□15% of 118 Plant Sciences Graduate programs in the 2010 National Research Council rankings. Similarly to PMCB, plant breeding faculty have excellent research productivity, and many participate in the PMCB program. We will draw on PMCB's experiences in recruiting highly qualified students, utilizing an innovative curriculum and other preparatory mechanisms to develop students for competitive placement in high-impact positions in research, teaching and industry and will strive to have a high job placement.

In conjunction with UF/IFAS Communications, the UF/IFAS Plant Breeders Working Group is establishing a marketing and branding campaign to recruit high-quality students. This recruiting investment for the new graduate program will attract more student applications to CALS overall and in particular to other graduate programs and departments at UF. The program will only accept 5-6 students a year in the first five cycles, which should result in other top applicants being re-directed to other departmental graduate programs.

E. If the proposed program substantially duplicates a program at FAMU or FIU, provide, (in consultation with the affected university), an analysis of how the program might have an impact upon that university's ability to attract students of races different from that which is predominant on their campus in the subject program. The university's Equal Opportunity Officer shall review this section of the proposal and then sign and date Appendix B to indicate that the analysis required by this subsection has been completed .

The proposed program does not duplicate any program at FAMU or FIU.

By creating a diverse, robust educational and interdisciplinary area of excellence our goal is to support an exceptional academic environment where students, faculty, and staff members with diverse experiences and backgrounds can achieve their goals.

Plant Breeders at UF are already contributing to UF's diversity goal: as of June 2018 there were 43% women and 8% Hispanic/Latino studying plant breeding through graduate programs within the four UF departments. Faculty have and will continue to attract students from around the world, supporting the global impact of our plant breeding programs and highlighting the potential to become a global leader in plant breeding given the diversity of crops in Florida.

To help ensure racial and ethnic diversity inclusion and equity we intend to actively work on recruiting efforts with several UF offices including the recently created position of Chief Diversity Officer, the Office of Graduate

Diversity Initiatives (OGDI) and the Office of Graduate International Outreach (OGIO). These collaborations will include participating in graduate recruitment fairs; partnering with foundations, community and student support organizations; providing scholarships and assistantships for underrepresented students; and providing students with opportunities to participate in retention and professional development workshops.

We will also leverage resources and make use of opportunities focused on international outreach and student success offered by the OGIO. With Florida's geographical location, Latin America has been identified as a target for OGIO's recruitment efforts, through the formation of agreements with sponsoring agencies to enroll Latin American graduate students with government funding. We also hope to further increase female enrollment in this important STEM discipline. Our faculty have served as advisors to the UF Plant Science Council, where women have served as presidents, vice-presidents and other leadership roles. Besides their annual spring workshop, professional development activities and discussions, they recently organized a Women in STEM discussion panel that highlighted the experiences of women working in the plant sciences.

III. Budget

A. Use Table 2 in Appendix A to display projected costs and associated funding sources for Year 1 and Year 5 of program operation. Use Table 3 in Appendix A to show how existing Education & General funds will be shifted to support the new program in Year 1. In narrative form, summarize the contents of both tables, identifying the source of both current and new resources to be devoted to the proposed program. (Data for Year 1 and Year 5 reflect snapshots in time rather than cumulative costs.)

The University of Florida is one of the most active and innovative land-grant universities in plant breeding and cultivar licensing in the country. The university employs 27 plant breeding faculty in four academic departments (Agronomy, Horticultural Sciences, Environmental Horticulture, and the SFRC) who are breeding 50 different plant species. Faculty within these departments contribute to the three-fold land grant mission of teaching, research and extension within the Institute of Food and Agricultural Sciences (IFAS), as well as academic units within the College of Agricultural and Life Sciences (CALS) at the University of Florida.

The primary costs of the Ph.D. program will be faculty and staff salaries and benefits. The faculty reallocated E&G is calculated based upon 1% of teaching of all teaching faculty salaries/benefits funded through E&G. As a result of UF's preeminence faculty hiring efforts, we expect that at least one tenure track faculty member will be hired in the next five years and housed in either HOS, ENH, SFRC, or Agronomy. This person will be expected to contribute to our new graduate teaching and advising efforts. We expect that by Year 5, this new faculty member "New Hire 1" will contribute 0.13 FTE toward the new plant breeding program. The faculty continuing E&G in Year 5 represents a cumulative value across all plant breeding teaching faculty contributing to the new program.

We also anticipate hiring an academic advisor to work half-time. This position is needed to coordinate all academic

(recruitment, advising, course scheduling, among others) and administrative activities associated with successfully managing this new graduate program. The A&P continuing E&G in Year 5 represents the half-time salary and benefits for the academic advisor.

Additional funds are available to support the proposed program through the Plant Breeding Graduate Initiative (PBGI). This initiative represents an annual funding opportunity provided by UF/IFAS Research and the Florida Foundation Seed Producers, a Direct Support Organization (DSO) that supports the plant breeding research programs. UF/IFAS Research currently provides $60,000 per cohort per year, which is matched with $60,000 from the plant breeders and provides three new graduate student assistantships each year. We are predicting that with the anticipated success of the program, the plant breeders will expand their support by Year 5 for a total of $90,000 per cohort year. Furthermore, we anticipate that the program will obtain support for one new Graduate Student Funding Award from the UF Graduate School in each of the first five years.

In the last 10 years, the 27 plant breeding faculty have secured approximately $81 million in federal and private funding. As the program grows in the number of students, we project an increase in the allocation of C&G funds secured by the plant breeders and used to support the enrollment growth.

As shown in Tables 2 and 3, the funding for the program will primarily come from the reallocation of existing resources. Our estimates are conservative. We assumed a total increase in faculty and staff salaries and benefits of only three percent over the next five years. We assumed zero increase in state operating funds over the five-year period. Based on projected enrollment trends (Table 1-B), the E&G cost per student FTE decreases from $34,763 in Year 1 to $18,823 in Year 5. Total projected E&G costs for Year 1 are $121,672 and for Year 5 are $268,222. The visibility provided by the graduate program will also increase UF/IFAS chances to obtain industry support targeting education of new plant breeders.

B. Please explain whether the university intends to operate the program through continuing education on a cost- recovery basis, seek approval for market tuition rate, or establish differentiated graduate- level tuition. Provide a rationale for doing so and a timeline for seeking Board of Governors' approval, if appropriate. Please include the expected rate of tuition that the university plans to charge for this program and use this amount when calculating cost entries in Table 2.

We do not intend to operate the program through continuing education on a cost-recovery basis, seek approval for market tuition rate, or establish differentiated graduate-level tuition. The expected rate of tuition and fees will be based on the University's standard costs and projected estimates, which is $528.69 per credit hour for the 2019-2020 academic year for Florida residents.

C. If other programs will be impacted by a reallocation of resources for the

proposed program, identify the program and provide a justification for reallocating resources. Specifically address the potential negative impacts that implementation of the proposed program will have on related undergraduate programs (i.e., shift in faculty effort, reallocation of instructional resources, reduced enrollment rates, greater use of adjunct faculty and teaching assistants). Explain what steps will be taken to mitigate any such impacts. Also, discuss the potential positive impacts that the proposed program might have on related undergraduate programs (i.e., increased undergraduate research opportunities, improved quality of instruction associated with cutting- edge research, improved labs and library resources).

We anticipate that the Ph.D. program will have no negative impacts on existing undergraduate or graduate programs but will rather have a variety of positive impacts across all the departments involved. Students will not be allowed to transfer from current departmental Ph.D. degrees into the plant breeding Ph.D. program for the first five years, thus ensuring the new program will avoid any potential negative impact on existing programs due to migration of current Ph.D. students. This program will create a curriculum that can be advertised and promoted. With this increased visibility, we expect more support and recognition from the industry and funding agencies. We envision this new graduate program to have a global reach and thus competing with other national and international plant breeding universities for top students while avoiding competition within and among other CALS graduate programs. This will also provide an opportunity for our best undergraduate students to pursue graduate studies at UF instead of enrolling in other universities.

This program is expected to recruit top students with interest in plant breeding (maximum of 5 students per year in the first cycle). This net increase in CALS students will increase the number of students taking graduate classes already offered by plant breeders and other faculty within each department. This program, with current support of the Plant Breeders Working Group (PBWG) and UF/IFAS Research via the Plant Breeding Graduate Initiative, will ensure graduate assistantships for 3-4 students annually, therefore achieving more than 60-80% of the recruitment goal through internal scholarships, while the remaining support will be covered by individual plant breeding programs at UF.

UF/IFAS plant breeders are housed in different departments and different research and education centers across the state. This interdisciplinary program will unify faculty working in breeding and formalize an educational program that is currently underway. The Ph.D. program will increase strong, collaborative research teams involving multiple faculty, Ph.D. students, master's students, and undergraduates. Thus, undergraduate involvement in these teams will prepare them for research careers and graduate programs in related fields. The interdisciplinary nature of the program will provide opportunities for undergraduates to perform high quality research under the mentoring of graduate students.

Because the curriculum of the program relies on current coursework being taught in the involved departments, most faculty will not see a change in their responsibilities, or their time assigned to the new program. In the meanwhile, the department may see an increase in Ph.D. students taking these courses in a regular basis. The proposed program attempts to minimize the effects of the reallocation of teaching resources by re-allocating only 1% per teaching faculty FTE to the new program. A few members of the faculty will be devoting more time and energy to the graduate program because of the need to lead the new program. However, a rotational leadership is proposed, which will minimize the time faculty devote to the program in the long-term.

We do not anticipate the use of adjunct faculty or additional funding for doctoral students to provide teaching assistance. Our doctoral students will be well-prepared to teach undergraduate courses under the supervision of an experienced faculty member, assuring quality educational delivery to undergraduates. This doctoral program, based on advanced methods of plant breeding with an interdisciplinary focus, will generate knowledge for new courses and content in the undergraduate programs across CALS, enriching the current offerings and providing the most current and relevant information for research careers.

Once the program is established and recognized, the possibility of creating a certificate with a strong distance education focus will be evaluated. This certificate program will target a different and complementary population not covered by the Ph.D. graduate program, primarily industry breeders seeking continuing education. We expect it will bring off-book revenues for CALS and the departments. Finally, the new doctoral program will be positioned to attract additional funding and resources, both internally and externally, which will have broad benefits for all aspects of the program.

D. Describe other potential impacts on related programs or departments (e.g., increased need for general education or common prerequisite courses, or increased need for required or elective courses outside of the proposed major).

Given the distinctive nature of this doctoral degree program, we anticipate primarily positive effects to related programs and departments. Most of the courses in the proposed curriculum currently exist and are service courses for numerous graduate programs in the biological sciences. Consequently, they will not be impacted by the additional student numbers generated after the program is approved.

This program will create a curriculum that can be advertised and promoted. With this increased visibility, we expect more support and recognition from the industry and funding agencies. The newly created program will invest in recruiting top students interested in plant breeding. The recruitment investment as well as the establishment of this new program will attract more students to consider the plant breeding programs in CALS and also other graduate programs in CALS.

We expect that this effort will increase the net number of applicants to CALS. The program will only accept a maximum of 5 students each year in the first five cycles, which should in turn result in other top applicants being re-directed to the departmental graduate programs. We have seen this kind of cross-departmental benefit from the recruiting efforts of the PMCB graduate program in the past.

Furthermore, a recent study of all graduates for each plant breeding faculty since the beginning of their career at UF in each of the four departments indicated that the 27 plant breeding faculty are not exclusively focused on preparing students as breeders. Out of a total of 241 graduate students under plant breeder supervision 113 students (46%) complete programs focused on plant breeding while 128 students (54%) focused on other traditional areas of specialization in their respective departments such as agronomy, horticulture, floriculture, pest management, plant physiology, nutrition, weed science, plant management, crop production, molecular and cellular biology and landscape management.

E. Describe what steps have been taken to obtain information regarding resources (financial and in-kind) available outside the institution (businesses, industrial organizations, governmental entities, etc.). Describe the external resources that appear to be available to support the proposed program.

Initially the program will be internally funded through royalty proceeds from plant breeding faculty via the UF/IFAS Plant Breeders Working Group (PBWG) and PBGI. However, as soon as the program is approved, we are strongly committed to identifying sources of extramural funding, a crucial element required to support graduate student research and competitive assistantships that will attract and retain outstanding students. The plant breeders are actively engaged in grantsmanship and have had success securing funding from both public and private sources. The list of federal funding agencies includes the National Science Foundation (NSF), US Department of Energy (DOE) and US Department of Agriculture – National Institute of Food and Agriculture (USDA-NIFA), while the list of private institutions includes many of the main breeding companies in several different crops.

We have conducted a survey with all UF plant breeders to estimate the amount of plant breeding related external support that they have received in the last 10 years (both public and private). The average total support comes to $3 million per breeder. In addition, we have spoken with industry representatives from different crops important for the state's agriculture. While no funding is currently committed at this stage, we have obtained several letters of support indicating significant interest in maintaining the collaboration with UF and in the creation of the program. Furthermore, the Plant Breeders Working Group has recently initiated, with the support of UF/IFAS Advancement, a campaign to communicate the impact that UF plant breeding has had for Florida and the world. We expect that this campaign will lead to private giving, which could in part be directed to support plant breeding students. Finally, the PBWG and UF/IFAS Research have established an initiative to continually fund students studying plant breeding. The Plant Breeding Graduate Initiative annually funds 3-4 graduate assistantships. The number of funded assistantships is expected to increase in the future.

The breeders have also identified additional federal programs to which we could apply for support of our plant breeding graduate program:

- Global Partnership Initiative for Plant Breeding Capacity Building (http://km.fao.org/gipb/)
- USDA-CSREES Agriculture and Food Research Initiative (http://www.csrees.usda.gov/fo/agriculturalandfoodresearchinitiativeafri.cfm)
- USDA-CSREES National Vegetable Crop Initiative (http://www.csrees.usda.gov/newsroom/newsletters/update08/042308.html)
- USDA-NIFA Food and Agricultural Sciences National Needs Graduate and Postgraduate Fellowship (NNF) Grants Program

  (https://www.nifa.usda.gov/funding-opportunity/food-and-agricultural-sciences-national-needs-graduate-and-postgraduate)

IV. Projected Benefit of the Program to the University, Local Community, and State

Use information from Tables 1 and 2 in Appendix A, and the supporting narrative for "Need and Demand" to prepare a concise statement that describes the projected benefit to the university, local community, and the state if the program is implemented. The projected benefits can be both quantitative and qualitative in nature, but there needs to be a clear distinction made between the two in the narrative.

A cross-departmental, interdisciplinary Ph.D. program in Plant Breeding will benefit the University of Florida and the SUS as it will support their missions by providing premier graduate education and increasing scholarship, research, and innovation. Specifically, the program supports the SUS 2025 Strategic Plan by increasing research activity and the number of graduates with interdisciplinary STEM education and credentials, expanding commercialization activities that will attract more research funding from federal and private sources, and promoting more collaboration with the private industry sectors. There is no such program in the state, thus this could be added to the list of specializations that the state and UF will be providing. This new degree will create a framework and administrative structure to leverage resources, faculty, courses, and student recruitment, which we expect will attract more federal and private funding.

The contribution that plant breeding has brought to local communities has been very evident in Florida. In 2019, 90% of the strawberry acreage and 100% of the blueberry acreage in Florida is occupied by UF-bred varieties. It

90% of the strawberry acreage and 100% of the blueberry acreage in Florida is occupied by UF-bred varieties. It was only in the last decade that Florida became a leader in blueberry production, in part because the UF/IFAS blueberry breeding program developed new varieties well adapted to Florida. We aim to build from these proven successes by continuing to grow current industries and creating new agricultural commodities in Florida.

Currently, plant breeders continue working at the community level to understand and solve the challenges of our stakeholders through better varieties. This results in producer profitability and industry sustainability. These industries in turn support other aspects of the local economy including packaging, food processing, transportation and finance.

Our proposed degree program will enrich UF's land-grant core mission by being among the top plant breeding programs in the nation and the world. Other benefits include the following:

Quantitative:

- Increasing the number of highly qualified graduate students to align UF with other peer APLU land-grant universities by addressing local, state, and national needs and demands in plant breeding.
- Increasing the cultural, ethnic, gender, socio-economic and international diversity of students, especially those under-represented in STEM discipline (i.e. women, African Americans, etc.) to reflect the breadth of thought essential for state, national, and world preeminence.
- Increasing the number of high-impact scholarly publications and creative works generated.
- Attracting more federal and private graduate funding, grants for student research programs, and increasing graduate student mentored undergraduate research.
- Increasing private and public funding from UF intellectual property, endowments, and federal sources.
- Boosting intellectual property income and the number of commercial products developed by plant breeders, which will have a local and statewide economic impact and generate employment opportunities.

Qualitative:

- Fostering the development of the "talent pipeline" that must exist to create the multi-disciplinary expertise needed to build the knowledge and innovation economy envisioned by the Florida Board of Governors.
- Increasing the visibility of faculty will increase their national and international leadership and recognition, expanding UF's competitive advantage for extramural funding and standing among AAU universities, particularly among those with similar programs.
- Augmenting the numbers of successful and proud UF alumni donating to endowments, offering internships and employment opportunities, and engaging in student recruitment.
- Developing the knowledge base needed to create improved policies and transformative programs that benefit plant breeding stakeholders in an increasingly dynamic and global society and economy.
- Providing expert professional leadership and capacity in the public, private, and nonprofit sectors to address critical problems and needs of local stakeholders.

V. Access and Articulation – Bachelor's Degrees Only

A. If the total number of credit hours to earn a degree exceeds 120, provide a justification for an exception to the policy of a 120 maximum and submit a separate request to the Board of Governors for an exception along with notification of the program's approval. (See criteria in Board of Governors Regulation 6C-8.014)

Not applicable.

B. List program prerequisites and provide assurance that they are the same as the approved common prerequisites for other such degree programs within the SUS (see link to the Common Prerequisite Manual on the resource page for new program proposal). The courses in the Common Prerequisite Counseling Manual are intended to be those that are required of both native and transfer students prior to entrance to the major program, not simply lower-level courses that are required prior to graduation. The common prerequisites and substitute courses are mandatory for all institution programs listed, and must be approved by the Articulation Coordinating Committee (ACC). This requirement includes those programs designated as "limited access."

If the proposed prerequisites are not listed in the Manual, provide a rationale for a request for exception to the policy of common prerequisites. NOTE: Typically, all lower-division courses required for admission into the major will be considered prerequisites. The curriculum can require lower-division courses that are not prerequisites for admission into the major, as long as those courses are built into the curriculum for the upper-level 60 credit hours. If there are already common prerequisites for other degree programs with the same proposed CIP, every effort must be made to utilize the previously approved prerequisites instead of recommending an additional "track" of prerequisites for that CIP. Additional tracks may not be approved by the ACC, thereby holding up the full approval of the degree

program. Programs will not be entered into the State University System Inventory until any exceptions to the approved common prerequisites are approved by the ACC.

Not applicable.

C. If the university intends to seek formal Limited Access status for the proposed program, provide a rationale that includes an analysis of diversity issues with respect to such a designation. Explain how the university will ensure that Florida College System transfer students are not disadvantaged by the Limited Access status. NOTE: The policy and criteria for Limited Access are identified in Board of Governors Regulation 6C-8.013. Submit the Limited Access Program Request form along with this document.

Not applicable.

D. If the proposed program is an AS-to-BS capstone, ensure that it adheres to the guidelines approved by the Articulation Coordinating Committee for such programs, as set forth in Rule 6A-10.024 (see link to the Statewide Articulation Manual on the resource page for new program proposal). List the prerequisites, if any, including the specific AS degrees which may transfer into the program.

Not applicable.

Institutional Readiness

VI. Related Institutional Mission and Strength

A. Describe how the goals of the proposed program relate to the institutional mission statement as contained in the SUS Strategic Plan and the University Strategic Plan (see link to the SUS Strategic Plan on the resource page for new program proposal).

The SUS Strategic Plan has set goals to increase the number of graduates with degrees in STEM fields. More specifically, the UF Strategic Plan listed Biological Sciences as an area of emphasis. Plant Breeding is an integrative science that requires knowledge of biology, genetics, chemistry, statistics, and computer science. Additionally, it draws support from many STEM disciplines within CALS including Agronomy, Horticultural Science, Plant Pathology, Entomology & Nematology, Forestry, Biology, Genetics, Plant Molecular & Cellular Biology, and Applied Statistics. Well educated plant breeders must be able to draw on information and expertise in these fields and incorporate the art of selection for desirable attributes in the final product of released varieties.

As indicated in sections above, national and international groups have recognized that prior investments in preparation of plant breeders in the 1970s and 1980s are being lost to retirement and program closures. The University of Florida is unique in having a diversity of plant breeding research programs focused on specialty horticultural, ornamental, and unique agronomic and forage crops. With this focus, a UF degree in plant breeding is well positioned to fill the need for plant breeders with diverse experiences that few, if any, other institutions can accomplish. The abundance of resources available for graduate students at UF provides an exceptionally wide spectrum of research opportunities that are not available at typical mid-western land-grant institutions that are narrowly focused on two or three major cereal crops.

In addition to adding a relevant and valuable STEM graduate program that supports one of the major agricultural sectors in the state of Florida, this program will help meet SUS metrics such as higher numbers of graduate degrees in STEM, and an increase in the number of patents, licenses and options executed. These increases will result from UF/IFAS plant breeding programs' development of plant cultivars that are patented and/or licensed to be grown over thousands of acres which return royalties to the UF/IFAS system in support of the research and education programs.

B. Describe how the proposed program specifically relates to existing institutional strengths, such as programs of emphasis, other academic programs, and/or institutes and centers.

The new interdisciplinary program will take advantage of existing institutional strengths by building upon the robust group of plant breeding research programs currently ongoing at UF, and by coordination across a wide array of academic courses in plant breeding and genetics, and support disciplines that are already in place but are scattered across a number of academic units. This new interdisciplinary program will help to focus faculty around a common core of academic work and strengthen our ability to recruit the best students into our program. The vitality of the current faculty is indicated by a steady climb in royalty income generated by released UF/IFAS cultivars, which approached $15 million in 2018. The UF/IFAS Plant Breeders Working Group has committed part of these resources to support this graduate program.

The faculty involved in the proposed interdisciplinary plant breeding program are from diverse backgrounds, and

The faculty involved in the proposed interdisciplinary plant breeding program are from diverse backgrounds, and most have contributed their expertise in plant breeding through leadership roles in professional societies, including service as editors of major refereed journals in the field. These faculty associated with the plant breeding program are nationally and internationally recognized, and have an impressive list of achievements and awards, including presidents and fellows of the Crop Science Society of America, the American Society of Horticultural Science, and the National Association of Plant Breeders. In addition, plant breeding faculty at UF have a rich history of educating students who become well positioned in academia and private industry sectors. These practicing professionals will be an excellent resource for recruitment of new students.

C. Provide a narrative of the planning process leading up to submission of this proposal. Include a chronology in table format of the activities, listing both university personnel directly involved and external individuals who participated in planning. Provide a timetable of events necessary for the implementation of the proposed program.

Previous internal reviews of four UF/IFAS departments of Agronomy, Horticultural Sciences, Environmental Horticulture and School of Forest Resources and Conservation have recognized that plant breeding and genetics faculty were strengths of these units but have pointed out that programs were fragmented and sometimes lacked focused interaction with other departments.

The UF/IFAS Plant Breeders Working Group (PBWG) has met annually since the early-1990s to discuss and review issues relevant to cultivar development, and matters concerning educating graduate students in plant breeding. At the 2007 PBWG annual meeting a committee was organized to begin the process of consideration of an interdepartmental graduate program. At that time the planning committee consisted of Drs. Dave Clark and Maria Gallo as co-chairs, Barry Tillman, Eilene Kabelka, Kevin Kenworthy, and Ken Quesenberry. A draft proposal was developed in 2009, but it was never formally submitted due to changes in requirements and committee members.

Considering the increasing demand for plant breeders and their roles in addressing future societal challenges, the interdisciplinary graduate program was added as one of the goals in the 2016-2019 Plant Breeders Working Group strategic plan. Our vision is to be a global leader in plant breeding education, research and germplasm/cultivar development and our mission is to ensure the viability of agriculture through exceptional plant breeding programs. One of the strategic goals is solely dedicated to establishing a graduate degree program in plant breeding. The expected key outcomes are to increase enrollment of high quality domestic and international graduate students and improve program visibility by delivering next generation breeders to institutions and key agricultural companies.

Several action steps were defined as a measure of success for this strategic goal. These included: (i) identify core plant breeding competencies, using the previously proposed curriculum as a resource; (ii) identify and hire a staff member to shepherd the proposed degree program to final approval; (iii) develop and submit the degree program proposal to CALS and university curriculum committees; and (iv) implement a new Ph.D. graduate program.

In January 2018, Ms. Eliana Kampf was hired as a graduate program coordinator. A Plant Breeding Committee (PBC) consisting of Dr. Patricio Munoz, Dr. Marcio Resende, and Ms. Eliana Kampf, under the supervision of the PBWG Executive Committee, initiated the development of the pre-proposal. The PBC conducted surveys of current students, alumni, industry, and other universities. The PBC also met with the CALS dean and UF/IFAS Research dean several times during Spring and Summer 2018. These leaders in agricultural teaching and research were very supportive of this initiative and have assisted immensely with documentation and with proposal development. The PBC also met with faculty from the UF/IFAS Department of Family, Youth and Community Sciences to gain insights from their pre-proposal development process (their Ph.D. degree program in Youth Development and Family Science was approved in 2017).

In August 15, 2018 the first draft of the pre-proposal was reviewed by PBWG members during the 2018 UF/IFAS Plant Breeders Working Group Annual Meeting and further developed during Fall 2018. During Fall 2018 the PBC and the PBWG executive committee met with the chairs of the four departments involved, and all chairs fully supported the creation of a plant breeding degree. The pre-proposal was signed by Dr. Rob Gilbert (Agronomy Chair), Dr. Red Baker (School of Forest Resources and Conservation Director), Dr. Chris Chase (Horticultural Sciences Interim Chair) and Dr. Dean Kopsell (Environmental Horticulture Chair) and in November 2018 it was reviewed by Dr. Turner (CALS Dean).

The pre-proposal was then sent to the Provost's Office and in December 2018, the pre-proposal was endorsed by Dr. Chris J. Hass, Associate Provost for Academic and Faculty Affairs, who praised the group for a "well-written, substantive and enticing pre-proposal." In February 2019 the pre-proposal was approved by the Council of Academic Vice Presidents (CAVP) Academic Program Coordination review group with no concerns.

Planning Process

Date	Participants	Planning Activity
2007	Plant Breeding Working Group Annual Meeting members	Committee formed for pr development

2008	Drs. Dave Clark and Maria Gallo as co-chairs, Barry Tillman, Eilene Kabelka, Kevin Kenworthy, and Ken Quesenberry	Proposal development
Fall 2008	Dr. Kirby Barrick, Dean of the College of Agricultural and Life Sciences and Dr. Mark McLellan Dean for Research and Director Florida Agricultural Experiment Station	Review of proposal draft
2016	PBWG	2016-2019 PBWG Strate created
Jan. 2018	PBWG Executive Committee	Plant Breeding Graduate coordinator hired
Spring and Summer 2018	Dr. Patricio Munoz, Dr. Marcio Resende, and Ms. Eliana Kampf	Development of a new pr proposal following the 2(streamlined guidelines
Spring and Summer 2018	Dr. Elaine Turner, College of Agricultural and Life Sciences (CALS) dean and Dr. Jackie Burns, UF/IFAS Research dean	Review of pre-proposal a suggested revisions
Summer 2018	Drs. Rob Gilbert (Agronomy), Red Baker (SFRC), Chris Chase (Horticultural Sciences), Dean Kopsell (Environmental Horticulture)	Pre-proposal presentatior chairs of these 4 departm
Fall 2018	Drs. Rob Gilbert (Agronomy), Red Baker (SFRC), Chris Chase (Horticultural Sciences), Dean Kopsell (Environmental Horticulture)	Pre-proposal signed by cl these 4 departments
Nov. 2018	Dr. Turner, CALS Dean	Pre-proposal final review
Dec. 2018	Dr. Chris J. Hass, Associate Provost for Academic Affairs	Pre-proposal review
Feb. 2019	Council of Academic Vice Presidents (CAVP) Academic Program Coordination review group	Pre-proposal approval (n concerns)

In Spring-Fall 2019 the PBC, with the support of the PBWG Executive Committee, worked toward this full proposal. In November 2019 this full proposal was presented to the PBWG Executive Committee for review and then to the CALS Dean's Office for review. The full proposal was submitted to the CALS Curriculum Committee in November 2019, which approved our proposal pending few changes. These changes have been fully addressed and incorporated to this present proposal version.

Timeline of Events Leading to Implementation

Date	Implementation Activity
Nov. 2018	Pre-proposal vetted by Dr. Turner, CALS Dean
Dec. 2018	Pre-proposal approved by Associate Provost for Academic Affairs
Feb. 2019	Pre-proposal approved by Council of Academic Vice Presidents (CAVP) Academic Program Coordination review group with no major concerns.
Nov. 2019	Full Proposal submitted to CALS Curriculum Committee
Spring 2020	UF Graduate School Technical review
Spring 2020	Graduate Council Review and Discussion
Spring 2020	Graduate Council approval
Spring/Summer 2020	University Curriculum Committee Information Item
Spring/Summer 2020	Faculty Senate Steering Committee approval
Spring/Summer 2020	Faculty Senate review and approval
Fall 2020	UF Academic Affairs Approval
Fall 2020	Board of Trustees review and approval
Spring 2021	Submission for February 2021 consideration by the Board of Governors
Fall 2021	Plant Breeding Ph.D. Program implementation

/II. Program Quality Indicators - Reviews and Accreditation

Identify program reviews, accreditation visits, or internal reviews for any university degree programs related to the proposed program, especially any within the same academic unit. List all recommendations and summarize the institution's progress in implementing the recommendations.

This section is based on the 2009-2016 State Board of Governors (BOG) Academic Program Reviews (conducted every 7 years) for plant breeding related Ph.D. degrees in three CALS departments, one school and one interdisciplinary program; respectively, the Agronomy (AGR), Horticultural Sciences (HOS), and Environmental Horticulture (ENH) Departments, the School of Forest Resources and Conservation (SFRC), and the Plant Molecular and Cellular Biology (PMCB) Graduate Program.

Previous reviews of these four UF/IFAS units (AGR, HOS, ENH and SFRC) have recognized that plant breeding and genetics faculty were strengths of these units but pointed out that programs were fragmented and sometime lacked focused interaction with other departments. Despite being the largest land-grant university without a formal

plant breeding graduate program, UF/IFAS has the largest number of plant breeding faculty of any university in the nation, we have one of the largest cultivar development programs, and we are one of the few universities working with specialty crops. The proposed interdisciplinary program will unify UF/IFAS faculty working in breeding and formalize a program that is already underway. This program will create a curriculum that can be advertised and promoted. The increased national and international visibility is expected to generate more support from industry and funding agencies and increase the number and quality of our graduate students.

Some of the departments have also indicated the need to recruit more highly qualified graduate students. For example, the SFRC Advisory Board conducted a full SWOT review and recommended focusing recruiting on quality and diversity of applicants, as part of making UF a "Top 10 University." HOS and ENH pointed out the steep competition for high caliber students from other peer universities. Likewise, PMCB has listed recruitment and securing enrollment of top graduate students among their top five impediments. The proposed program will invest in recruiting, enrolling and graduating highly competitive plant breeding graduate students. We expect that this effort will increase the net number of applicants to CALS. The recruitment investment will bring more students to consider not only plant breeding programs but also other departments and programs in CALS. The program will only accept 5-6 students per year in the first cycle, which should in turn result in other top applicants being re-directed to other UF departmental graduate programs. We have seen this kind of cross-departmental benefit from the recruiting efforts of the PMCB graduate program in the past. This increase in CALS students will also increase the number of students taking graduate classes already offered by plant breeders and other faculty within each department.

Another common issue identified by these departments is the limited funding for fellowships and assistantships to support graduate students. HOS and ENH pointed out that their graduate assistants are mainly supported by funding from individual faculty members' research programs, meaning that faculty with limited resources will be less active in graduate education. PMCB notes that limited internal funding to support a competitive stipend means the best applicants frequently accept offers from competing universities that offer better benefits. The new plant breeding program, with current support of the Plant Breeders Workgroup (PBWG) and UF/IFAS Research via the Plant Breeding Graduate Initiative intends to address this limitation by providing funds to early career faculty who are still building their research programs. The PBGI will ensure assistantships for 3-4 students annually and thus more than 60-80% of the recruitment goal will be achieved with internal assistantships.

Agronomy's last external review in 2012 identified opportunities to more closely involve off-campus faculty in graduate education. HOS and ENH also pointed out in their 2015 BOG report that the lack of online/distance courses hinders the participation of off-campus faculty and students. The HOS graduate program has few online courses and even though some classes are available via video conferencing to students located in Research and Education Centers, further efforts are needed to offer courses via distance education. The Environmental Horticulture program also needs more online graduate level course offerings. SFRC plans to add graduate level courses to supplement all Ph.D. students' choice of courses and will increase their distance education portfolio in a strategic manner to support graduate education. SFRC faculty are spread throughout the state, limiting their collaboration. One of the goals in the 2016-2019 Plant Breeders Working Group Strategic Plan is to expand online instruction with credit-based courses, short courses, and webinars. This plan is currently being implemented and four out of the six proposed core courses will be available for online delivery in 2020. The proposed plant breeding program will improve efficiency of graduate education by unifying on-campus and off-campus faculty already working together in plant breeding and formalizing a program currently underway but with more emphasis in online delivery to further integrate off-campus faculty. Synergy and collaborative research and extension between the RECs and the main campus is an added strength.

The Department of Agronomy emphasizes that future research endeavors will be increasingly interdisciplinary, specifically requiring partnerships with statistics, food science, economics, environmental horticulture, environmental engineering, hydrology, agricultural engineering, and microbiology. SFRC also works with a diversity of departments around UF to identify appropriate courses for Ph.D. students to provide a high quality, holistic education. HOS, ENH and AGR take note of their critical mass of renowned plant breeders and geneticists specializing in field production of vegetables and fruit crops, forages, plant breeding, molecular genetics, crop physiology and management. Research programs are internationally recognized and are highly successful in securing national competitive funding and provide an excellent opportunity to educate students in crop breeding with the latest tools of the field. Another of the strengths of the new plant breeding degree program will be its interdisciplinary emphasis and ability to educate well rounded breeders that succeed in academia and industry. This will be achieved by focusing on traditional and advanced methods that will incorporate different disciplines and experts from the university.

The program will also continue to facilitate development of professional competencies among its students, developing the professional skills sought by industry and academia. For example, the Plant Breeders Working Group (PBWG) provides financial support of the Plant Science Council (PSC), a University of Florida graduate student organization for students involved in plant sciences (https://www.ufplants.org/). The PSC has held an annual symposium since 2017 with invited speakers from industry to boost professional development and engagement of graduate students with a broader audience.

Plant breeding faculty in the involved departments and units have excellent collaboration and on-going research

projects with private industry. The impact of research discoveries linked to the proposed program will expand since between 30-70% of net royalties from licensed cultivars are returned to UF/IFAS plant breeding research programs. With a robust graduate program there are more opportunities for students to connect their research with producers and industry (R&D) and become the next face of innovation in plant breeding. Graduate students in this new program will have an opportunity to gain from a diverse array of research programs and the program's research expertise and student development will make our graduates highly competitive in the job market.

Once the program is established and recognized, the program will evaluate the possibility of creating a certificate with a strong distance education focus. This certificate program will target primarily industry breeders seeking continuing education, which is a different and complementary population not covered by a traditional Ph.D. graduate program. We expect it will bring off-book revenues as well as additional recognition for UF/IFAS and its departments.

VIII. Curriculum

A. Describe the specific expected student learning outcomes associated with the proposed program. If a bachelor's degree program, include a web link to the Academic Learning Compact or include the document itself as an appendix.

Student Learning Outcome (SLO) 1 Knowledge
Explain and apply fundamental theories and principles of plant breeding, genetics and genomics, plant biochemistry, plant transformation technologies and computational genetics.

Assessment Method:
- Evaluation of the student's program of study and completion of IDP (Individual Development Plan).
- Successful defense of qualifying exam by the end of the student's second year.
- Successful defense of dissertation approved by the supervisory committee using a faculty-developed rubric.

Targeted outcome: 90% of all students in the program to successfully pass and/or attain all these assessment milestones.

SLO 2 Knowledge
Apply genetic inheritance theory to crops of interest. Having an understanding of a targeted crops life cycle, mode of reproduction and trait inheritance will determine the best strategies for trait improvement.

Assessment Methods:
- Evaluation of the student's program of study and completion of IDP (Individual Development Plan).
- Successful defense of qualifying exam by the end of the student's second year.
- Successful defense of dissertation recognized by the supervisory committee using a faculty-developed rubric.

Targeted outcome: 90% of all students in the program to successfully pass and/or attain all these assessment milestones.

SLO 3 Skills
Use critical thinking to review scientific literature, evaluate, plan, analyze, and design experiments related to plant breeding and cultivar development.

Assessment Methods:
- Preparation of one or more manuscripts judged ready for publication in peer-refereed research journals, at professional conferences, and/or at industry field days.
- Successful defense of dissertation recognized by the supervisory committee using a faculty-developed rubric.

Targeted outcome: 90% of the students will meet these criteria.

SLO 4 Skills
Communicate effectively and clearly in written and oral form plant breeding ideas, technical data and design information to students, scientists, and the public.

Assessment Methods:
- Number of students giving oral and poster talks at state, national and international scientific meetings.
- Written and oral presentations required for advancement to Ph.D. candidacy
- First author publications and publications co-authored with advisors and/or collaborators.
- Annual written evaluations by advisor and supervisory committee

Target Outcome: 90% of the students will meet these criteria.

SLO 5 Skills

Prepare and complete plant breeding research of sufficient quality to be published in peer reviewed journals, at professional conferences, and/or at industry field days.

Assessment Methods:

- One or more manuscripts ready for submission in peer-refereed research journals, at professional conferences, and/or at industry field days.

Target Outcome: 90% of the students will meet these criteria.

SLO 6 Professional Behavior

Students will interact with peers, faculty, and staff with honesty, respect, ethical behavior, cultural sensitivity, fellowship and cooperation.

Assessment Methods:

- Consistent adherence during the degree program to the University of Florida's Honor Code (evidenced by student permanent file).
- Observations and feedback by faculty advisor and supervisory committee during class activities, seminars, research work, dissertation defense and participation in the faculty's department seminar program and professional societies.
- Annual written evaluations by advisor and supervisory committee
- Completion of IDP (Individual Development Plan)

Targeted Outcome: 90% of active students will have no additions to their permanent file indicating concern with this SLO.

B. Describe the admission standards and graduation requirements for the program.

Admission will require a recognized baccalaureate or graduate degree from a regionally accredited U.S. institution or a comparable degree from an international institution. The process will consider the verbal and quantitative GRE scores, and a minimum undergraduate GPA for students without an M.S. degree. Additional requirements include a minimum of three letters of reference, a statement of purpose, and a resume, which the plant breeding admissions committee will use to assess the student's qualifications for admission to the program and potential for research scholarship. International students must comply with current UF standards for admission to the Graduate School, including requirements for English language competency and financial responsibility.

Applicants should have a B.S. or M.S. in agricultural, horticultural, forestry, biological or chemical sciences with desirable advanced undergraduate coursework in genetics, statistics, plant breeding, and biochemistry. However, outstanding students from a broad range of science and engineering disciplines will be considered. Prior completion of a master's degree from a regionally accredited institution or international equivalent is desirable, preferably in a field of study that provides the student with a solid grounding in the scientific method and plant sciences.

The plant breeding doctoral degree requires a minimum of 90 credit hours beyond a bachelor's degree. Students entering the doctoral program with a completed master's degree may transfer up to 30 hours of graduate credits, subject to existing UF Graduate School policies. Five core courses, listed in VIII section C, are required for a total of 14 credit hours and must be taken during the first fall and spring semesters. AGR6325L Plant Breeding Techniques (1 credit) is also a required core course, but can be taken anytime during their graduate studies. As a result, students must take a combined total of 15 credit hours of core courses. Students need to obtain a grade of at least B or above in each of these courses. If similar level course(s) were taken prior to the doctoral degree, a petition must be submitted by the student's supervisory committee chair to exclude and/or replace specific core courses. The petition needs to be approved by the program graduate coordinator and submitted to CALS and the Graduate School, when deemed necessary. Additionally, students must take at least two additional courses (minimum of six credits) from the list of elective courses provided in VIII section C.

Doctoral students must complete an Individual Development Plan (IDP), conduct independent research satisfactorily and maintain a 3.0 GPA. Students must establish a supervisory committee by the end of the first year, comprised of at least three plant breeding faculty members and one external faculty member. Written and oral qualifying exams are required for all candidates for a Ph.D. degree. It is recommended that the exams will be completed by the end of the second year. Successful completion of the qualifying exams will be determined by the student's supervisory committee, as each student and exam will be unique. The student is considered to have satisfactorily passed the qualifying exam when the decision of the supervisory committee is unanimously affirmed. If the examination is unsatisfactory, the supervisory committee may permit a second examination or deny the student from continuing in the program.

For completion of their degree, all doctoral students must have at least one first author publication submitted to a peer-reviewed journal in their research field before graduation; students will be strongly encouraged to publish

peer reviewed journal in their research field before graduation, students will be strongly encouraged to publish before graduating. This requirement may be waived under extenuating circumstances, as approved by the supervisory committee and the program's leadership (graduate coordinator and/or director). Students will be expected to participate every year in the Plant Breeders Working Group annual meetings.

Doctoral students should also pass a final examination, administered by the student's supervisory committee. The examination format is at the discretion of the supervisory committee and consistent with the UF Graduate School policies. The graduate supervisory committee will assess the written dissertation and will examine the student's overall comprehension and knowledge in a final defense of the dissertation.

C. Describe the curricular framework for the proposed program, including number of credit hours and composition of required core courses, restricted electives, unrestricted electives, thesis requirements, and dissertation requirements. Identify the total numbers of semester credit hours for the degree.

The Ph.D. will require a minimum of 90 post-baccalaureate credit hours. Up to 30 credits may be transferred from an M.S. or other master's program from a regionally accredited institution or international equivalent. The doctoral course work will include core courses (15 credits), elective courses (minimum 6 credits), and dissertation research.

The curriculum was designed to provide the student with a strong background in the scientific method, data collection and analysis of data during the first semester, and plant breeding during the second semester. This ensures that students will be prepared to take specialized courses and have the ability to formulate their dissertation studies.

Curriculum Overview

Requirements	Year 1			Year 2			Yea
	Fall	Spring	Summer	Fall	Spring	Summer	
Core Courses	STA 6093	AGR 5321C		-			
	AGR 5266C	HOS 6XXX [2]					
	HOS 6XXX [1]	HOS 6XXX [1]					
Elective Courses			x	x	x		
Research	x	x	x	x	x	x	x
Qualifying Exam						x	
Journal Article							x
Final Exam							

[1] Journal Colloquium

[2] Survey of Breeding Tools & Methods

Students are required to take the core courses listed below:

Required Core Courses	
STA 6093	Introduction to Applied Statistics for Agricultural and Life Sciences
AGR 5266C	Field Plot Techniques
HOS 6XXX [1]	Journal Colloquium
AGR 5321C	Genetic Improvement of Plants
HOS 6XXX [2]	Survey of Breeding Tools & Methods
AGR 6325L	Plant Breeding Techniques*

* Required, but students can take it any spring semester of odd years in coordination with their supervisory committee

Students must choose a minimum of 6 additional credits from the following list of elective courses or as determined by the supervisory committee.

Elective Courses	
HOS 6201	Breeding Perennial Cultivars
PCB 5065	Advanced Genetics
AGR 5307	Molecular Genetics for Crop Improvement
HOS 5242	Genetic and Breeding of Vegetable Crops
GMS 6231	Genomics and Bioinformatics
AGR 6XXX	Plant Chromosomes and Genomes
PCB 6555	Introduction to Quantitative Genetics
HOS 6236	Molecular Marker-Assisted Plant Breeding
AGR 6322	Advanced Plant Breeding

Additional support courses may be determined by the doctoral supervisory committee accordingly to the area of study (ex. plant pathology, entomology, etc.).

Dissertation Research	
PLS 7979	Advanced Research
PLS 7980	Doctoral Research

Please note that HOS 6XXX[1] Journal Colloquium, HOS 6XXX[2] Survey of Breeding Tools & Methods and AGR 6XXX Plant Chromosomes and Genomes are currently offered as special topics courses in the Graduate Catalog but are expected to be approved by the Academic Approval Tracking System and have their own prefixes and course numbers assigned before the start of this new graduate degree program.

D. Provide a sequenced course of study for all majors, concentrations, or areas of emphasis within the proposed program.

Proposed Plan of Study for a Ph.D. student in Plant Breeding:

	Proposed Plan of Study
Term	**Course**
Fall Year 1	STA 6093 Introduction to Applied Statistics for Agricultural and Life Science
	AGR 5266C Field Plot Techniques
	HOS 6XXX[1] Journal Colloquium
	PLS 7979 Advanced Research
Spring Year 1	AGR 5321C Genetic Improvement of Plants
	HOS 6XXX[2] Survey of Breeding Tools & Methods
	HOS 6XXX[1] Journal Colloquium
	PLS 7979 Advanced Research
Summer Year 1	PLS 7979 Advanced Research
Fall Year 1	Elective course(s)
	PLS 7979 Advanced Research
Spring Year 2	Elective course(s)
	PLS 7979 Advanced Research
	AGR 6325L Plant Breeding Techniques
Summer Year 2	PLS 7979 Advanced Research
Fall Year 3	PLS 7980 Doctoral Research
Spring Year 3	PLS 7980 Doctoral Research
Summer Year 3	PLS 7980 Doctoral Research
Fall Year 4	PLS 7980 Doctoral Research

Spring Year 4	PLS 7980 Doctoral Research
Summer Year 4	PLS 7980 Doctoral Research

E. Provide a one- or two-sentence description of each required or elective course.

Core Courses :

STA 6093 Introduction to Applied Statistics for Agricultural and Life Sciences (3 credits, letter graded)
Provides students with a conceptual and practical understanding of the application of statistics in the agricultural and life sciences. A combination of lectures, programming demonstrations, data exercises using the programming language R, group activities, and primary literature will be used.

AGR 5266C Field Plot Technique (3 credits, letter graded)
Techniques and procedures used in design and analysis of field plot, greenhouse, and laboratory research experiments. Application of research methodology, the analysis and interpretation of research results. Offered fall term. Prerequisite: STA3023.

AGR 5321C Genetic Improvement of Plants (3 credits, letter graded)
Genetic basis for crop improvement including methods for improving crop yield, pest resistance, and adaptability. Emphasis on manipulating genetic variability in self- and cross-pollinated annual and perennial crop plants. Offered fall term. Prerequisite: AGR 3303.

HOS 6XXX
2

Survey of Breeding Tools & Methods (3 credits, letter graded)
A complete survey of methods and strategies commonly used in plant breeding and cultivar development. Course will cover, in a modular fashion, methodologies from traditional plant breeding methods to molecular methods. Lectures and/or hands-on activities will be taught by experts currently using these methods. Offered spring term. Prerequisite: AGR 5321 or equivalent.

AGR 6325L Plant Breeding Techniques (1 credit, letter graded)
Examination of various breeding techniques used by agronomic and horticultural crop breeders in Florida. Field and lab visits to active plant breeding programs, with discussion led by a specific breeder each week. Hands-on experience in breeding programs. Offered spring term in odd-numbered years. Prerequisite: AGR 3303 or equivalent. Co-requisite: AGR 6322.

HOS 6XXX
1

Journal Colloquium (1 credit, letter graded)
Course will focus on critical discussion and presentation of contemporary plant breeding topics. A forum for students to explore the role of research, research paradigms, critical issues, emerging events, and scholarly writings through interactions with speakers, faculty and each other. Offered spring and fall terms.

Elective Courses:

HOS 6201 Breeding Perennial Cultivars (3 credits, letter graded)
Methods of breeding perennial fruit and ornamental cultivars using mutations, cell and tissue culture, polyploidy, recurrent selection, and wide hybridization. Conservation and domestication of wild plants. Offered odd-numbered years in fall. Prerequisite: AGR 3303.

PCB 5065 Advanced Genetics (4 credits, letter graded)
Examines genetic principles including gene and gene function; recombination and linkage; molecular markers, multipoint linkage analysis, and positional cloning; and quantitative, population, developmental, and non-Mendelian genetics. Offered in fall term. For graduate students in any life science discipline. Prerequisite: AGR 3303 or PCB 3063 and BCH 4024 or BCH 5045.

AGR 5307 Molecular Genetics for Crop Improvement (3 credits, letter graded)
Lectures and laboratory demonstrations for a thorough understanding of concepts and applied aspects of plant molecular and cellular biology. Discussion of current research in plant biotechnology and functional genomics. Offered spring term. Prerequisite: AGR 3303.

HOS 5242 Genetics and Breeding of Vegetable Crops (3 credits, letter graded)

Traditional and molecular breeding methods for vegetable crops and the influence of scientific research, government policies, and consumer preferences on vegetable crop improvement. Prerequisite: AGR 3303 or equivalent.

GMS 6231 Genomics and Bioinformatics (3 credits, letter graded)
Principles of genomic characterization and bioinformatic analysis of eukaryotes. Prerequisite: STA 6166 and PCB 5065 or consent of instructor.

AGR 6XXX Plant Chromosomes and Genomes (3 credits, letter graded)
This course is designed to introduce students to plant chromosome structures, inheritance, and the basic genomic tools to analyze plant genomes. Concepts to be introduced include plant DNA organization in chromosome structure, principles and technologies of cytogenetics, plant genomic DNA structure and function, transcriptome, DNA sequencing technologies/applications, basic tools for nucleotide sequence analysis, and plant genomic database exploring. Prerequisites AGR3303 Genetics or PCB 3063 Genetics

PCB 6555 Introduction to Quantitative Genetics (3 credits, letter graded)
Intended for students of all disciplines who are interested in genetic principles and biometric evaluation of characters that exhibit continuous variation in natural populations or breeding programs. Prerequisite: STA 6166. Offered spring of odd years.

HOS 6236 Molecular Marker-Assisted Plant Breeding (3 credits, letter graded)
Providing an overview of terminology, methodology, and applied examples of utilizing molecular markers in a plant breeding program. Offered fall term of odd years. Prerequisite: STA 6093 and AGR 5321C or equivalents.

AGR 6322 Advanced Plant Breeding (3 credits, letter graded)
Theory and use of biometrical genetic models for analytical evaluation of qualitative and quantitative characteristics, with procedures applicable to various types of plant species. Offered spring term in even-numbered years. Prerequisite: AGR 3303, AGR 4231, AGR 6311, and STA 6167.

Dissertation Research:

PLS 7979 Advanced Research (1-12 credits, S/U graded)
Research for doctoral students before admission to candidacy. Designed for students with a master's degree in the field of study or for students who have been accepted for a doctoral program. Not appropriate for students who have been admitted to candidacy.

PLS 7980 Research for Doctoral Dissertation (1-15 credits, S/U graded)
Research for Doctoral Dissertation.

F. For degree programs in the science and technology disciplines, discuss how industry-driven competencies were identified and incorporated into the curriculum and indicate whether any industry advisory council exists to provide input for curriculum development and student assessment.

Our integrated curriculum will equip students with traditional and contemporary breeding methodologies, including molecular techniques (ex: genomic prediction and editing), quantitative genetics, and analysis of breeding trials. Our curriculum was developed upon consultation with industry, non-profit, and academic sectors. While there are currently no specific guidelines for industry-driven competencies, our faculty interact regularly with industry stakeholders and many of our students who were educated in plant breeding have secured jobs in the private sector. Industry representatives from different crops provided their input with regards to the curriculum and one multinational offered to participate as a member of an advisory board (see support letters). We plan to implement a program advisory board with internal and external academic representatives as well as stakeholders including the private sector. The board will meet every other year to review and update the strategic plan for the program, including a review of the curriculum.

G. For all programs, list the specialized accreditation agencies and learned societies that would be concerned with the proposed program. Will the university seek accreditation for the program if it is available? If not, why? Provide a brief timeline for seeking accreditation, if appropriate.

No accreditation will be sought for this proposed graduate program. The American learned societies with interest in this program include: Crop Science Society of America (CSSA, crops.org), American Society for Horticultural Science (ASHS, ashs.org), National Association of Plant Breeders (NAPB, plantbreeding.org), Plant Breeding Coordinating Committee (PBCC, plantbreeding.org/content/pbcc), and their equivalent international societies, such as the CGIAR (cgiar.org, formerly known as the Consultative Group on International Agricultural Research), the European Association for Research on Plant Breeding (EUCARPIA, eucarpia.org), International Society for Horticultural Science (ISHS, ishs.org) and the Global Partnership Initiative for Plant Breeding Capacity Building (GIPB, fao.org/in-action/plant-breeding/en). While we expect that our students and faculty will interact closely

with these societies, none of these societies accredit academic programs in the area of plant breeding.

H. For doctoral programs, list the accreditation agencies and learned societies that would be concerned with corresponding bachelor's or master's programs associated with the proposed program. Are the programs accredited? If not, why?

There are no learned societies or accrediting organizations for corresponding bachelor's or master's programs in the area of plant breeding.

I. Briefly describe the anticipated delivery system for the proposed program (e.g., traditional delivery on main campus; traditional delivery at branch campuses or centers; or nontraditional delivery such as distance or distributed learning, self-paced instruction, or external degree programs). If the proposed delivery system will require specialized services or greater than normal financial support, include projected costs in Table 2 in Appendix A. Provide a narrative describing the feasibility of delivering the proposed program through collaboration with other universities, both public and private. Cite specific queries made of other institutions with respect to shared courses, distance/distributed learning technologies, and joint-use facilities for research or internships.

This program will be a hybrid of traditional and distance delivery methods to graduate students residing on the main campus of the University of Florida and at the UF/IFAS Research and Education Centers (RECs) located throughout Florida using existing faculty from the Departments of Agronomy, Environmental Horticulture and Horticultural Sciences, and the School of Forest Resources and Conservation.

The delivery system for this program will be a mix of traditional delivery to students present on main campus and nontraditional delivery by distance learning to students across the state in the different RECs. The long-term aim is to have all courses include an online component. Some of the courses, such as PCB 6555 Introduction to Quantitative Genetics, are currently being offered fully online while AGR 5321C Genetic Improvement of Plants is scheduled to be offered online in Spring 2020. All courses currently offer the possibility of distance learning through synchronous online delivery. This proven method has worked well and received positive feedback from students and faculty located across the state at the RECs. Since approximately 60% of plant breeding faculty are based at six RECs located across the state from Marianna to Homestead, it is crucial that students advised by off-campus faculty and conducting research at these locations be able to attend classes remotely with the aid of technology.

No specialized services are needed for the proposed delivery system nor do we expect it to require greater than normal financial support. It is not anticipated that the proposed PB graduate program will involve other universities and no such queries have been submitted. Collaboration with other universities in the state is limited since we are proposing the first plant breeding graduate program in Florida.

IX. Faculty Participation

A. Use Table 4 in Appendix A to identify existing and anticipated full-time (not visiting or adjunct) faculty who will participate in the proposed program through Year 5. Include (a) faculty code associated with the source of funding for the position; (b) name; (c) highest degree held; (d) academic discipline or specialization; (e) contract status (tenure, tenure-earning, or multi-year annual [MYA]); (f) contract length in months; and (g) percent of annual effort that will be directed toward the proposed program (instruction, advising, supervising internships and practica, and supervising thesis or dissertation hours).

Table 4 lists the Graduate Faculty who will participate in the PB graduate program and will serve as chairs or members of supervisory committees of students. External members of these committees will be chosen from the graduate faculty members not affiliated with the PB program. We anticipate that by Year 5 of the program, we will have two additional new hires at the assistant professor level.

B.

Use Table 2 in Appendix A to display the costs and associated funding resources for existing and anticipated full-time faculty (as identified in Table 4 in Appendix A). Costs for visiting and adjunct faculty should be included in the category of Other Personnel Services (OPS). Provide a narrative summarizing projected costs and funding sources.

One of the primary costs of the Ph.D. program will be faculty and staff salaries and benefits. The reallocated E&G base is calculated based upon the percentage of faculty and staff salaries/benefits funded through E&G for the effort proposed on Table 4. We are also assuming an annual salary increase of 3% for faculty and staff. Based on projected enrollment trends (Table 1-B), the E&G cost per student FTE decreases from $37,049 in Year 1 to $17,820 in Year 5. Total projected E&G costs for Year 1 are $120,672 and for Year 5 are $253,937.

$17,820 in Year 5. Total projected E&G costs for Year 1 are $129,672 and for Year 5 are $253,937.

C. Provide in the appendices the abbreviated curriculum vitae (CV) for each existing faculty member (do not include information for visiting or adjunct faculty).

This information is provided in Appendix C.

D. Provide evidence that the academic unit(s) associated with this new degree have been productive in teaching, research, and service. Such evidence may include trends over time for average course load, FTE productivity, student HC in major or service courses, degrees granted, external funding attracted, as well as qualitative indicators of excellence.

As mentioned before, the proposed Ph.D. degree will be an interdisciplinary degree involving four IFAS units (AGR, HOS, ENH and SFRC) and will be administrated under the Horticultural Sciences Department where most of the plant breeders are housed. While statistics and academic indicators have not been generated for the subset of faculty working in plant breeding in each of these departments, we nevertheless collected productivity and quality indicators across these departments and among the PBWG to demonstrate that breeding faculty are active in research, teaching and extension. Plant breeding faculty are nationally and internationally recognized and have an impressive list of achievements and awards commensurate with their peers at top-tier institutions.

The table below shows the total number of faculty, the number of plant breeding faculty and their corresponding percentage in each of these four IFAS units. These faculty have research, teaching and extension responsibilities, thus fulfilling the land-grant mission.

	Total Faculty	Plant Breeders	Percentage of Total Dep Faculty in Plant Br
Agronomy (AGR)	30	7	23%
Environmental Horticulture (ENH)	34	3	9%
Horticultural Sciences HOS)	58	15	26%
School Forest Res. & Cons. (SFRC)	73	2	3%

The average Ph.D. students enrolled over the past six years across these departments was 32 for AGR, 63 for HOS and ENH combined (since their Ph.D. degree is jointly administered by ENH and HOS), and 42 for SFRC-Forest Resources and Conservation (FRC) major. All these departments had a significant increase in student enrollment during this period. From 2013to 2018, AGR increased their Ph.D. enrollment by 32%; HOS combined with ENH had an increase of 20%; and SFRC-FRC major had an increase of 45%.

Plant breeders in these four departments have chaired and successfully graduated a total of 128 graduate students, with 50 graduates in AGR, 66 in HOS and ENH, and 22 in SFRC.

In the last 10 years, plant breeding faculty have secured external support of approximately $60 million in federal and private funding, bringing the average total support to nearly $3 million per breeder. Such external funding includes research grants from the National Institutes of Health, National Science Foundation, and the United States Department of Agriculture and contracts through private industry. The development of cultivars and varieties by IFAS plant breeders not only contribute to augment Florida's agricultural industry but its positive impact have also significantly increased globally. For instance, in the last 10 years, more than 300 new cultivars have been developed by the University of Florida and cultivars for each of our 50 crops continue to grow year after year. Licensing of these cultivars has generated royalties that have seen an increase of $1 million per year each of the last seven years, with $14 million generated in 2018. With one of the most aggressive royalty re-investments initiatives of the nation, between 30-70% of this revenue is returned to research programs dedicated to developing cultivars and educating students. This re-investment initiative has positively impacted the quantity and quality of research carried by plant breeding faculty in UF/IFAS.

Graduate students working with plant breeding faculty regularly publish their research in top-rated peer-reviewed agriculture, horticulture, forestry and plant breeding journals, including: *Crop Science* , *Journal of the American Society of Horticultural Sciences, Horticulture Research* , *Plant Breeding* , *Molecular Breeding* , *Genetics* , *G3* , *Plant Molecular Biology* , *Plant Genome* , *Theoretical and Applied Genetics* , *The Plant Cell* , and *Proceedings of the National Academy of Sciences* . This clearly demonstrates the capacity of plant breeders to successfully prepare the new generation of plant breeders.

In their last academic program review, HOS generated an average of 77 scientific publications per year, ENH reported a similar number and AGR produced an annual average of 86 publications. SFRC reported a total of 140 publications in 2015. Faculty scholarly activity has increased steadily when HOS reported over 120 scientific publications in 2018. The impact of publications measured by the i10-index (number of publications with at least 10 citations) for HOS and ENH with a weighted average (by faculty tenure level) was 41, and 18, respectively.

Total Enrollment by Department and Degree for the Period of 2013-2018, Fall term (Source: OIPR – Office of Institutional Planning and Research)

		2013	2014	2015	2016	2017	
HOS + ENH	Total	99	91	96	99	122	
	Ph.D.	61	57	62	55	70	
	M.S.	38	34	34	44	52	
AGR	Total	44	53	68	68	74	
	Ph.D.	25	30	37	35	32	
	M.S.	19	23	31	33	42	
SFRC-FRC	Total	89	98	114	127	128	
	Ph.D.	31	36	44	45	51	
	M.S.	58	62	70	82	77	

Graduate Degrees Granted by Department from 2013-2019 (Source: GIMS)

		2013-14	2014-15	2015-16	2016-17	2017-18	2
HOS	Ph.D.	7	9	14	8	8	
	M.S.	13	8	7	10	9	
ENH	Ph.D.	4	5	2	4	3	
	M.S.	8	7	8	5	7	
AGR	Ph.D.	6	5	6	7	6	
	M.S.	11	5	7	17	17	
SFRC-FRC	Ph.D.	3	5	7	3	11	
	M.S.	19	25	37	37	44	

Academic Fundable Credit Hours (Student Credit Hours, Graduate) (Source: CALS)

	2013-14	2014-15	2015-16	2016-17	2017-18	
HOS	1777	1435	1681	998	1535	
ENH	540	503	555	766	851	
AGR	849	1047	1022	1310	1432	
SFRC-FRC	1657	2129	2465	2315	2521	

Faculty Grant Funding and IDC by Department from 2013-2017 (Source: UF/IFAS Research)

		2013	2014	2015	2016	201
	Grant Funds	5,564,603.00	5,018,844.44	6,338,086.61	5,250,075.49	5,36
	IDC	1,111,325.00	1,134,128.40	1,598,038.00	1,329,821.73	1,28
	Grant Funds	445,058.00	312,450.00	519,913.13	584,355.73	53
	IDC	30,737.00	43,877.00	118,590.80	98,377.90	11
	Grant Funds	1,801,546.00	2,862,657.86	1,987,456.15	5,273,010.76	1,10
	IDC	414,445.00	736,036.67	489,030.40	568,942.96	23
	Grant Funds	9,250,561.00	11,438,137.60	8,937,291.75	6,549,550.41	6,08
	IDC	1,251,015.00	1,816,688.29	1,540,241.00	1,290,980.68	1,16

Plant Breeding Royalty Funding Generated by Department from 2013-2018 (Source: UF/IFAS Research)

	2013	2014	2015	2016	2017	
HOS	$4,020,156.02	$6,300,633.80	$6,845,691.01	$6,976,180.13	$9,185,992.36	$8,
ENH	$97,649.32	$198,561.96	$183,839.57	$247,114.71	$307,335.72	$
AGR	$461,555.62	$639,837.49	$351,467.66	$569,959.38	$506,736.57	$
SFRC	$0.00	$184.03	$127.82	$0.00	$170.11	

Faculty Refereed Publications by Department from 2013-2018 (Source: UF/IFAS Research)

	2013	2014	2015	2016	2017	
HOS	81	65	101	75	75	
ENH	20	22	24	25	24	
AGR	60	58	87	78	94	
SFRC	103	121	140	135	133	

X. Non-Faculty Resources

A. Describe library resources currently available to implement and/or sustain the proposed program through Year 5. Provide the total number of volumes and serials available in this discipline and related fields. List major journals that are available to the university's students. Include a signed statement from the Library Director that this subsection and subsection B have been reviewed and approved.

The Libraries of the University of Florida form the largest information resource system in the state of Florida. The libraries hold 6,169,930 print volumes, 1,489,569 e-books (books in digital format), 145,280 full-text e-journal titles, and 1,092 electronic databases as of 2018. The George A. Smathers Libraries of the University of Florida, a system of six research libraries, includes libraries for sciences, humanities & social sciences, architecture & fine arts, education, and health sciences. The UF Levin School of Law supports a related, but independent law library. Additional library resources are available in two specialized libraries, the UF Digital Collections and the Special & Area Studies Collection. Books and periodicals, related to plant breeding are located primarily in the Marston Science Library.

Electronic books, journals and many key databases, such as Web of Science, BIOSIS Citation Index, CAB Abstracts, Proquest SciTech Collection and others, are available via the internet to UF students, faculty and staff. Many relevant databases are multidisciplinary and are funded centrally. The UF Libraries expend over $10.6 million annually on electronic resources. Listed below is a selection of the important journals available through UF Libraries for use by students pursuing a doctorate degree in plant breeding:

- *American Journal of Botany*
- *Annual Review of Plant Biology*
- *Crop Science*
- *Current Opinion in Plant Biology*
- *Euphytica*
- *Journal of Experimental Botany*
- *Plant Breeding*
- *The Plant Cell*
- *Plant Cell and Environment*
- *Plant Molecular Biology*
- *Plant Physiology*
- *Plant Science*
- *Proceedings of the National Academy of Sciences of the USA*
- *Scientia Horticulturae*
- *Theoretical and Applied Genetics: International Journal of Plant Breeding Research*
- *Trends in Plant Science*

In addition, there are a growing number of open access journals in the field; the content of these journals is freely available to readers. Important titles of open access journals related to plant breeding include:

- *Frontiers in Plant Science*
- *Genetics*
- *G3: Genes, Genomes, Genetics*
- *HortScience**
- *Journal of American Society of Horticultural Science**
- *New Phytologist*
- *Plant Biotechnology Journal*
- *Plant Genome*
- *Plant Journal*

*These journals will become freely available without a subscription as of January 1, 2020.

The Libraries hold memberships in a number of consortia, and in institutions such as the Center for Research Libraries, ensuring access to materials not held locally. "UBorrow" service allows UF patrons to easily borrow materials from any other Florida state university or college library. Materials not held in UF collections and unavailable via UBorrow are procured through Interlibrary Loan. Interlibrary Loan requests are fulfilled at no cost to the library patron; participation in this library collection exchange program is paid for by the UF Libraries. All students, faculty, and staff may use Interlibrary Loan services.

With monies allocated through the Provost and the UF budgeting process, the library materials budget is determined by the Dean of Libraries in consultation with the Senior Associate Dean for Scholarly Resources & Research Services and subject specialist librarians. The librarian subject specialists for the agricultural sciences and biological/life sciences, with input from the Plant Molecular & Cell Biology Program, Department of Biology, Department of Horticultural Sciences and the Department of Environmental Horticulture faculty, determine acquisition priorities for the year. Standing subscriptions to journal literature and databases make up the majority of purchasing. Online research guides for all UF disciplines and many specific topics are available from the library

website http://library.ufl.edu. Many online tutorials for specific databases are also available. Additionally, the UF Libraries offer consultations, workshops, and events throughout the year.

B. Describe additional library resources that are needed to implement and/or sustain the program through Year 5. Include projected costs of additional library resources in Table 2 in Appendix A. Please include the signature of the Library Director in Appendix B.

No additional library resources beyond the current allocation and normal growth in holdings already in place to support current programs are necessary to implement or sustain the graduate program in Plant Breeding.

C. Describe classroom, teaching laboratory, research laboratory, office, and other types of space that are necessary and currently available to implement the proposed program through Year 5.

Facilities available to students in the Plant Breeding graduate program will be derived from the multiple academic units and Research and Education Centers participating, including the four UF/IFAS departments of Agronomy, Horticulture Sciences, and Environmental Horticulture, the School of Forest Resources and Conservation and the six REC units in Wimauma, Lake Alfred, Apopka, Homestead, Belle Glade and Marianna. Overall, these units include all the laboratory, greenhouse and field facilities of the Plant Breeding faculty, classrooms, computer facilities, and core laboratories of the Interdisciplinary Center for Biotechnology Research (ICBR), and Genetics Institute. It is important to mention that the proposed courses for this degree, including the new course, will utilize classrooms, teaching and research laboratories and other types of space that currently exist and are utilized by the above departments and research and education centers (RECs).

Among the proposed core courses, STA 6093 Introduction to Applied Statistics for Agricultural and Life Sciences is 100% online, and does not require any physical space. Similarly, AGR 5321C Genetic Improvement of Plants offered by Agronomy, is 80-99% online with some in-person exams or projects. Classroom space is readily available for AGR 5321C, when needed.

The four departments involved currently provide workspaces for each graduate student enrolled under the supervision of a faculty member in such department.

There are no specific needs for specially equipped classrooms for instruction in this program, except those that are required for students with disabilities. Non special-use classroom space is centrally managed at the University of Florida. Our requirements for classroom space are currently met and we do not anticipate additional needs.

D. Describe additional classroom, teaching laboratory, research laboratory, office, and other space needed to implement and/or maintain the proposed program through Year 5. Include any projected Instruction and Research (I&R) costs of additional space in Table 2 in Appendix A. Do not include costs for new construction because that information should be provided in response to X (E) below.

Two spaces are needed. First, an office for the program administrator large enough to conduct meetings with up to two students and/or faculty members. Second, a common office area for graduate students as they move between Research and Education Centers and the Main Campus, and/or for students housed in Main Campus programs, which have insufficient space to accommodate them. Options for internal reallocation of space within UF/IFAS will be considered to meet these needs.

E. If a new capital expenditure for instructional or research space is required, indicate where this item appears on the university's fixed capital outlay priority list. Table 2 in Appendix A includes only Instruction and Research (I&R) costs. If non-I&R costs, such as indirect costs affecting libraries and student services, are expected to increase as a result of the program, describe and estimate those expenses in narrative form below. It is expected that high enrollment programs in particular would necessitate increased costs in non-I&R activities.

At this point no additional research or instructional spaces are required to successfully implement and grow this proposed program.

F. Describe specialized equipment that is currently available to implement the proposed program through Year 5. Focus primarily on instructional and research requirements.

For instructional purposes our proposed program requires classrooms equipped with online delivery equipment. All classrooms being utilized for this degree are either already well-equipped for online delivery or are being promptly updated by the four departments involved. For research, all plant breeding faculty laboratories are well-equipped to instruct graduate students on techniques and methods used in plant breeding.

G. Describe additional specialized equipment that will be needed to implement and/or sustain the proposed program through Year 5. Include projected costs of additional equipment in

the proposed program through Year 5. Include projected costs of additional equipment in Table 2 in Appendix A.

No additional specialized equipment will be needed to implement the program.

H. Describe any additional special categories of resources needed to implement the program through Year 5 (access to proprietary research facilities, specialized services, extended travel, etc.). Include projected costs of special resources in Table 2 in Appendix A.

None.

I. Describe fellowships, scholarships, and graduate assistantships to be allocated to the proposed program through Year 5. Include the projected costs in Table 2 in Appendix A.

It is anticipated that all doctoral students in this program will receive graduate assistantship or fellowship support since financial support is a critical element in recruitment of top applicants and maintenance of a Ph.D. program. The plant breeders are envisioning a unique program that has continuous support from licensing royalties. Since 2010, the UF/IFAS Plant Breeders Working Group (PBWG) and UF/IFAS Research have funded 23 graduate student assistantships through the Plant Breeding Graduate Initiative (PBGI). The proposed program is expected to recruit top students with interest in plant breeding (maximum of 5-6 students per year in the first cycle). With continuing support of the Plant Breeders Workgroup (PBWG) and IFAS-Research, the PBGI will ensure assistantships for 3-4 students annually and thus 60-80% of the recruitment goal will be achieved with internal funding.

We also project an increase in the philanthropy endowments represented by the Plant Breeding Graduate Initiative (PBGI). The PBGI represents an annual funding opportunity provided by UF/IFAS Research and Florida Foundation Seed Producers, a Direct Support Organization (DSO) that supports the plant breeding research programs. IFAS Research currently funds $60,000 per cohort per year, while the plant breeders provide $60,000. We are predicting that with the success of the program the plant breeders will expand their support by Year 5 for a total of $90,000 per year. Furthermore, we are anticipating that the program will obtain support for one Graduate School Funding Award (GSFA) each year for the first five years.

The visibility provided by this new graduate program will increase UF/IFAS opportunities to obtain industry support targeting development of new plant breeders. Moreover, the plant breeding faculty have an excellent track record of obtaining extramural support and the number of grant-supported assistantships has grown steadily. The increased visibility of this new interdisciplinary program would enhance plant breeding faculty's chances of more successfully competing for extramural research project funding.

Also, the addition of this doctoral program will make us competitive for university-wide fellowships that are limited to doctoral students and we plan to take advantage of those opportunities.

J. Describe currently available sites for internship and practicum experiences, if appropriate to the program. Describe plans to seek additional sites in Years 1 through 5.

The UF/IFAS Plant Breeding Graduate Program is a field-based applied breeding program which provides students with hands-on experience and exposure to 50 crops that our faculty research and investigate. As part of their plant breeding education, both our on-campus or off-campus students are required to carry out extensive field work research. UF/IFAS provides research support for faculty members including facilities on the University of Florida campus plus off-campus facilities including 12 Research and Education Centers, five Research and Demonstration Sites (that include two biological stations) and a research forest. We therefore feel that we will be able to provide adequate sites for student research and experiential learning.

Even though we do not require an internship or practicum for doctoral students in the proposed degree program, students are encouraged to pursue an outside internship with industry, governmental agencies, and non-governmental organizations with the duration of at least one month. We have excellent collaborative relationships with industry and other organizations so our students will be able to gain experience in other applied breeding programs especially with potential future employers (private and public).

CITED LITERATURE

Guner, N. and T. C. Wehner. 2003. Survey of U.S. land-grant universities for training of plant breeding students. Crop Science 43: 1938-1944.

USDA Plant Breeding Working Group. 2015. USDA Roadmap for plant breeding. https://www.usda.gov/sites/default/files/documents/usda-roadmap-plant-breeding.pdf

(accessed 1 August 2019)

Sylak-Glassman et al. 2016. Examination of plant breeding at U.S. academic institutions and private companies in

2015. IDA Paper P-5331. Institute for Defense Analyses (IDA)

Science and Technology Policy Institute, Washington, DC. https://bit.ly/2t3vpGj

doi:10.2134/csa2018.63.0701

Board of Governors, State University System of Florida

Request to Offer a New Degree Program

(Please do not revise this proposal format without prior approval from Board staff)

University of Florida	Fall 2021
University Submitting Proposal	**Proposed Implementation Term**
College of Agricultural and Life Sciences	Horticultural Sciences, Agronomy, School of F Resources and Conservation, Environmental Hc
Name of College(s) or School(s)	**Name of Department(s)/ Division(s)**
Plant Breeding	Doctor of Philosophy
Academic Specialty or Field	**Complete Name of Degree**
01.1104	
Proposed CIP Code	

The submission of this proposal constitutes a commitment by the university that, if the proposal is approved, the necessary financial resources and the criteria for establishing new programs have been met prior to the initiation of the program.

Date Approved by the University Board of Trustees

Signature of Chair, Board of Trustees **Date**

Provide headcount (HC) and full-time equivalent (FTE) student estimates of majors for Years 1 through 5. HC and FTE estimates should be identical to those in Table 1 in Appendix A. Indicate the program costs for the first and the fifth years of implementation as shown in the appropriate columns in Table 2 in Appendix A. Calculate an Educational and General (E&G) cost per FTE for Years 1 and 5 (Total E&G divided by FTE).

Implementation Timeframe	Projected Enrollment (From Table 1)			Projected Program C (From Table 2)		
	HC	FTE		E&G Cost per FTE	E&G Funds	Contract & Grants Funds
Year 1	5	3.5		$34,473	$120,657	$33,278
Year 2	10	7.25				
Year 3	15	11				
Year 4	20	14.5				
Year 5	20	14.5		$23,174	$336,027	$210,063

Note: This outline and the questions pertaining to each section must be reproduced within the body of the proposal to ensure that all sections have been satisfactorily addressed. Tables 1 through 4 are to be included as Appendix A and not reproduced within the body of the proposals because this often causes errors in the automatic calculations.

Introduction

I. Program Description and Relationship to System-Level Goals

A. Briefly describe within a few paragraphs the degree program under consideration, including (a) level; (b) emphases, including majors, concentrations, tracks, or specializations; (c) total number of credit hours; and (d) overall purpose, including examples of employment or education opportunities that may be available to program graduates.

The University of Florida is one of the most active and innovative land-grant universities in plant breeding and variety licensing in the country. The university employs 27 faculty positions, breeding 50 plant species in four academic departments (Agronomy, Horticultural Sciences, Environmental Horticulture, and the School of Forest Resources and Conservation - SFRC) within the Institute of Food and Agricultural Sciences (UF/IFAS). However, we are the largest land-grant university in the country without a formal plant breeding graduate education program. Furthermore, a plant breeding graduate degree program is currently not offered in the state of Florida.

The interdisciplinary Ph.D. degree in Plant Breeding is proposed to fill the demand for breeding research and for educating new plant breeding graduates. The program will create a framework and administrative structure to leverage resources, faculty, courses, and student recruitment, which will attract federal and private funding and increase the number of graduate STEM degrees awarded at UF. It will be administered by the UF/IFAS College of Agricultural and Life Sciences (CALS) to provide a comprehensive plant breeding education. Our integrated curriculum will equip students with traditional and next-generation breeding methodologies, including molecular

curriculum will equip students with traditional and contemporary breeding methodologies, including molecular techniques (e.g. genomic prediction and genome editing), quantitative genetics, and analysis of breeding trials. Our curriculum was developed upon consultation with industry, non-profit, and academic sectors. The CALS plant breeding graduate program will prepare breeders proficient to work in both academia and industry, and thus supply the large demand that exists for plant breeders.

The proposed Ph.D. degree will require a minimum of 90 credit hours beyond the bachelor's degree. To graduate in the program, students are required to have a minimum of 40 credits of coursework toward their major. This coursework will include required courses (20 credits) which will provide a strong foundation in experimentation, data analysis and plant breeding; followed by a minimum of 20 additional credits selected from an array of electives. Approved elective courses will be drawn both from within CALS as well as existing UF areas of expertise outside of CALS in genetics, statistics, biology, molecular biology, bioinformatics, and genomics.

Over the past 30 years, 113 alumni have graduated from CALS graduate degree programs offered by the four departments mentioned above; however, none of them graduated with a formal plant breeding degree even though they all worked in plant breeding projects. Many of these graduates are now leading or employed in productive and innovative plant breeding programs in the public and private sector in the USA and internationally. Appendix F lists numerous examples of plant breeding graduates successfully employed in academia, industry, government and research institutions nationally and globally.

We expect extensive student interest in this interdisciplinary STEM program. Dozens of inquiries from prospective students are received by each of the 27 UF plant breeders every year, and there is an extraordinary demand from the private sector for highly-qualified, specialized plant breeders (see Appendix E).

B. Please provide the date when the pre-proposal was presented to CAVP (Council of Academic Vice Presidents) Academic Program Coordination review group. Identify any concerns that the CAVP review group raised with the pre-proposed program and provide a brief narrative explaining how each of these concerns has been or is being addressed.

The pre-proposal was presented to the CAVP Academic Program Coordination review group on February 22, 2019. No concerns were raised.

C. If this is a doctoral level program please include the external consultant's report at the end of the proposal as Appendix D. Please provide a few highlights from the report and describe ways in which the report affected the approval process at the university.

In the fall of 2019, four external reviewers who are highly recognized in the discipline of plant breeding were asked by Dr. Elaine Turner, Dean of the College of Agricultural and Life Sciences (CALS), to provide feedback on the Plant Breeding Ph.D. program full proposal. These were:

Reviewer 1: Dr. William Tracy, Professor of Agronomy at the University of Wisconsin-Madison, former Department Chair. Dr. Tracy is a member of the graduate faculty of the interdepartmental graduate training program in Plant Breeding and Genetics, which is very similar in design and objectives to our proposed program.

Reviewer 2: Dr. Wayne Smith, Professor of Cotton Breeding and Associate Department Head, Department of Soil and Crop Sciences at Texas A&M University, and Vice-Chair of the Plant Breeding Coordinating Committee (PBCC) Executive Committee.

Reviewer 3: Dr. B. Todd Campbell, Research Geneticist, USDA-ARS, Coastal Plains Soil, Water, and Plant Research Center and former President of the National Association of Plant Breeders (NAPB).

Reviewer 4: Dr. Rex Bernardo, Professor and Endowed Chair of corn breeding at the University of Minnesota, and former Associate Director of Graduate Studies and former Director of Graduate Studies in Applied Plant Sciences at the University of Minnesota.

The four external reviewer reports are in Appendix D. All reviewers were positive and supportive, strongly endorsing the proposed University of Florida Ph.D. program.

Regarding the overall merit of the proposed program, the reviewers emphasized that UF has, perhaps, the strongest public cultivar development program in the US, with a very strong faculty. Mobilizing this group toward a unified graduate curriculum and program will quickly move UF plant breeding into the top five programs if not the top three in the nation. The reviewers noted that the present lack of a plant breeding graduate program has been a missed opportunity for UF to become one of the leading Ph.D. plant breeding programs at present.

Regarding the demand for Ph.D. plant breeders in the Southeast region, the United States and the world, the reviewers emphasized that "Demand for PhD plant breeders has been strong since the 1970 PVP act (Plant Variety Protection Act) and especially since the 1994 PVP act and the advent of patented genetic products and procedures since 1985." Despite the consolidation of the seed industry, the demand for plant breeders remains strong, and industry may be the primary employer in the future. There are numerous reports of insufficient

graduates to fill the needs of the industry. In the last 10-15 years, we have seen a large, increased investment by private industry to build plant breeding capacity. During this time, plant breeding has evolved and become even more multi-disciplinary in nature, as reflected in the construction of the degree program proposal.

Regarding the importance of such a program in the Southeast region, the United States and the world, reviewers commented that the University of Florida is strategically located to play a vital role in U.S. crop improvement, given its research programs on plants that are of economic importance in the Southeast U.S. One reviewer noted the unique ability to study breeding of subtropical and tropical crops and the adaptation of temperate crops such as blueberries and strawberries to those conditions. Another reviewer emphasized that there are a number of crops/plants unique to Florida that are not addressed elsewhere in the region or country. Thus, the proposed program is not only locally important, but will fill a national and international gap in the plant breeding area.

Regarding the potential of the program to provide the educational needs of future plant breeders, one reviewer emphasized that UF has a strong and knowledgeable group of plant breeding faculty. Another reviewer emphasized that the academic program as outlined is adequate to meet the educational needs of future plant breeders. A few recommendations were suggested by the reviewers which are addressed in the last paragraph of this section. Overall, reviewers agreed that the program will provide a high quality education for future plant breeders.

Regarding the ability of plant breeding faculty and administration at UF to build a successful program, reviewers emphasized that the proposal addresses the administration of the program extremely well. They emphasized that UF is a leading land-grant university in this area with excellent faculty and administrators who will ensure a successful program. The breadth and diversity of the existing plant breeding effort at UF (e.g.- diversity of crops and plants already with plant breeding efforts) is leveraged to build a strong interdisciplinary plant breeding program that offers students unique and diverse educational opportunities. Reviewers also stressed that UF faculty are very productive in releasing cultivars and in academic research, which are key to the success of the proposed program.

Regarding the financial and other resources available, one reviewer emphasized that potential resources listed in the proposal exceed those of any other institution he knows of, except, perhaps, Texas A&M University. Another reviewer noted that creating this very strong plant breeding degree program requires little to no initial investment. Overall, reviewers thought this section was well explained and documented.

Regarding advice for achieving program success based on experience at their own institution, reviewers were unanimously confident that UF will be successful with this graduate program. One reviewer highly praised the program's interdisciplinary educational approach of balancing traditional plant breeding methods and successfully incorporating modern methods such as genomics and bioinformatics in the curriculum and program. Their suggestions and recommendations were incorporated in the present proposal, more specifically:

- The reviewers emphasize the need to expose students to management, professional development and financial courses, while recognizing the limitations of number of credits courses to achieve the needed training. This proposal is addressing this topic with a special journal club that focuses on management decisions, professional development and financial aspects of being a plant breeder in the public and private sectors.
- The reviewers also recommend that the faculty work toward developing and supporting a strong student cohort and community approach which is addressed by offering core classes and journal clubs built in the program with this objective.
- One reviewer suggested a clarification on our distance delivery which is addressed and already incorporated to Section I part F (page 6).
- Additional statistical courses have been added as electives as suggested by one reviewer.
- For the time being, the program will only accept students in the fall semesters.
- One reviewer recommended that courses focus primarily on principles and concepts rather than knowledge specific to crop types or species. In this proposal the core courses, as well as the electives focus on concepts that are broadly applicable. However, the electives "Breeding Perennial Cultivars" and "Genetic and Breeding of Vegetable Crops" are more targeted due to the specific and very different nature of these crops.
- One final recommendation was regarding the leadership of the program, especially in the first years of establishment. This will be addressed with UF administration to ensure the rotation length is not too short for each program director and that the leadership time is recognized for the faculty leading the program.

D. Describe how the proposed program is consistent with the current State University System (SUS) Strategic Planning Goals. Identify which specific goals the program will directly support and which goals the program will indirectly support (see link to the SUS Strategic Plan on the resource page for new program proposal).

The proposed degree program is consistent with the current State University System's (SUS) 2025 Strategic Planning Goals, which focus on excellence, productivity and strategic priorities for a knowledge economy. Specifically, the proposed degree program directly supports the strategic goals as follows:

I. Excellence. The Board of Governors continues to expect the state universities to provide academic programs of the highest quality, to produce world class, consequential research, and to reach out and engage Florida's

of the highest quality, to produce world class, consequential research, and to reach out and engage Florida's communities and businesses in a meaningful and measurable way.

The proposed Plant Breeding (PB) doctoral program will create a new highly renowned STEM program. The new program will strengthen the reputation of the academic programs at the University of Florida and thus the state. Plant Breeding is a well-recognized field both nationally and internationally. A few AAU and land-grant Universities offer a doctoral program in this area, and none are located in the state of Florida. Faculty at UF are well recognized in different sub-areas of plant breeding and formalizing the PB program will create greater visibility and increase recruitment of top state, national and international students further strengthening the reputation of this UF program and aligning it with state pre-eminence goals. The PB Ph.D. degree will provide a strong basis for conducting research that examines new potential crops for a local need with a global impact, as well as the continued improvement of crops that support Florida's rural economies. UF Plant Breeders, as a part of the land-grant mission, are already engaged with a diverse group of stakeholders and industries ranging from nursery and landscape, fruits and vegetables, and forestry for pulp and lumber. This program will strengthen relationships with Florida stakeholders through increased awareness of our programs and by providing graduates to work in our industries.

II. Productivity. Florida must become more competitive in the national and global economy. To accomplish this, the state must increase the educational attainment levels of its citizens and the state universities must respond by awarding more degrees in specific high demand programs, particularly the STEM disciplines.

Currently all plant breeding faculty are preparing the next generation of doctoral level plant breeders. However, this is done across multiple departments that have different curriculum and graduation requirements. The creation of the new PB Ph.D. program will streamline the requirements for graduation by formalizing the program, ensuring high quality, increasing efficiency and streamlining the degree requirements. A streamlined program will be more attractive to potential students and increase the number of degrees awarded. UF/IFAS plant breeders are inventors of new cultivars with high productivity. In the last 10 years more than 300 new plant varieties have been released. We expect that by formalizing the new program more funding and more highly-qualified Ph.D. students will contribute to increasing the productivity in the development of new plant cultivars, and in engaging Florida's agricultural and natural resources industries.

Through mentorship of CALS graduate students, UF/IFAS plant breeders are already contributing to UF's diversity goal of preparing the next generation, where currently 43% of students are women and 8% are Hispanic/Latino. The new Ph.D. program will boost the cultural, ethnic, gender, and socio-economic diversity by recruiting under-represented students in STEM (including women and returning adults). The PB program will further support faculty in their recruitment of students from around the world, supporting the global impact of our plant breeding programs and highlighting the potential for UF to become a global leader in plant breeding given the unique diversity of crops in Florida.

III. Strategic priorities. The Board of Governors acknowledges that simply producing more with greater efficiencies is not inherently strategic, so this plan also has a focus on Strategic Priorities within each of the tripartite missions that need to be prioritized to better align university outputs with state economic and workforce needs.

UF/IFAS plant breeding research programs have long enjoyed a strong partnership with Florida's agricultural and natural resources industries. By being strategically located in the center of production of their respective crops, breeders located in Gainesville and at UF/IFAS Research and Education Centers (RECs) throughout the state have become integral components of these industries. The agronomic, horticultural, and ornamental varieties they develop are used by farmers, ranchers, and homeowners in Florida, the nation, and the world.

Offering a diverse educational and interdisciplinary program will increase the number of students and faculty engaged in collaborative research and plant breeding efforts worldwide. A Ph.D. program in plant breeding will increase the cultural, ethnic, gender, and socio-economic diversity of students, faculty and staff reflecting the breadth of thought essential for state, national and world preeminence. The Florida Department of Economic Opportunity projects that life scientist jobs will increase by 12.5% in the next eight years. This category includes the occupations of soil and plant scientists (8.4% growth) and biological scientist (9.3% growth). Plant breeders fall into both plant scientist and biological scientist categories.

Additionally, plant breeding faculty have a strong track-record of successful grantsmanship and will continue to attract external funding from federal and private organizations, therefore promoting more collaboration with private industry on research projects. The external support coming from industry through plant breeding royalties has increased by $1 million each year since 2013. The external funding and royalty income are being re-invested to increase fellowships and research, thus increasing the productivity and reputation of UF plant breeding.

E. If the program is to be included in a category within the Programs of Strategic Emphasis as described in the SUS Strategic Plan, please indicate the category and the justification for inclusion.

The Programs of Strategic Emphasis Categories:

1. Critical Workforce:
   - Education
   - Health

- Gap Analysis

2. Economic Development:
   - Global Competitiveness
3. Science, Technology, Engineering, and Math (STEM)

Please see the Programs of Strategic Emphasis (PSE) methodology for additional explanations on program inclusion criteria at the resource page for new program proposal .

The new degree proposed should be included in the Science, Technology, Engineering, and Math (STEM) Program of Strategic Emphasis as described in the SUS Strategic Plan, further classified as STEM CIP (Classification of Instructional Programs) 01.11 Plant Sciences and, more specifically, as 01.1104 Agricultural and Horticultural Plant Breeding.

The proposed program will focus on the application of genetics and genetic engineering to the improvement of agricultural plant health, the development of new plant varieties, and the selective improvement of agricultural plant populations. Doctoral students in this program will be educated in genetics, genetic engineering, population genetics, agronomy, plant protection, and biotechnology as well as biological sciences related to plant reproduction, molecular biology and genomics. This new STEM Ph.D. degree will provide qualified students with core scientific skills necessary for success in plant breeding (as opposed to broader agronomic or horticultural skills), which in turn will strengthen our ability to recruit the top students to UF.

F. Identify any established or planned educational sites at which the program is expected to be offered and indicate whether it will be offered only at sites other than the main campus.

Courses for the plant breeding Ph.D. program will be offered on main campus with the goal of both face-to-face and live on-line delivery. The majority of classes will be delivered from main campus but made available to students on and off main campus through on-line technologies that will allow graduate students located at RECs to pursue their studies close to their crop's center of production. This increases opportunities for students to engage with and advance their education combined with a full immersion from stakeholders in the production systems and the associated advantages and challenges of producing food, feed, and fiber for the local, national and global economies.

Institutional and State Level Accountability

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II. Need and Demand

A. Need: Describe national, state, and/or local data that support the need for more people to be prepared in this program at this level. Reference national, state, and/or local plans or reports that support the need for this program and requests for the proposed program which have emanated from a perceived need by agencies or industries in your service area. Cite any specific need for research and service that the program would fulfill.

An unmet need for plant breeding skill development in both traditional and genomic methodologies is widely recognized. The need to educate future plant breeders in specialty crops, the integration of molecular tools, and the fact that graduate education has become concentrated in a small number of universities focused on a few major row crops (e.g., corn and soybeans) were highlighted by The National Plant Breeding Coordinating Committee (http://cuke.hort.ncsu.edu/gpb/pr/pbccmain.html) as major issues facing plant breeding nationally and internationally.

In a national survey, Guner and Wehner (2003) indicate that the majority of plant breeders were being trained at the University of Wisconsin-Madison, North Carolina State University, University of Nebraska-Lincoln, Cornell University, University of Minnesota-St. Paul, Iowa State University, and Texas A&M University which focus on a small number of major crops. Their geographic distribution and breeding focus result in an imbalance in graduate student training in western and southeastern regions of the United States. These regions contain unique environments (i.e. southern California and Florida) that produce specialty crops not found in other areas of the U.S. The University of Florida has highly regarded breeding programs for a diversity of crops, including several specialty crops of regional and international importance (e.g., oranges, strawberries, blueberries). This is largely owed to Florida's tropical and subtropical environments which allow breeding and production of specialty crops that cannot be grown in other areas of the U.S. These facts further emphasize the University of Florida's unique situation and bring an enormous opportunity for UF to become a leader in Plant Breeding education among its peer institutions.

We have assessed the needs for more people to be educated in Plant Breeding using different sources and approaches. At a regional level, and according to the Florida Department of Economic Opportunity, it is forecasted that life scientist jobs will increase by 12.5% in the next eight years. This category includes the occupations of soil and plant scientist (8.4% growth) and biological scientist (9.3% growth). Plant breeders fall into both plant scientist and biological scientist categories. Moreover, the Bureau of Labor and Statistics (https://www.bls.gov/home.htm) estimates a national growth of 8.8% in plant science careers, and within this group, a growth of 17.8% in

research and development. Following these expected increases in job opportunities, a 2015 survey of private and U.S. university plant-breeding programs reported that the number of domestic private sector positions for Ph.D.-level plant breeders is one third larger than the number of domestic academic positions. When international plant breeding positions are considered, nearly three times as many private sector positions are available (Sylak-Glassman et al., 2016). When the private sector was asked if they had enough qualified applicants for plant breeding positions, most of the responses indicated that there were not enough well-qualified applicants.

This result is supported by a statement from The National Association of Plant Breeders (https://www.plantbreeding.org/) publicizing a lack of qualified plant breeders, especially in specialty crops like fruits and vegetables. To build on this survey carried out by Sylak-Glassman et al. (2016), we have reached out to industry representatives of different crops nationally and internationally. We collected letters of support from nine companies engaged in the local, national and global production of row crops, fruits and vegetables (see Appendix E). The general consensus is that there is demand for Ph.D. level plant breeders, and they supported the creation of a formal graduate program in plant breeding in CALS. Finally, the USDA Roadmap for Plant Breeding (USDA Plant Breeding Working Group, 2015) emphasizes that stakeholders have continued to call for increased USDA involvement in the preparation of plant breeding professionals.
Altogether, we observe a strong need for more professionals at the regional, national and international level, and an opportunity to position the University of Florida at the forefront of plant breeding education and research. The proposed program will address these issues by increasing the number of Ph.D. degrees in plant breeding awarded at UF and improving UF's visibility at the state, national, and international levels. As a result, UF's plant breeding programs will more easily compete for federal and private funds.

B. Demand: Describe data that support the assumption that students will enroll in the proposed program. Include descriptions of surveys or other communications with prospective students.

We expect extensive student interest in this interdisciplinary STEM program. Each of the 27 UF plant breeders receives dozens of inquiries from prospective students every year, and there is extraordinary demand from the private sector for high-quality plant breeders. In the last 30 years, 113 plant breeding alumni have graduated from four UF/IFAS departments (Horticultural Sciences, Environmental Horticulture, Agronomy and School of Forest Resources and Conservation). However, none of them graduated with a formal plant breeding degree. No students are currently enrolled in similar programs in the state of Florida.

Moreover, the National Plant Breeding Coordinating Committee (http://cuke.hort.ncsu.edu/gpb/pr/pbccmain.html) points out that education of plant breeders has become concentrated in a small number of universities focused on major row crops. The University of Florida is located in a sub-tropical location with a unique emphasis on specialty crops. The climate of Florida and broad research programs in UF/IFAS position the proposed program to lead plant breeding education and research related to specialty crops both nationally and globally.

We have surveyed current and former University of Florida students as well as AAU land-grant institutions that offer comparable doctoral programs to assess the demand for a Ph.D. in Plant Breeding. Among 34 public and 26 private AAU and land-grant universities only six offer comparable doctoral programs and only one is located in the Southeast.

We surveyed three out of the six universities with similar graduate degrees in plant breeding: University of Wisconsin-Madison, University of California-Davis, Texas A&M University, and Cornell University. While UC-Davis does not have a graduate degree titled "Plant Breeding", we nevertheless include it for comparison, as it is known for training plant breeders and resides in a state with a large specialty crop industry, similar to Florida. In general, the representatives from these institutions all indicated either a stable number of students going into their programs or an increase in interest in their program, given by the number of students applying. Each year, these programs each have 5-8 new students, which is similar to the projected number of students in this proposed CALS graduate program. Cornell University indicated they only accept 10% of the applicants, which suggests they receive 50-80 applications per year. The University of Wisconsin-Madison indicated they have graduated 337 students from their program since their founding in 1968 and that "the program is still running strong".

In addition, we sent a survey to 49 graduate students enrolled as of June 2018 in graduate programs in four UF/IFAS departments (Agronomy, Horticultural Sciences, School of Forest Resources and Conservation, Environmental Horticulture) pursuing degrees related to plant breeding. The response rate was 86% and students were asked, if given the option, to choose which three Ph.D. degree titles would be more beneficial for their career plans. Forty-eight percent of the students indicated that they would prefer a Ph.D. in Plant Breeding with formal and structured graduate education tailored to all relevant aspects of plant breeding that would prepare career-ready plant breeders. Forty-five percent of the students surveyed indicated they would prefer a Ph.D. in their current major (e.g. Agronomy or Horticultural Sciences) with a concentration in plant breeding while only 7% of the students preferred to keep the same degree title as currently awarded by these four departments.

C. If substantially similar programs (generally at the four-digit CIP Code or 60 percent similar in core courses), either private or public exist in the state, identify the institution(s) and geographic location(s). Summarize the outcome(s) of communication with such programs with regard to the potential impact on their enrollment and opportunities for possible

with regard to the potential impact on their enrollment and opportunities for possible collaboration (instruction and research). In Appendix C, provide data that support the need for an additional program.

There are no similar programs at either private or public institutions in the state of Florida.

D. Use Table 1 in Appendix A (1-A for undergraduate and 1-B for graduate) to categorize projected student headcount (HC) and Full Time Equivalents (FTE) according to primary sources. Generally undergraduate FTE will be calculated as 30 credit hours per year and graduate FTE will be calculated as 24 credit hours per year. Describe the rationale underlying enrollment projections. If students within the institution are expected to change majors to enroll in the proposed program at its inception, describe the shifts from disciplines that will likely occur.

We anticipate that the majority of our students will register as full-time students, generally taking 24 credits per year (0.75 FTE). We expect that students who graduated from a preceding degree program at other Florida public universities, out-of-state residents and international residents will account for the initial applicants to our doctoral program. In addition, we expect that we will also attract other students from state and local industries, such as working professionals who want to advance in their careers. This expectation stems from the strong partnerships that UF plant breeding faculty have with Florida's agricultural and natural resources industries.

We expect to focus our recruitment efforts on attracting high-quality students who have completed degrees from other Florida or out-of-state universities, with special attention to underrepresented minorities, low-income or first-generation college students. Over time, students from other universities within the state, as well as out-of-state residents and international students and those from industry will be drawn to our program and will account for the majority of our students. We base this on the results of surveys of current and former students, as well as our survey of other comparable programs across the country.

We also anticipate that students who have recently graduated from one of the four departments (Horticultural Sciences, Environmental Horticulture, SFRC and Agronomy) that offer a degree related to plant breeding might apply to our program in this first year. However, we will not allow current Ph.D. students enrolled in any of the four UF departments mentioned above to transfer to our proposed plant breeding doctoral program for the first five years of our program. The program will only accept 5-6 students a year in the first five cycles, which should result in other top applicants being re-directed to other UF departmental graduate programs.

Furthermore, several plant breeding faculty have participated in the interdisciplinary Plant Molecular and Cellular Biology (PMCB) Graduate Program, established 30 years ago and well-recognized nationwide as a center of excellence for plant biology faculty focusing on genetic, molecular, and cellular research. Similar to PMCB recruitment strategy, the PB program will launch a proactive recruitment plan to identify and attract top state, national and international students to the University of Florida and aligning it with state pre-eminence goals. In conjunction with UF/IFAS Communications, the UF/IFAS Plant Breeders Working Group is establishing a marketing and branding campaign, including a revamped website, innovative media outreach, wide-ranging advertising campaign, among others.

We will identify prospective applicants using well-known student prospects databases such as the State of Florida Graduate Candidate Identification System (GCIS), GRE Search, National Name Exchange (NNE), FAMU Feeder Fellows, National McNair Fellowship among others. Moreover, we also anticipate actively engaging with UF recruiting initiatives, in special those spearheaded by CALS, the Office of Graduate Diversity Initiatives (OGDI) and the Office of Graduate International Outreach (OGIO). These collaborations will include participating in graduate recruitment fairs; partnering with foundations, community and student support organizations; providing scholarships and assistantships for underrepresented students; and providing students with opportunities to participate in retention and professional development workshops. In addition, we will make use of the powerful plant breeding faculty connection with UF alumni who are well positioned in academia and private industry sectors. These practicing professionals will be an excellent resource for recruitment of new students.

With this increased visibility, we expect more support and recognition from the industry, peer universities and funding agencies. We envision this new graduate program to have a global reach and thus competing with other national and international plant breeding universities for top students. This recruiting investment for the new graduate program will attract more student applications to CALS overall and in particular to other graduate programs and departments at UF.

E. If the proposed program substantially duplicates a program at FAMU or FIU, provide, (in consultation with the affected university), an analysis of how the program might have an impact upon that university's ability to attract students of races different from that which is predominant on their campus in the subject program. The university's Equal Opportunity Officer shall review this section of the proposal and then sign and date Appendix B to indicate that the analysis required by this subsection has been completed .

The proposed program does not duplicate a program at FAMU or FIU.

The proposed program does not duplicate any program at FAMU or FIU.

By creating a diverse, robust educational and interdisciplinary area of excellence our goal is to support an exceptional academic environment where students, faculty, and staff members with diverse experiences and backgrounds can achieve their goals.

Plant Breeders at UF are already contributing to UF's diversity goal: as of June 2018, there were 43% women and 8% Hispanic/Latino studying plant breeding through graduate programs within the four UF departments. Faculty have and will continue to attract students from around the world, supporting the global impact of our plant breeding programs and highlighting the potential to become a global leader in plant breeding given the diversity of crops in Florida.

To help ensure racial and ethnic diversity inclusion and equity we intend to actively work on recruiting efforts with several UF offices including the recently created position of Chief Diversity Officer, the Office of Graduate Diversity Initiatives (OGDI) and the Office of Graduate International Outreach (OGIO). These collaborations will include participating in graduate recruitment fairs; partnering with foundations, community and student support organizations; providing scholarships and assistantships for underrepresented students; and providing students with opportunities to participate in retention and professional development workshops.

We will also leverage resources and make use of opportunities focused on international outreach and student success offered by the OGIO. With Florida's geographical location, Latin America has been identified as a target for OGIO's recruitment efforts, through the formation of agreements with sponsoring agencies to enroll Latin American graduate students with government funding. We also hope to further increase female enrollment in this important STEM discipline. Our faculty have served as advisors to the UF Plant Science Council, where women have served as presidents, vice-presidents and other leadership roles. Besides their annual spring workshop, professional development activities and discussions, they recently organized a Women in STEM discussion panel that highlighted the experiences of women working in the plant sciences.

III. Budget

A. Use Table 2 in Appendix A to display projected costs and associated funding sources for Year 1 and Year 5 of program operation. Use Table 3 in Appendix A to show how existing Education & General funds will be shifted to support the new program in Year 1. In narrative form, summarize the contents of both tables, identifying the source of both current and new resources to be devoted to the proposed program. (Data for Year 1 and Year 5 reflect snapshots in time rather than cumulative costs.)

The University of Florida is one of the most active and innovative land-grant universities in plant breeding and cultivar licensing in the country. The university employs 27 plant breeding faculty in four academic departments (Agronomy, Horticultural Sciences, Environmental Horticulture, and the SFRC) who are breeding 50 different plant species. Faculty within these departments contribute to the three-fold land grant mission of teaching, research and extension within the Institute of Food and Agricultural Sciences (IFAS), as well as academic units within the College of Agricultural and Life Sciences (CALS) at the University of Florida.

The primary costs of the Ph.D. program will be faculty and staff salaries and benefits. The faculty reallocated E&G is calculated based upon 1% of teaching of all teaching faculty salaries/benefits funded through E&G. As a result of UF's preeminence faculty hiring efforts, we expect that at least one tenure track faculty member will be hired in the next five years and housed in either HOS, ENH, SFRC, or Agronomy. This person will be expected to contribute to our new graduate teaching and advising efforts. We expect that by Year 5, this new faculty member "New Hire 1" will contribute 0.13 FTE toward the new plant breeding program. The faculty continuing E&G in Year 5 represents a cumulative value across all plant breeding teaching faculty contributing to the new program.

We also anticipate hiring an academic advisor to work half-time. This position is needed to coordinate all academic (recruitment, advising, course scheduling, among others) and administrative activities associated with successfully managing this new graduate program. The A&P continuing E&G in Year 5 represents the half-time salary and benefits for the academic advisor.

Additional funds are available to support the proposed program through the Plant Breeding Graduate Initiative (PBGI). This initiative represents an annual funding opportunity provided by UF/IFAS Research and the Florida Foundation Seed Producers, a Direct Support Organization (DSO) that supports the plant breeding research programs. UF/IFAS Research currently provides $60,000 per cohort per year, which is matched with $60,000 from the plant breeders and provides three new graduate student assistantships each year. We are predicting that with the anticipated success of the program, the plant breeders will expand their support by Year 5 for a total of $90,000 per cohort year. Furthermore, we anticipate that the program will obtain support for one new Graduate Student Funding Award from the UF Graduate School in each of the first five years.

In the last 10 years, the 27 plant breeding faculty have secured approximately $81 million in federal and private funding. As the program grows in the number of students, we project an increase in the allocation of C&G funds

secured by the plant breeders and used to support the enrollment growth.

As shown in Tables 2 and 3, the funding for the program will primarily come from the reallocation of existing resources. Our estimates are conservative. We assumed a total increase in faculty and staff salaries and benefits of only three percent over the next five years. We assumed zero increase in state operating funds over the five-year period. Based on projected enrollment trends (Table 1-B), the E&G cost per student FTE decreases from $34,763 in Year 1 to $18,823 in Year 5. Total projected E&G costs for Year 1 are $121,672 and for Year 5 are $268,222. The visibility provided by the graduate program will also increase UF/IFAS chances to obtain industry support targeting education of new plant breeders.

B. Please explain whether the university intends to operate the program through continuing education on a cost-recovery basis, seek approval for market tuition rate, or establish differentiated graduate-level tuition. Provide a rationale for doing so and a timeline for seeking Board of Governors' approval, if appropriate. Please include the expected rate of tuition that the university plans to charge for this program and use this amount when calculating cost entries in Table 2.

We do not intend to operate the program through continuing education on a cost-recovery basis, seek approval for market tuition rate, or establish differentiated graduate-level tuition. The expected rate of tuition and fees will be based on the University's standard costs and projected estimates, which is $528.69 per credit hour for the 2019-2020 academic year for Florida residents.

C. If other programs will be impacted by a reallocation of resources for the proposed program, identify the program and provide a justification for reallocating resources. Specifically address the potential negative impacts that implementation of the proposed program will have on related undergraduate programs (i.e., shift in faculty effort, reallocation of instructional resources, reduced enrollment rates, greater use of adjunct faculty and teaching assistants). Explain what steps will be taken to mitigate any such impacts. Also, discuss the potential positive impacts that the proposed program might have on related undergraduate programs (i.e., increased undergraduate research opportunities, improved quality of instruction associated with cutting-edge research, improved labs and library resources).

We anticipate that the Ph.D. program will have no negative impacts on existing undergraduate or graduate programs but will rather have a variety of positive impacts across all the departments involved. Students will not be allowed to transfer from current departmental Ph.D. degrees into the plant breeding Ph.D. program for the first five years, thus ensuring the new program will avoid any potential negative impact on existing programs due to migration of current Ph.D. students. This program will create a curriculum that can be advertised and promoted. With this increased visibility, we expect more support and recognition from the industry and funding agencies. We envision this new graduate program to have a global reach and thus competing with other national and international plant breeding universities for top students while avoiding competition within and among other CALS graduate programs. This will also provide an opportunity for our best undergraduate students to pursue graduate studies at UF instead of enrolling in other universities.

This program is expected to recruit top students with interest in plant breeding (maximum of 5 students per year in the first cycle). This net increase in CALS students will increase the number of students taking graduate classes already offered by plant breeders and other faculty within each department. This program, with current support of the Plant Breeders Working Group (PBWG) and UF/IFAS Research via the Plant Breeding Graduate Initiative, will ensure graduate assistantships for 3-4 students annually, therefore achieving more than 60-80% of the recruitment goal through internal scholarships, while the remaining support will be covered by individual plant breeding programs at UF.

UF/IFAS plant breeders are housed in different departments and different research and education centers across the state. This interdisciplinary program will unify faculty working in breeding and formalize an educational program that is currently underway. The Ph.D. program will increase strong, collaborative research teams involving multiple faculty, Ph.D. students, master's students, and undergraduates. Thus, undergraduate involvement in these teams will prepare them for research careers and graduate programs in related fields. The interdisciplinary nature of the program will provide opportunities for undergraduates to perform high quality research under the mentoring of graduate students.

Because the curriculum of the program relies on current coursework being taught in the involved departments, most faculty will not see a change in their responsibilities, or their time assigned to the new program. In the meanwhile, the department may see an increase in Ph.D. students taking these courses in a regular basis. The proposed program attempts to minimize the effects of the reallocation of teaching resources by re-allocating only 1% per teaching faculty FTE to the new program. A few members of the faculty will be devoting more time and energy to the graduate program because of the need to lead the new program. However, a rotational leadership is proposed, which will minimize the time faculty devote to the program in the long-term.

We do not anticipate the use of adjunct faculty or additional funding for doctoral students to provide teaching assistance. Our doctoral students will be well-prepared to teach undergraduate courses under the supervision of an experienced faculty member, assuring quality educational delivery to undergraduates. This doctoral program, based on advanced methods of plant breeding with an interdisciplinary focus, will generate knowledge for new courses and content in the undergraduate programs across CALS, enriching the current offerings and providing the most current and relevant information for research careers.

Once the program is established and recognized, the possibility of creating a certificate with a strong distance education focus will be evaluated. This certificate program will target a different and complementary population not covered by the Ph.D. graduate program, primarily industry breeders seeking continuing education. In the future, we expect it will bring off-book revenues for CALS and the departments. Finally, the new doctoral program will be positioned to attract additional funding and resources, both internally and externally, which will have broad benefits for all aspects of the program.

D. Describe other potential impacts on related programs or departments (e.g., increased need for general education or common prerequisite courses, or increased need for required or elective courses outside of the proposed major).

Given the distinctive nature of this doctoral degree program, we anticipate primarily positive effects to related programs and departments. Most of the courses in the proposed curriculum currently exist and are service courses for numerous graduate programs in the biological sciences. Consequently, they will not be impacted by the additional student numbers generated after the program is approved. This program will create a curriculum that can be advertised and promoted. With this increased visibility, we expect more support and recognition from the industry and funding agencies. The newly created program will invest in recruiting top students interested in plant breeding. The recruitment investment as well as the establishment of this new program will attract more students to consider the plant breeding programs in CALS and also other graduate programs in CALS.

We expect that this effort will increase the net number of applicants to CALS. The program will only accept a maximum of 5 students each year in the first five cycles, which should in turn result in other top applicants being re-directed to the departmental graduate programs. We have seen this kind of cross-departmental benefit from the recruiting efforts of the PMCB graduate program in the past.

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We conducted a survey of all plant breeding faculty in each of the four departments to determine how many of their alumni graduated with a focus on plant breeding since the beginning of their careers at UF. The results showed that, out of a total of 241 graduate students under the supervision of plant breeders, 113 students (46%) completed programs focused on plant breeding. The other 128 students (54%) focused on other traditional areas of specialization in their respective departments such as agronomy, horticulture, floriculture, pest management, plant physiology, nutrition, weed science, plant management, crop production, molecular and cellular biology and landscape management. This demonstrates that the 27 plant breeding faculty are not exclusively focused on preparing students as plant breeders, and their departments will not be negatively affected by the creation of this degree program.

E. Describe what steps have been taken to obtain information regarding resources (financial and in-kind) available outside the institution (businesses, industrial organizations, governmental entities, etc.). Describe the external resources that appear to be available to support the proposed program.

Initially the program will be internally funded through royalty proceeds from plant breeding faculty via the UF/IFAS Plant Breeders Working Group (PBWG) and PBGI. However, as soon as the program is approved, we are strongly committed to identifying sources of extramural funding, a crucial element required to support graduate student research and competitive assistantships that will attract and retain outstanding students. The plant breeders are actively engaged in grantsmanship and have had success securing funding from both public and private sources. The list of federal funding agencies includes the National Science Foundation (NSF), US Department of Energy (DOE) and US Department of Agriculture – National Institute of Food and Agriculture (USDA-NIFA), while the list of private institutions includes many of the main breeding companies in several different crops.

We have conducted a survey with all UF plant breeders to estimate the amount of plant breeding related external support that they have received in the last 10 years (both public and private). The average total support comes to $3

million per breeder. In addition, we have spoken with industry representatives from different crops important for the state's agriculture. While no funding is currently committed at this stage, we have obtained several letters of support indicating significant interest in maintaining the collaboration with UF and in the creation of the program. Furthermore, the Plant Breeders Working Group has recently initiated, with the support of UF/IFAS Advancement, a campaign to communicate the impact that UF plant breeding has had for Florida and the world. We expect that this campaign will lead to private giving, which could in part be directed to support plant breeding students. Finally, the PBWG and UF/IFAS Research have established an initiative to continually fund students studying plant breeding. The Plant Breeding Graduate Initiative annually funds 3-4 graduate assistantships. The number of funded assistantships is expected to increase in the future.

The breeders have also identified additional federal programs to which we could apply for support of our plant breeding graduate program:

- Global Partnership Initiative for Plant Breeding Capacity Building (http://km.fao.org/gipb/)
- USDA-CSREES Agriculture and Food Research Initiative (http://www.csrees.usda.gov/fo/agriculturalandfoodresearchinitiativeafri.cfm)
- USDA-CSREES National Vegetable Crop Initiative (http://www.csrees.usda.gov/newsroom/newsletters/update08/042308.html)
- USDA-NIFA Food and Agricultural Sciences National Needs Graduate and Postgraduate Fellowship (NNF) Grants Program

  (https://www.nifa.usda.gov/funding-opportunity/food-and-agricultural-sciences-national-needs-graduate-and-postgraduate)

IV. Projected Benefit of the Program to the University, Local Community, and State

Use information from Tables 1 and 2 in Appendix A, and the supporting narrative for "Need and Demand" to prepare a concise statement that describes the projected benefit to the university, local community, and the state if the program is implemented. The projected benefits can be both quantitative and qualitative in nature, but there needs to be a clear distinction made between the two in the narrative.

A cross-departmental, interdisciplinary Ph.D. program in Plant Breeding will benefit the University of Florida and the SUS as it will support their missions by providing premier graduate education and increasing scholarship, research, and innovation. Specifically, the program supports the SUS 2025 Strategic Plan by increasing research activity and the number of graduates with interdisciplinary STEM education and credentials, expanding commercialization activities that will attract more research funding from federal and private sources, and promoting more collaboration with the private industry sectors. There is no such program in the state, thus this could be added to the list of specializations that the state and UF will be providing. This new degree will create a framework and administrative structure to leverage resources, faculty, courses, and student recruitment, which we expect will attract more federal and private funding.

The contribution that plant breeding has brought to local communities has been very evident in Florida. In 2019, 90% of the strawberry acreage and 100% of the blueberry acreage in Florida is occupied by UF-bred varieties. It was only in the last decade that Florida became a leader in blueberry production, in part because the UF/IFAS blueberry breeding program developed new varieties well adapted to Florida. We aim to build from these proven successes by continuing to grow current industries and creating new agricultural commodities in Florida.

Currently, plant breeders continue working at the community level to understand and solve the challenges of our stakeholders through better varieties. This results in producer profitability and industry sustainability. These industries in turn support other aspects of the local economy including packaging, food processing, transportation and finance.

Our proposed degree program will enrich UF's land-grant core mission by being among the top plant breeding programs in the nation and the world. Other benefits include the following:

Quantitative:

- Increasing the number of highly qualified graduate students to align UF with other peer APLU land-grant universities by addressing local, state, and national needs and demands in plant breeding.
- Increasing the cultural, ethnic, gender, socio-economic and international diversity of students, especially those under-represented in STEM discipline (i.e. women, African Americans, etc.) to reflect the breadth of thought essential for state, national, and world preeminence.
- Increasing the number of high-impact scholarly publications and creative works generated.
- Attracting more federal and private graduate funding, grants for student research programs, and increasing graduate student mentored undergraduate research.
- Increasing private and public funding from UF intellectual property, endowments, and federal sources.
- Boosting intellectual property income and the number of commercial products developed by plant breeders, which will have a local and statewide economic impact and generate employment opportunities.

Qualitative:

- Fostering the development of the "talent pipeline" that must exist to create the multi-disciplinary expertise needed to build the knowledge and innovation economy envisioned by the Florida Board of Governors.
- Increasing the visibility of faculty will increase their national and international leadership and recognition, expanding UF's competitive advantage for extramural funding and standing among AAU universities, particularly among those with similar programs.
- Augmenting the numbers of successful and proud UF alumni donating to endowments, offering internships and employment opportunities, and engaging in student recruitment.
- Developing the knowledge base needed to create improved policies and transformative programs that benefit plant breeding stakeholders in an increasingly dynamic and global society and economy.
- Providing expert professional leadership and capacity in the public, private, and nonprofit sectors to address critical problems and needs of local stakeholders.

V. Access and Articulation – Bachelor's Degrees Only

A. If the total number of credit hours to earn a degree exceeds 120, provide a justification for an exception to the policy of a 120 maximum and submit a separate request to the Board of Governors for an exception along with notification of the program's approval. (See criteria in Board of Governors Regulation 6C-8.014)

Not applicable.

B. List program prerequisites and provide assurance that they are the same as the approved common prerequisites for other such degree programs within the SUS (see link to the Common Prerequisite Manual on the resource page for new program proposal). The courses in the Common Prerequisite Counseling Manual are intended to be those that are required of both native and transfer students prior to entrance to the major program, not simply lower-level courses that are required prior to graduation. The common prerequisites and substitute courses are mandatory for all institution programs listed, and must be approved by the Articulation Coordinating Committee (ACC). This requirement includes those programs designated as "limited access."

If the proposed prerequisites are not listed in the Manual, provide a rationale for a request for exception to the policy of common prerequisites. NOTE: Typically, all lower-division courses required for admission into the major will be considered prerequisites. The curriculum can require lower-division courses that are not prerequisites for admission into the major, as long as those courses are built into the curriculum for the upper-level 60 credit hours. If there are already common prerequisites for other degree programs with the same proposed CIP, every effort must be made to utilize the previously approved prerequisites instead of recommending an additional "track" of prerequisites for that CIP. Additional tracks may not be approved by the ACC, thereby holding up the full approval of the degree program. Programs will not be entered into the State University System Inventory until any exceptions to the approved common prerequisites are approved by the ACC.

Not applicable.

C. If the university intends to seek formal Limited Access status for the proposed program, provide a rationale that includes an analysis of diversity issues with respect to such a designation. Explain how the university will ensure that Florida College System transfer students are not disadvantaged by the Limited Access status. NOTE: The policy and criteria for Limited Access are identified in Board of Governors Regulation 6C-8.013. Submit the Limited Access Program Request form along with this document.

Not applicable.

D. If the proposed program is an AS-to-BS capstone, ensure that it adheres to the guidelines approved by the Articulation Coordinating Committee for such programs, as set forth in Rule 6A-10.024 (see link to the Statewide Articulation Manual on the resource page for new program proposal). List the prerequisites, if any, including the specific AS degrees which may transfer into the program.

Not applicable.

Institutional Readiness

VI. Related Institutional Mission and Strength

A. Describe how the goals of the proposed program relate to the institutional mission statement as contained in the SUS Strategic Plan and the University Strategic Plan (see link to the SUS Strategic Plan on the resource page for new program proposal).

The SUS Strategic Plan has set goals to increase the number of graduates with degrees in STEM fields. More specifically, the UF Strategic Plan listed Biological Sciences as an area of emphasis. Plant Breeding is an integrative science that requires knowledge of biology, genetics, chemistry, statistics, and computer science. Additionally, it draws support from many STEM disciplines within CALS including Agronomy, Horticultural Science, Plant Pathology, Entomology & Nematology, Forestry, Biology, Genetics, Plant Molecular & Cellular Biology, and Applied Statistics. Well educated plant breeders must be able to draw on information and expertise in these fields and incorporate the art of selection for desirable attributes in the final product of released varieties.

As indicated in sections above, national and international groups have recognized that prior investments in preparation of plant breeders in the 1970s and 1980s are being lost to retirement and program closures. The University of Florida is unique in having a diversity of plant breeding research programs focused on specialty horticultural, ornamental, and unique agronomic and forage crops. With this focus, a UF degree in plant breeding is well positioned to fill the need for plant breeders with diverse experiences that few, if any, other institutions can accomplish. The abundance of resources available for graduate students at UF provides an exceptionally wide spectrum of research opportunities that are not available at typical mid-western land-grant institutions that are narrowly focused on two or three major cereal crops.

In addition to adding a relevant and valuable STEM graduate program that supports one of the major agricultural sectors in the state of Florida, this program will help meet SUS metrics such as higher numbers of graduate degrees in STEM, and an increase in the number of patents, licenses and options executed. These increases will result from UF/IFAS plant breeding programs' development of plant cultivars that are patented and/or licensed to be grown over thousands of acres which return royalties to the UF/IFAS system in support of the research and education programs.

B. Describe how the proposed program specifically relates to existing institutional strengths, such as programs of emphasis, other academic programs, and/or institutes and centers.

The new interdisciplinary program will take advantage of existing institutional strengths by building upon the robust group of plant breeding research programs currently ongoing at UF, and by coordination across a wide array of academic courses in plant breeding and genetics, and support disciplines that are already in place but are scattered across a number of academic units. This new interdisciplinary program will help to focus faculty around a common core of academic work and strengthen our ability to recruit the best students into our program. The vitality of the current faculty is indicated by a steady climb in royalty income generated by released UF/IFAS cultivars, which approached $15 million in 2018. The UF/IFAS Plant Breeders Working Group has committed part of these resources to support this graduate program.

The faculty involved in the proposed interdisciplinary plant breeding program are from diverse backgrounds, and most have contributed their expertise in plant breeding through leadership roles in professional societies, including service as editors of major refereed journals in the field. These faculty associated with the plant breeding program are nationally and internationally recognized, and have an impressive list of achievements and awards, including presidents and fellows of the Crop Science Society of America, the American Society of Horticultural Science, and the National Association of Plant Breeders. In addition, plant breeding faculty at UF have a rich history of educating students who become well positioned in academia and private industry sectors. These practicing professionals will be an excellent resource for recruitment of new students.

C. Provide a narrative of the planning process leading up to submission of this proposal. Include a chronology in table format of the activities, listing both university personnel directly involved and external individuals who participated in planning. Provide a timetable of events necessary for the implementation of the proposed program.

Previous internal reviews of four UF/IFAS departments of Agronomy, Horticultural Sciences, Environmental Horticulture and School of Forest Resources and Conservation have recognized that plant breeding and genetics faculty were strengths of these units but have pointed out that programs were fragmented and sometimes lacked focused interaction with other departments.

The UF/IFAS Plant Breeders Working Group (PBWG) has met annually since the early-1990s to discuss and review issues relevant to cultivar development, and matters concerning educating graduate students in plant breeding. At the 2007 PBWG annual meeting a committee was organized to begin the process of consideration of an interdepartmental graduate program. At that time the planning committee consisted of Drs. Dave Clark and Maria Gallo as co-chairs, Barry Tillman, Eilene Kabelka, Kevin Kenworthy, and Ken Quesenberry. A draft proposal was developed in 2009, but it was never formally submitted due to changes in requirements and committee members.

committee members.

Considering the increasing demand for plant breeders and their roles in addressing future societal challenges, the interdisciplinary graduate program was added as one of the goals in the 2016-2019 Plant Breeders Working Group strategic plan. Our vision is to be a global leader in plant breeding education, research and germplasm/cultivar development and our mission is to ensure the viability of agriculture through exceptional plant breeding programs. One of the strategic goals is solely dedicated to establishing a graduate degree program in plant breeding. The expected key outcomes are to increase enrollment of high quality domestic and international graduate students and improve program visibility by delivering next generation breeders to institutions and key agricultural companies.

Several action steps were defined as a measure of success for this strategic goal. These included: (i) identify core plant breeding competencies, using the previously proposed curriculum as a resource; (ii) identify and hire a staff member to shepherd the proposed degree program to final approval; (iii) develop and submit the degree program proposal to CALS and university curriculum committees; and (iv) implement a new Ph.D. graduate program.

In January 2018, Ms. Eliana Kampf was hired as a graduate program coordinator. A Plant Breeding Committee (PBC) consisting of Dr. Patricio Munoz, Dr. Marcio Resende, and Ms. Eliana Kampf, under the supervision of the PBWG Executive Committee, initiated the development of the pre-proposal. The PBC conducted surveys of current students, alumni, industry, and other universities. The PBC also met with the CALS dean and UF/IFAS Research dean several times during Spring and Summer 2018. These leaders in agricultural teaching and research were very supportive of this initiative and have assisted immensely with documentation and with proposal development. The PBC also met with faculty from the UF/IFAS Department of Family, Youth and Community Sciences to gain insights from their pre-proposal development process (their Ph.D. degree program in Youth Development and Family Science was approved in 2017).

In August 15, 2018 the first draft of the pre-proposal was reviewed by PBWG members during the 2018 UF/IFAS Plant Breeders Working Group Annual Meeting and further developed during Fall 2018. During Fall 2018 the PBC and the PBWG executive committee met with the chairs of the four departments involved, and all chairs fully supported the creation of a plant breeding degree. The pre-proposal was signed by Dr. Rob Gilbert (Agronomy Chair), Dr. Red Baker (School of Forest Resources and Conservation Director), Dr. Chris Chase (Horticultural Sciences Interim Chair) and Dr. Dean Kopsell (Environmental Horticulture Chair) and in November 2018 it was reviewed by Dr. Turner (CALS Dean).

The pre-proposal was then sent to the Provost's Office and in December 2018, the pre-proposal was endorsed by Dr. Chris J. Hass, Associate Provost for Academic and Faculty Affairs, who praised the group for a "well-written, substantive and enticing pre-proposal." In February 2019 the pre-proposal was approved by the Council of Academic Vice Presidents (CAVP) Academic Program Coordination review group with no concerns.

Planning Process

Date	Participants	Planning Activity
2007	Plant Breeding Working Group Annual Meeting members	Committee formed for pr development
2008	Drs. Dave Clark and Maria Gallo as co-chairs, Barry Tillman, Eilene Kabelka, Kevin Kenworthy, and Ken Quesenberry	Proposal development
Fall 2008	Dr. Kirby Barrick, Dean of the College of Agricultural and Life Sciences and Dr. Mark McLellan Dean for Research and Director Florida Agricultural Experiment Station	Review of proposal draft
2016	PBWG	2016-2019 PBWG Strate created
Jan. 2018	PBWG Executive Committee	Plant Breeding Graduate coordinator hired
Spring and Summer 2018	Dr. Patricio Munoz, Dr. Marcio Resende, and Ms. Eliana Kampf	Development of a new pr proposal following the 2(streamlined guidelines
Spring and Summer 2018	Dr. Elaine Turner, College of Agricultural and Life Sciences (CALS) dean and Dr. Jackie Burns, UF/IFAS Research dean	Review of pre-proposal a suggested revisions
Summer 2018	Drs. Rob Gilbert (Agronomy), Red Baker (SFRC), Chris Chase (Horticultural Sciences), Dean Kopsell (Environmental Horticulture)	Pre-proposal presentatior chairs of these 4 departm
Fall 2018	Drs. Rob Gilbert (Agronomy), Red Baker (SFRC), Chris Chase (Horticultural Sciences), Dean Kopsell (Environmental Horticulture)	Pre-proposal signed by cl these 4 departments
Nov. 2018	Dr. Turner, CALS Dean	Pre-proposal final review
Dec. 2018	Dr. Chris J. Hass, Associate Provost for Academic Affairs	Pre-proposal review
Feb. 2019	Council of Academic Vice Presidents (CAVP) Academic Program Coordination review group	Pre-proposal approval (n concerns)

In Spring-Fall 2019 the PBC, with the support of the PBWG Executive Committee, worked toward this full proposal. In November 2019 this full proposal was presented to the PBWG Executive Committee for review and then to the CALS Dean's Office for review. The full proposal was submitted to the CALS Curriculum Committee in November 2019, which approved our proposal pending few changes. These changes have been fully addressed and incorporated to this present proposal version.

Timeline of Events Leading to Implementation

Date	Implementation Activity
Nov. 2018	Pre-proposal vetted by Dr. Turner, CALS Dean
Dec. 2018	Pre-proposal approved by Associate Provost for Academic Affairs
Feb. 2019	Pre-proposal approved by Council of Academic Vice Presidents (CAVP) Academic Program Coordination review group with no major concerns.
Nov. 2019	Full Proposal submitted to CALS Curriculum Committee
Spring 2020	UF Graduate School Technical review
Spring 2020	Graduate Council Review and Discussion
Spring 2020	Graduate Council approval
Spring/Summer 2020	University Curriculum Committee Information Item
Spring/Summer 2020	Faculty Senate Steering Committee approval
Spring/Summer 2020	Faculty Senate review and approval
Fall 2020	UF Academic Affairs Approval
Fall 2020	Board of Trustees review and approval
Spring 2021	Submission for February 2021 consideration by the Board of Governors
Fall 2021	Plant Breeding Ph.D. Program implementation

/II. Program Quality Indicators - Reviews and Accreditation

Identify program reviews, accreditation visits, or internal reviews for any university degree programs related to the proposed program, especially any within the same academic unit. List all recommendations and summarize the institution's progress in implementing the recommendations.

This section is based on the 2009-2016 State Board of Governors (BOG) Academic Program Reviews (conducted every 7 years) for plant breeding related Ph.D. degrees in three CALS departments, one school and one interdisciplinary program; respectively, the Agronomy (AGR), Horticultural Sciences (HOS), and Environmental Horticulture (ENH) Departments, the School of Forest Resources and Conservation (SFRC), and the Plant Molecular and Cellular Biology (PMCB) Graduate Program.

Previous reviews of these four UF/IFAS units (AGR, HOS, ENH and SFRC) have recognized that plant breeding and genetics faculty were strengths of these units but pointed out that programs were fragmented and sometime lacked focused interaction with other departments. Despite being the largest land-grant university without a formal plant breeding graduate program, UF/IFAS has the largest number of plant breeding faculty of any university in the nation, we have one of the largest cultivar development programs, and we are one of the few universities working with specialty crops. The proposed interdisciplinary program will unify UF/IFAS faculty working in breeding and formalize a program that is already underway. This program will create a curriculum that can be advertised and promoted. The increased national and international visibility is expected to generate more support from industry and funding agencies and increase the number and quality of our graduate students.

Some of the departments have also indicated the need to recruit more highly qualified graduate students. For example, the SFRC Advisory Board conducted a full SWOT review and recommended focusing recruiting on quality and diversity of applicants, as part of making UF a "Top 10 University." HOS and ENH pointed out the steep competition for high caliber students from other peer universities. Likewise, PMCB has listed recruitment and securing enrollment of top graduate students among their top five impediments. The proposed program will invest in recruiting, enrolling and graduating highly competitive plant breeding graduate students. We expect that this effort will increase the net number of applicants to CALS. The recruitment investment will bring more students to consider not only plant breeding programs but also other departments and programs in CALS. The program will only accept 5-6 students per year in the first cycle, which should in turn result in other top applicants being re-directed to other UF departmental graduate programs. We have seen this kind of cross-departmental benefit from the recruiting efforts of the PMCB graduate program in the past. This increase in CALS students will also increase the number of students taking graduate classes already offered by plant breeders and other faculty within each department.

Another common issue identified by these departments is the limited funding for fellowships and assistantships to support graduate students. HOS and ENH pointed out that their graduate assistants are mainly supported by funding from individual faculty members' research programs, meaning that faculty with limited resources will be less active in graduate education. PMCB notes that limited internal funding to support a competitive stipend means

the best applicants frequently accept offers from competing universities that offer better benefits. The new plant breeding program, with current support of the Plant Breeders Workgroup (PBWG) and UF/IFAS Research via the Plant Breeding Graduate Initiative intends to address this limitation by providing funds to early career faculty who are still building their research programs. The PBGI will ensure assistantships for 3-4 students annually and thus more than 60-80% of the recruitment goal will be achieved with internal assistantships.

Agronomy's last external review in 2012 identified opportunities to more closely involve off-campus faculty in graduate education. HOS and ENH also pointed out in their 2015 BOG report that the lack of online/distance courses hinders the participation of off-campus faculty and students. The HOS graduate program has few online courses and even though some classes are available via video conferencing to students located in Research and Education Centers, further efforts are needed to offer courses via distance education. The Environmental Horticulture program also needs more online graduate level course offerings. SFRC plans to add graduate level courses to supplement all Ph.D. students' choice of courses and will increase their distance education portfolio in a strategic manner to support graduate education. SFRC faculty are spread throughout the state, limiting their collaboration. One of the goals in the 2016-2019 Plant Breeders Working Group Strategic Plan is to expand online instruction with credit-based courses, short courses, and webinars. This plan is currently being implemented and four out of the six proposed core courses will be available for online delivery in 2020. The proposed plant breeding program will improve efficiency of graduate education by unifying on-campus and off-campus faculty already working together in plant breeding and formalizing a program currently underway but with more emphasis in online delivery to further integrate off-campus faculty. Synergy and collaborative research and extension between the RECs and the main campus is an added strength.

The Department of Agronomy emphasizes that future research endeavors will be increasingly interdisciplinary, specifically requiring partnerships with statistics, food science, economics, environmental horticulture, environmental engineering, hydrology, agricultural engineering, and microbiology. SFRC also works with a diversity of departments around UF to identify appropriate courses for Ph.D. students to provide a high quality, holistic education. HOS, ENH and AGR take note of their critical mass of renowned plant breeders and geneticists specializing in field production of vegetables and fruit crops, forages, plant breeding, molecular genetics, crop physiology and management. Research programs are internationally recognized and are highly successful in securing national competitive funding and provide an excellent opportunity to educate students in crop breeding with the latest tools of the field. Another of the strengths of the new plant breeding degree program will be its interdisciplinary emphasis and ability to educate well rounded breeders that succeed in academia and industry. This will be achieved by focusing on traditional and advanced methods that will incorporate different disciplines and experts from the university.

The program will also continue to facilitate development of professional competencies among its students, developing the professional skills sought by industry and academia. For example, the Plant Breeders Working Group (PBWG) provides financial support of the Plant Science Council (PSC), a University of Florida graduate student organization for students involved in plant sciences (https://www.ufplants.org/). The PSC has held an annual symposium since 2017 with invited speakers from industry to boost professional development and engagement of graduate students with a broader audience.

Plant breeding faculty in the involved departments and units have excellent collaboration and on-going research projects with private industry. The impact of research discoveries linked to the proposed program will expand since between 30-70% of net royalties from licensed cultivars are returned to UF/IFAS plant breeding research programs. With a robust graduate program there are more opportunities for students to connect their research with producers and industry (R&D) and become the next face of innovation in plant breeding. Graduate students in this new program will have an opportunity to gain from a diverse array of research programs and the program's research expertise and student development will make our graduates highly competitive in the job market.

Once the program is established and recognized, the program will evaluate the possibility of creating a certificate with a strong distance education focus. This certificate program will target primarily industry breeders seeking continuing education, which is a different and complementary population not covered by a traditional Ph.D. graduate program. We expect it will bring off-book revenues as well as additional recognition for UF/IFAS and its departments.

VIII. Curriculum

A. Describe the specific expected student learning outcomes associated with the proposed program. If a bachelor's degree program, include a web link to the Academic Learning Compact or include the document itself as an appendix.

Student Learning Outcome (SLO) 1 Knowledge

Explain and apply fundamental theories and principles of plant breeding, genetics and genomics, plant biochemistry, plant transformation technologies and computational genetics.

Assessment Method:

- Evaluation of the student's program of study and completion of IDP (Individual Development Plan).
- Successful defense of qualifying exam by the end of the student's second year.
- Successful defense of dissertation approved by the supervisory committee using a faculty-developed rubric.

Targeted outcome: 90% of all students in the program to successfully pass and/or attain all these assessment milestones.

SLO 2 Knowledge

Apply genetic inheritance theory to crops of interest. Having an understanding of a targeted crops life cycle, mode of reproduction and trait inheritance will determine the best strategies for trait improvement.

Assessment Methods:

- Evaluation of the student's program of study and completion of IDP (Individual Development Plan).
- Successful defense of qualifying exam by the end of the student's second year.
- Successful defense of dissertation recognized by the supervisory committee using a faculty-developed rubric.

Targeted outcome: 90% of all students in the program to successfully pass and/or attain all these assessment milestones.

SLO 3 Skills

Use critical thinking to review scientific literature, evaluate, plan, analyze, and design experiments related to plant breeding and cultivar development.

Assessment Methods:

- Preparation of one or more manuscripts judged ready for publication in peer-refereed research journals, at professional conferences, and/or at industry field days.
- Successful defense of dissertation recognized by the supervisory committee using a faculty-developed rubric.

Targeted outcome: 90% of the students will meet these criteria.

SLO 4 Skills

Communicate effectively and clearly in written and oral form plant breeding ideas, technical data and design information to students, scientists, and the public.

Assessment Methods:

- Number of students giving oral and poster talks at state, national and international scientific meetings.
- Written and oral presentations required for advancement to Ph.D. candidacy
- First author publications and publications co-authored with advisors and/or collaborators.
- Annual written evaluations by advisor and supervisory committee

Target Outcome: 90% of the students will meet these criteria.

SLO 5 Skills

Prepare and complete plant breeding research of sufficient quality to be published in peer reviewed journals, at professional conferences, and/or at industry field days.

Assessment Methods:

- One or more manuscripts ready for submission in peer-refereed research journals, at professional conferences, and/or at industry field days.

Target Outcome: 90% of the students will meet these criteria.

SLO 6 Professional Behavior

Students will interact with peers, faculty, and staff with honesty, respect, ethical behavior, cultural sensitivity, fellowship and cooperation.

Assessment Methods:

- Consistent adherence during the degree program to the University of Florida's Honor Code (evidenced by student permanent file).
- Observations and feedback by faculty advisor and supervisory committee during class activities, seminars, research work, dissertation defense and participation in the faculty's department seminar program and professional societies.
- Annual written evaluations by advisor and supervisory committee
- Completion of IDP (Individual Development Plan)

Targeted Outcome: 90% of active students will have no additions to their permanent file indicating concern with this SLO.

B. Describe the admission standards and graduation requirements for the program.

Admission will require a recognized baccalaureate or graduate degree from a regionally accredited U.S. institution or a comparable degree from an international institution. The process will consider the verbal and quantitative GRE scores and a minimum undergraduate GPA for students without an M.S. degree. Additional requirements include a minimum of three letters of reference, a statement of purpose, and a resume, which the plant breeding admissions committee will use to assess the student's qualifications for admission to the program and potential for research scholarship. International students must comply with current UF standards for admission to the Graduate School, including requirements for English language competency and financial responsibility.

Applicants should have a B.S. or M.S. in agricultural, horticultural, forestry, biological or chemical sciences with desirable advanced undergraduate coursework in genetics, statistics, plant breeding, and biochemistry. However, outstanding students from a broad range of science and engineering disciplines will be considered. Prior completion of a master's degree from a regionally accredited institution or international equivalent is desirable, preferably in a field of study that provides the student with a solid grounding in the scientific method and plant sciences.

The plant breeding doctoral degree requires a minimum of 90 credit hours beyond a bachelor's degree and includes required courses, elective courses and dissertation research. To graduate in the program, students are required to have a minimum of 40 credits of coursework toward their major. All students are required to take 20 credits from required courses (listed in VIII section C Table 1) and choose a minimum of 20 additional credits from the list of elective courses (listed in VIII section C Table 2) or as determined by the supervisory committee.

The curriculum was designed to provide the student with a strong background in the scientific method, data collection and analysis of data during the first semester, and plant breeding during the second semester. This ensures that students will be prepared to take specialized courses and have the ability to formulate their dissertation studies.

Doctoral students must complete an Individual Development Plan (IDP), conduct independent research satisfactorily and maintain a 3.0 GPA. Students must establish a supervisory committee by the end of the first year, comprised of at least three plant breeding faculty members, including the chair, and one external faculty member. Written and oral qualifying exams are required for all candidates for a Ph.D. degree. It is recommended that the qualifying exams will be completed by the end of the second year. Successful completion of the qualifying exams will be determined by the student's supervisory committee, as each student and exam will be unique. The student is considered to have satisfactorily passed the qualifying exam when the decision of the supervisory committee is unanimously affirmed. If the examination is unsatisfactory, the supervisory committee may permit a second examination or deny the student from continuing in the program.

For completion of their degree, all doctoral students must have at least one first author publication submitted to a peer-reviewed journal in their research field before graduation; students will be strongly encouraged to publish before graduating. This requirement may be waived under extenuating circumstances, as approved by the supervisory committee and the program's leadership (graduate coordinator and/or director). Students are required to participate every year in the Plant Breeders Working Group annual meetings.

Doctoral students should also pass a final examination, administered by the student's supervisory committee. The examination format is at the discretion of the supervisory committee and consistent with the UF Graduate School policies. The graduate supervisory committee will assess the written dissertation and will examine the student's overall comprehension and knowledge in a final defense of the dissertation.

C. Describe the curricular framework for the proposed program, including number of credit hours and composition of required core courses, restricted electives, unrestricted electives, thesis requirements, and dissertation requirements. Identify the total numbers of semester credit hours for the degree.

The Plant Breeding Ph.D. degree will require a minimum of 90 post-baccalaureate credit hours and will include required courses, elective courses and dissertation research. To graduate in the program, students are required to have a minimum of 40 credits of coursework toward their major. All students are required to take 20 credits from required courses (Table 1) and choose a minimum of 20 additional credits from the list of elective courses (Table 2) or as determined by the supervisory committee. Students admitted with a M.S. degree may transfer up to 30 credits toward their elective courses requirement from a regionally accredited institution or international equivalent, subject to existing UF Graduate School policies.

The required courses STA 6093 Introduction to Applied Statistics for Agricultural and Life Sciences (3 credits), AGR 5266C Field Plot Techniques (3 credits), AGR 5321C Genetic Improvement of Plants (3 credits) and HOS 6XXX2 Survey of Breeding Tools & Methods (3 credits) must be taken during the first fall and spring semesters. AGR6325L Plant Breeding Techniques (1 credit) and PCB 6555 Introduction to Quantitative Genetics (3 credits).

also required courses for the major, can be taken anytime during the students' graduate studies. In addition, students are required to take four credits of HOS 6XXX[1]

Journal Colloquium, which can also be taken any fall or spring semester during the students' graduate studies. Students are required to maintain at least a B (3.00 truncated) in all required courses toward the major.

Furthermore, students must also chose a minimum of 20 additional credits from the list of elective courses provided in VIII section C Table 2. Students entering the doctoral program with a completed master's degree may transfer up to 30 hours of graduate credits toward their elective courses requirement from a regionally accredited institution or international equivalent, subject to existing UF Graduate School policies.
If similar level course(s) were taken prior to the doctoral degree, a petition must be submitted by the student's supervisory committee chair to exclude and/or replace specific courses. The petition needs to be approved by the program graduate coordinator and submitted to CALS and the Graduate School, when deemed necessary.

In summary, all students must take the 20 credits of required courses listed in Table 1 and choose a minimum of 20 additional credits from the list of elective courses listed in Table 2. The doctoral supervisory committee may determine additional elective courses according to the area of plant breeding specialization.

Table 1. List of required courses

Required Courses	**Credit H**
AGR 5266C Field Plot Techniques	
AGR 5321C Genetic Improvement of Plants	
AGR 6325L Plant Breeding Techniques *	
PCB 6555 Introduction to Quantitative Genetics **	
HOS 6XXX[1] Journal Colloquium ***	
HOS 6XXX[2] Survey of Breeding Tools & Methods	
STA 6093 Introduction to Applied Statistics for Agricultural and Life Sciences	
TOTAL	

* Students can take AGR 6325L any spring semester of odd years in coordination with their supervisory committee.
** Students can take PCB 6555 any fall semester of even years in coordination with their supervisory committee.
*** Students can take HOS 6XXX[1]

Journal Colloquium (1 credit) any fall and spring semester to be counted toward the total 4 credits required during their graduate studies.

Table 2. List of elective courses.

Elective Courses	**Credit H**
AGR 5307 Molecular Genetics for Crop Improvement	
AGR 6322 Advanced Plant Breeding	
AGR 6XXX Plant Chromosomes and Genomes	
AGR 5444 Ecophysiology of Crop Production	
BCH 5045 Graduate Survey of Biochemistry	
NEM 5004C Graduate Survey of Nematology	
ENY 5006 Graduate Survey of Entomology	
ENY 5006L Graduate Survey of Entomology Laboratory	
GMS 6231 Genomics and Bioinformatics	
HOS 5242 Genetic and Breeding of Vegetable Crops	
HOS 6201 Breeding Perennial Cultivars	
HOS 6236 Molecular Marker-Assisted Plant Breeding	
HOS 6932 Horticultural Physiology	
PCB 5065 Advanced Genetics	
PCB 5530 Plant Molecular Biology and Genomics	
PCB 6685 Population Genetics	
PLP 5005C General Plant Pathology	
PLP 6291 Plant Disease Diagnosis	

Please note that HOS 6XXX[1]

Journal Colloquium, HOS 6XXX

Survey of Breeding Tools & Methods and AGR 6XXX Plant Chromosomes and Genomes are currently offered as special topics courses in the Graduate Catalog but are expected to be approved by the Academic Approval Tracking System and have their own prefixes and course numbers assigned before the start of this new graduate degree program.

Dissertation Research	Credit ho
PLS 7979Advanced Research	va
PLS 7980 Doctoral Research	va

D. Provide a sequenced course of study for all majors, concentrations, or areas of emphasis within the proposed program.

Term	Course
Fall Year 1	STA 6093 Introduction to Applied Statistics for Agricultural and Life Science
	AGR 5266C Field Plot Techniques
	HOS 6XXX 1 Journal Colloquium
	PLS 7979 Advanced Research or Elective Courses
Spring Year 1	AGR 5321C Genetic Improvement of Plants
	HOS 6XXX 1 Journal Colloquium
	HOS 6XXX 2 Survey of Breeding Tools & Methods
	PLS 7979 Advanced Research or Elective Courses
Summer Year 1	PLS 7979 Advanced Research or Elective Courses
Fall Year 2	HOS 6XXX 1 Journal Colloquium
	PLS 7979 Advanced Research or Elective Courses
Spring Year 2	AGR 6325L Plant Breeding Techniques
	HOS 6XXX 1 Journal Colloquium
	PLS 7979 Advanced Research or Elective Courses
Summer Year 2	PLS 7979 Advanced Research or Elective Courses
Fall Year 3	PCB 6555 Introduction to Quantitative Genetics
	PLS 7980 Doctoral Research or Elective Courses
Spring Year 3	PLS 7980 Doctoral Research or Elective Courses
Summer Year 3	PLS 7980 Doctoral Research
Fall Year 4	PLS 7980 Doctoral Research
Spring Year 4	PLS 7980 Doctoral Research

Summer Year 4	PLS 7980 Doctoral Research	
		Overal

E. Provide a one- or two-sentence description of each required or elective course.

Required Courses :

AGR 5266C Field Plot Technique (3 credits, letter graded)
Techniques and procedures used in design and analysis of field plot, greenhouse, and laboratory research experiments. Application of research methodology, the analysis and interpretation of research results. Offered fall term. Prerequisite: STA3023.

AGR 5321C Genetic Improvement of Plants (3 credits, letter graded)
Genetic basis for crop improvement including methods for improving crop yield, pest resistance, and adaptability. Emphasis on manipulating genetic variability in self- and cross-pollinated annual and perennial crop plants. Offered fall term. Prerequisite: AGR 3303.

AGR 6325L Plant Breeding Techniques (1 credit, letter graded)
Examination of various breeding techniques used by agronomic and horticultural crop breeders in Florida. Field and lab visits to active plant breeding programs, with discussion led by a specific breeder each week. Hands-on experience in breeding programs. Offered spring term in odd-numbered years. Prerequisite: AGR 3303 or equivalent. Co-requisite: AGR 6322.

HOS **6XXX**
1

Journal Colloquium (1 credit, letter graded)
Course will focus on critical discussion and presentation of contemporary plant breeding topics. A forum for students to explore the role of research, research paradigms, critical issues, emerging events, and scholarly writings through interactions with speakers, faculty and each other. Offered spring and fall terms.

HOS **6XXX**
2

Survey of Breeding Tools & Methods (3 credits, letter graded)
A complete survey of methods and strategies commonly used in plant breeding and cultivar development. Course will cover, in a modular fashion, methodologies from traditional plant breeding methods to molecular methods. Lectures and/or hands-on activities will be taught by experts currently using these methods. Offered spring term. Prerequisite: AGR 5321 or equivalent.

PCB 6555 Introduction to Quantitative Genetics (3 credits, letter graded)
Intended for students of all disciplines who are interested in genetic principles and biometric evaluation of characters that exhibit continuous variation in natural populations or breeding programs. Prerequisite: STA 6166. Offered spring of odd years.

STA 6093 Introduction to Applied Statistics for Agricultural and Life Sciences (3 credits, letter graded)
Provides students with a conceptual and practical understanding of the application of statistics in the agricultural and life sciences. A combination of lectures, programming demonstrations, data exercises using the programming language R, group activities, and primary literature will be used.

Elective Courses:

AGR 5307 Molecular Genetics for Crop Improvement (3 credits, letter graded)
Lectures and laboratory demonstrations for a thorough understanding of concepts and applied aspects of plant molecular and cellular biology. Discussion of current research in plant biotechnology and functional genomics. Offered spring term. Prerequisite: AGR 3303.

AGR 6322 Advanced Plant Breeding (3 credits, letter graded)
Theory and use of biometrical genetic models for analytical evaluation of qualitative and quantitative characteristics, with procedures applicable to various types of plant species. Offered spring term in even-numbered years. Prerequisite: AGR 3303, AGR 4231, AGR 6311, and STA 6167.

AGR 6XXX Plant Chromosomes and Genomes (3 credits, letter graded)
This course is designed to introduce students to plant chromosome structures, inheritance, and the basic genomic tools to analyze plant genomes. Concepts to be introduced include plant DNA organization in chromosome structure, principles and technologies of cytogenetics, plant genomic DNA structure and function, transcriptome, DNA sequencing technologies/applications, basic tools for nucleotide sequence analysis, and plant genomic database exploring. Prerequisites AGR3303 Genetics or PCB 3063 Genetics

BCH 5045 Graduate Survey of Biochemistry (4 credits, letter graded)
Introduction to plant, animal, and microbial biochemistry for graduate students who have not had biochemistry. Integration and regulation of biochemical processes stressed; limited discussion of some biochemical techniques. Prerequisite: inorganic chemistry, organic chemistry, biology.

ENY 5006 Graduate Survey of Entomology (2 credits, letter graded)
Insect structure, function, development, classification, ecological niches, and control of those harmful to plants and animals. Corequisite: ENY 5006L.

ENY 5006L Graduate Survey of Entomology Laboratory (1 credit, letter graded)
Practical experience working with insects, using laboratory equipment, dissecting insects, and preparing laboratory reports. Collection required. Corequisite: ENY 5006.

GMS 6231 Genomics and Bioinformatics (3 credits, letter graded)
Principles of genomic characterization and bioinformatic analysis of eukaryotes. Prerequisite: STA 6166 and PCB 5065 or consent of instructor.

HOS 5242 Genetics and Breeding of Vegetable Crops (3 credits, letter graded)
Traditional and molecular breeding methods for vegetable crops and the influence of scientific research, government policies, and consumer preferences on vegetable crop improvement. Prerequisite: AGR 3303 or equivalent.

HOS 6201 Breeding Perennial Cultivars (3 credits, letter graded)
Methods of breeding perennial fruit and ornamental cultivars using mutations, cell and tissue culture, polyploidy, recurrent selection, and wide hybridization. Conservation and domestication of wild plants. Offered odd-numbered years in fall. Prerequisite: AGR 3303.

HOS 6236 Molecular Marker-Assisted Plant Breeding (3 credits, letter graded)
Providing an overview of terminology, methodology, and applied examples of utilizing molecular markers in a plant breeding program. Offered fall term of odd years. Prerequisite: STA 6093 and AGR 5321C or equivalents.

HOS 6932 Horticultural Physiology (3 credits, letter graded)
This advanced course covers basic concepts and processes of plant physiology, including water relations, nutrient absorption, photosynthesis, respiration, carbohydrate partitioning, nutrition, and hormones. In order to deliver meaningful mastery of these contents, this course utilizes a combination of lectures and active-learning activities.

NEM 5004C Graduate Survey of Nematology (3 credits, letter graded)
Morphology, anatomy, development, feeding habits, life cycles, disease cycles, and control of nematodes that parasitize plants and animals. Role of plant parasitic nematodes in disease complexes and as vectors of plant viruses. "Free-living" nematodes that inhabit oceans, fresh water, and soil.

PCB 5065 Advanced Genetics (4 credits, letter graded)
Examines genetic principles including gene and gene function; recombination and linkage; molecular markers, multipoint linkage analysis, and positional cloning; and quantitative, population, developmental, and non-Mendelian genetics. Offered in fall term. For graduate students in any life science discipline. Prerequisite: AGR 3303 or PCB 3063 and BCH 4024 or BCH 5045.

PCB 5530 Plant Molecular Biology and Genomics (3 credits, letter graded)
Integrated overview of the fundamental mechanisms enabling plant growth, development, and function, and approaches to study these at molecular level. Topics include replication, repair, transcription, translation, cell cycle, transformation, gene tagging, structural genomics, proteomics, and metabolomics. Offered in fall term.

PCB 6685 Population Genetics (4 credits, letter graded)
Provides a comprehensive introduction to the mathematical theory of allele and genotype frequency dynamics within and between populations and will serve as a springboard to more advanced topics in evolutionary biology. Topics covered include deterministic and stochastic processes in evolution and an introduction to classical quantitative genetics theory.

PLP 5005C General Plant Pathology (4 credits, letter graded)
Microorganisms and environmental factors that cause disease in plants. Symptoms and losses caused by plant diseases. Principles of plant disease development, diagnosis, and control. Genetics and epidemiology of plant diseases. Offered fall semester. **Prerequisite:** Course in biology or botany.

PLP 6291 Plant Disease Diagnosis (3 credits, letter graded)
Methods used in diagnosing plant diseases caused by fungi, bacteria, viruses, and abiotic conditions. Offered fall semester. Prerequisite: PLP 3002C/PLP 5005C, PLP 6262C.

Dissertation Research:

PLS 7979 Advanced Research (1-12 credits, S/U graded)
Research for doctoral students before admission to candidacy. Designed for students with a master's degree in the field of study or for students who have been accepted for a doctoral program. Not appropriate for students who have been admitted to candidacy.

PLS 7980 Research for Doctoral Dissertation (1-15 credits, S/U graded)
Research for Doctoral Dissertation.

F. For degree programs in the science and technology disciplines, discuss how industry-driven competencies were identified and incorporated into the curriculum and indicate whether any industry advisory council exists to provide input for curriculum development and student assessment.

Our integrated curriculum will equip students with traditional and contemporary breeding methodologies, including molecular techniques (ex: genomic prediction and editing), quantitative genetics, and analysis of breeding trials. Our curriculum was developed upon consultation with industry, non-profit, and academic sectors. While there are currently no specific guidelines for industry-driven competencies, our faculty interact regularly with industry stakeholders and many of our students who were educated in plant breeding have secured jobs in the private sector. Industry representatives from different crops provided their input with regards to the curriculum and one multinational offered to participate as a member of an advisory board (see support letters). We plan to implement a program advisory board with internal and external academic representatives as well as stakeholders including the private sector. The board will meet every other year to review and update the strategic plan for the program, including a review of the curriculum.

G. For all programs, list the specialized accreditation agencies and learned societies that would be concerned with the proposed program. Will the university seek accreditation for the program if it is available? If not, why? Provide a brief timeline for seeking accreditation, if appropriate.

No accreditation will be sought for this proposed graduate program. The American learned societies with interest in this program include: Crop Science Society of America (CSSA, crops.org), American Society for Horticultural Science (ASHS, ashs.org), National Association of Plant Breeders (NAPB, plantbreeding.org), Plant Breeding Coordinating Committee (PBCC, plantbreeding.org/content/pbcc), and their equivalent international societies, such as the CGIAR (cgiar.org, formerly known as the Consultative Group on International Agricultural Research), the European Association for Research on Plant Breeding (EUCARPIA, eucarpia.org), International Society for Horticultural Science (ISHS, ishs.org) and the Global Partnership Initiative for Plant Breeding Capacity Building (GIPB, fao.org/in-action/plant-breeding/en). While we expect that our students and faculty will interact closely with these societies, none of these societies accredit academic programs in the area of plant breeding.

H. For doctoral programs, list the accreditation agencies and learned societies that would be concerned with corresponding bachelor's or master's programs associated with the proposed program. Are the programs accredited? If not, why?

There are no learned societies or accrediting organizations for corresponding bachelor's or master's programs in the area of plant breeding.

I. Briefly describe the anticipated delivery system for the proposed program (e.g., traditional delivery on main campus; traditional delivery at branch campuses or centers; or nontraditional delivery such as distance or distributed learning, self-paced instruction, or external degree programs). If the proposed delivery system will require specialized services or greater than normal financial support, include projected costs in Table 2 in Appendix A. Provide a narrative describing the feasibility of delivering the proposed program through collaboration with other universities, both public and private. Cite specific queries made of other institutions with respect to shared courses, distance/distributed learning technologies, and joint-use facilities for research or internships.

This program is primarily delivered in the classroom with some courses delivered online. Thus, the delivery will be a hybrid of traditional and distance delivery methods to graduate students residing on the main campus of the University of Florida and at the UF/IFAS Research and Education Centers (RECs) located throughout Florida using existing faculty from the Departments of Agronomy, Environmental Horticulture and Horticultural Sciences, and the School of Forest Resources and Conservation.

The delivery system for courses in this program will be a mix of traditional delivery to students present on main campus and nontraditional delivery by distance learning to students across the state in the different RECs. The long-term aim is to have all courses include an online component. Some of the courses, such as PCB 6555 Introduction to Quantitative Genetics, are currently being offered fully online while AGR 5321C Genetic Improvement of Plants is scheduled to be offered online in Spring 2020. All courses currently offer the possibility

of distance learning through synchronous online delivery. This proven method has worked well and received positive feedback from students and faculty located across the state at the RECs. Since approximately 60% of plant breeding faculty are based at six RECs located across the state from Marianna to Homestead, it is crucial that students advised by off-campus faculty and conducting research at these locations be able to attend classes remotely with the aid of technology.

No specialized services are needed for the proposed delivery system nor do we expect it to require greater than normal financial support. It is not anticipated that the proposed PB graduate program will involve other universities and no such queries have been submitted. Collaboration with other universities in the state is limited since we are proposing the first plant breeding graduate program in Florida.

IX. Faculty Participation

A. Use Table 4 in Appendix A to identify existing and anticipated full-time (not visiting or adjunct) faculty who will participate in the proposed program through Year 5. Include (a) faculty code associated with the source of funding for the position; (b) name; (c) highest degree held; (d) academic discipline or specialization; (e) contract status (tenure, tenure-earning, or multi-year annual [MYA]); (f) contract length in months; and (g) percent of annual effort that will be directed toward the proposed program (instruction, advising, supervising internships and practica, and supervising thesis or dissertation hours).

Table 4 lists the 27 graduate faculty, from the four UF/IFAS departments, who will participate in the PB interdisciplinary graduate program and will serve as chairs or members of supervisory committees of students. UF/IFAS plant breeders are housed in four different departments and different research and education centers across the state and this PB interdisciplinary program will unify faculty working in breeding. Even though PB faculty will not be budgeted by the proposed PB program, each faculty maintains their budgeted department in one of the four units mentioned before (HOS/ ENH, AGR or SFRC) all these faculty will be fully contributing in the PB program. Supervisory committee external members will be chosen from University of Florida graduate faculty members not affiliated with the PB program. We anticipate that by Year 5 of the program, we will have one additional new hire at the assistant professor level in one of the four academic departments (Agronomy, Horticultural Sciences, Environmental Horticulture, SFRC) involved in the creation of this new graduate degree.

Because the curriculum of the program relies on current coursework being taught in the involved departments, most faculty will not see a change in their responsibilities, or their time assigned to the new program. In the meantime, the department may see an increase in Ph.D. students taking these courses on a regular basis. The proposed program attempts to minimize the effects of the reallocation of teaching resources by re-allocating only 1% per teaching faculty FTE to the new program. A few members of the faculty will be devoting more time and energy to the graduate program because of the need to lead the new program. However, a rotational leadership is proposed, which will minimize the time faculty devote to the program in the long-term.

B.

Use Table 2 in Appendix A to display the costs and associated funding resources for existing and anticipated full-time faculty (as identified in Table 4 in Appendix A). Costs for visiting and adjunct faculty should be included in the category of Other Personnel Services (OPS). Provide a narrative summarizing projected costs and funding sources.

One of the primary costs of the Ph.D. program will be faculty and staff salaries and benefits. The reallocated E&G base is calculated based upon the percentage of faculty and staff salaries/benefits funded through E&G for the effort proposed on Table 4. We are also assuming an annual salary increase of 3% for faculty and staff. Based on projected enrollment trends (Table 1-B), the E&G cost per student FTE decreases from $37,049 in Year 1 to $17,820 in Year 5. Total projected E&G costs for Year 1 are $129,672 and for Year 5 are $253,937.

C. Provide in the appendices the abbreviated curriculum vitae (CV) for each existing faculty member (do not include information for visiting or adjunct faculty).

This information is provided in Appendix C.

D. Provide evidence that the academic unit(s) associated with this new degree have been productive in teaching, research, and service. Such evidence may include trends over time for average course load, FTE productivity, student HC in major or service courses, degrees granted, external funding attracted, as well as qualitative indicators of excellence.

As mentioned before, the proposed Ph.D. degree will be an interdisciplinary degree involving four IFAS units (AGR, HOS, ENH and SFRC) and will be administrated under the Horticultural Sciences Department where most

of the plant breeders are housed. While statistics and academic indicators have not been generated for the subset of faculty working in plant breeding in each of these departments, we nevertheless collected productivity and quality indicators across these departments and among the PBWG to demonstrate that breeding faculty are active in research, teaching and extension. Plant breeding faculty are nationally and internationally recognized and have an impressive list of achievements and awards commensurate with their peers at top-tier institutions.

The table below shows the total number of faculty, the number of plant breeding faculty and their corresponding percentage in each of these four IFAS units. These faculty have research, teaching and extension responsibilities, thus fulfilling the land-grant mission.

	Total Faculty	Plant Breeders	Percentage of Total Dep Faculty in Plant Br
Agronomy (AGR)	30	7	23%
Environmental Horticulture (ENH)	34	3	9%
Horticultural Sciences HOS)	58	15	26%
School Forest Res. & Cons. (SFRC)	73	2	3%

The average Ph.D. students enrolled over the past six years across these departments was 32 for AGR, 63 for HOS and ENH combined (since their Ph.D. degree is jointly administered by ENH and HOS), and 42 for SFRC-Forest Resources and Conservation (FRC) major. All these departments had a significant increase in student enrollment during this period. From 2013to 2018, AGR increased their Ph.D. enrollment by 32%; HOS combined with ENH had an increase of 20%; and SFRC-FRC major had an increase of 45%.

Plant breeders in these four departments have chaired and successfully graduated a total of 128 graduate students, with 50 graduates in AGR, 66 in HOS and ENH, and 22 in SFRC.

In the last 10 years, plant breeding faculty have secured external support of approximately $60 million in federal and private funding, bringing the average total support to nearly $3 million per breeder. Such external funding includes research grants from the National Institutes of Health, National Science Foundation, and the United States Department of Agriculture and contracts through private industry. The development of cultivars and varieties by IFAS plant breeders not only contribute to augment Florida's agricultural industry but its positive impact have also significantly increased globally. For instance, in the last 10 years, more than 300 new cultivars have been developed by the University of Florida and cultivars for each of our 50 crops continue to grow year after year. Licensing of these cultivars has generated royalties that have seen an increase of $1 million per year each of the last seven years, with $14 million generated in 2018. With one of the most aggressive royalty re-investments initiatives of the nation, between 30-70% of this revenue is returned to research programs dedicated to developing cultivars and educating students. This re-investment initiative has positively impacted the quantity and quality of research carried by plant breeding faculty in UF/IFAS.

Graduate students working with plant breeding faculty regularly publish their research in top-rated peer-reviewed agriculture, horticulture, forestry and plant breeding journals, including: *Crop Science*, *Journal of the American Society of Horticultural Sciences, Horticulture Research*, *Plant Breeding*, *Molecular Breeding*, *Genetics*, *G3*, *Plant Molecular Biology*, *Plant Genome*, *Theoretical and Applied Genetics*, *The Plant Cell*, and *Proceedings of the National Academy of Sciences*. This clearly demonstrates the capacity of plant breeders to successfully prepare the new generation of plant breeders.

In their last academic program review, HOS generated an average of 77 scientific publications per year, ENH reported a similar number and AGR produced an annual average of 86 publications. SFRC reported a total of 140 publications in 2015. Faculty scholarly activity has increased steadily when HOS reported over 120 scientific publications in 2018. The impact of publications measured by the i10-index (number of publications with at least 10 citations) for HOS and ENH with a weighted average (by faculty tenure level) was 41, and 18, respectively.

Total Enrollment by Department and Degree for the Period of 2013-2018, Fall term (Source: OIPR – Office of Institutional Planning and Research)

		2013	2014	2015	2016	2017	
HOS + ENH	Total	99	91	96	99	122	
	Ph.D.	61	57	62	55	70	
	M.S.	38	34	34	44	52	
AGR	Total	44	53	68	68	74	
	Ph.D.	25	30	37	35	32	
	M.S.	19	23	31	33	42	
SFRC-FRC	Total	89	98	114	127	128	
	Ph.D.	31	36	44	45	51	
	M.S.	58	62	70	82	77	

Graduate Degrees Granted by Department from 2013-2019 (Source: GIMS)

		2013-14	2014-15	2015-16	2016-17	2017-18	2
HOS	Ph.D.	7	9	14	8	8	
	M.S.	13	8	7	10	9	
ENH	Ph.D.	4	5	2	4	3	
	M.S.	8	7	8	5	7	
AGR	Ph.D.	6	5	6	7	6	
	M.S.	11	5	7	17	17	
SFRC-FRC	Ph.D.	3	5	7	3	11	
	M.S.	19	25	37	37	44	

Academic Fundable Credit Hours (Student Credit Hours, Graduate) (Source: CALS)

	2013-14	**2014-15**	**2015-16**	**2016-17**	**2017-18**	
HOS	1777	1435	1681	998	1535	
ENH	540	503	555	766	851	
AGR	849	1047	1022	1310	1432	
SFRC-FRC	1657	2129	2465	2315	2521	

Faculty Grant Funding and IDC by Department from 2013-2017 (Source: UF/IFAS Research)

		2013	2014	2015	2016	201
	Grant Funds	5,564,603.00	5,018,844.44	6,338,086.61	5,250,075.49	5,36
	IDC	1,111,325.00	1,134,128.40	1,598,038.00	1,329,821.73	1,28
	Grant Funds	445,058.00	312,450.00	519,913.13	584,355.73	53
	IDC	30,737.00	43,877.00	118,590.80	98,377.90	11
	Grant Funds	1,801,546.00	2,862,657.86	1,987,456.15	5,273,010.76	1,10
	IDC	414,445.00	736,036.67	489,030.40	568,942.96	23
	Grant Funds	9,250,561.00	11,438,137.60	8,937,291.75	6,549,550.41	6,08
	IDC	1,251,015.00	1,816,688.29	1,540,241.00	1,290,980.68	1,16

Plant Breeding Royalty Funding Generated by Department from 2013-2018 (Source: UF/IFAS Research)

	2013	2014	2015	2016	2017	
HOS	$4,020,156.02	$6,300,633.80	$6,845,691.01	$6,976,180.13	$9,185,992.36	$8,
ENH	$97,649.32	$198,561.96	$183,839.57	$247,114.71	$307,335.72	$
AGR	$461,555.62	$639,837.49	$351,467.66	$569,959.38	$506,736.57	$
SFRC	$0.00	$184.03	$127.82	$0.00	$170.11	

Faculty Refereed Publications by Department from 2013-2018 (Source: UF/IFAS Research)

	2013	2014	2015	2016	2017	
HOS	81	65	101	75	75	
ENH	20	22	24	25	24	
AGR	60	58	87	78	94	
SFRC	103	121	140	135	133	

X. Non-Faculty Resources

A. Describe library resources currently available to implement and/or sustain the proposed program through Year 5. Provide the total number of volumes and serials available in this discipline and related fields. List major journals that are available to the university's students. Include a signed statement from the Library Director that this subsection and subsection B have been reviewed and approved.

The Libraries of the University of Florida form the largest information resource system in the state of Florida. The libraries hold 6,169,930 print volumes, 1,489,569 e-books (books in digital format), 145,280 full-text e-journal titles, and 1,092 electronic databases as of 2018. The George A. Smathers Libraries of the University of Florida, a system of six research libraries, includes libraries for sciences, humanities & social sciences, architecture & fine arts, education, and health sciences. The UF Levin School of Law supports a related, but independent law library. Additional library resources are available in two specialized libraries, the UF Digital Collections and the Special & Area Studies Collection. Books and periodicals, related to plant breeding are located primarily in the Marston Science Library.

Electronic books, journals and many key databases, such as Web of Science, BIOSIS Citation Index, CAB

Electronic books, journals and many key databases, such as Web of Science, BIOSIS Citation Index, CAB Abstracts, Proquest SciTech Collection and others, are available via the internet to UF students, faculty and staff. Many relevant databases are multidisciplinary and are funded centrally. The UF Libraries expend over $10.6 million annually on electronic resources. Listed below is a selection of the important journals available through UF Libraries for use by students pursuing a doctorate degree in plant breeding:

- *American Journal of Botany*
- *Annual Review of Plant Biology*
- *Crop Science*
- *Current Opinion in Plant Biology*
- *Euphytica*
- *Journal of Experimental Botany*
- *Plant Breeding*
- *The Plant Cell*
- *Plant Cell and Environment*
- *Plant Molecular Biology*
- *Plant Physiology*
- *Plant Science*
- *Proceedings of the National Academy of Sciences of the USA*
- *Scientia Horticulturae*
- *Theoretical and Applied Genetics: International Journal of Plant Breeding Research*
- *Trends in Plant Science*

In addition, there are a growing number of open access journals in the field; the content of these journals is freely available to readers. Important titles of open access journals related to plant breeding include:

- *Frontiers in Plant Science*
- *Genetics*
- *G3: Genes, Genomes, Genetics*
- *HortScience**
- *Journal of American Society of Horticultural Science**
- *New Phytologist*
- *Plant Biotechnology Journal*
- *Plant Genome*
- *Plant Journal*

*These journals will become freely available without a subscription as of January 1, 2020.

The Libraries hold memberships in a number of consortia, and in institutions such as the Center for Research Libraries, ensuring access to materials not held locally. "UBorrow" service allows UF patrons to easily borrow materials from any other Florida state university or college library. Materials not held in UF collections and unavailable via UBorrow are procured through Interlibrary Loan. Interlibrary Loan requests are fulfilled at no cost to the library patron; participation in this library collection exchange program is paid for by the UF Libraries. All students, faculty, and staff may use Interlibrary Loan services.

With monies allocated through the Provost and the UF budgeting process, the library materials budget is determined by the Dean of Libraries in consultation with the Senior Associate Dean for Scholarly Resources & Research Services and subject specialist librarians. The librarian subject specialists for the agricultural sciences and biological/life sciences, with input from the Plant Molecular & Cell Biology Program, Department of Biology, Department of Horticultural Sciences and the Department of Environmental Horticulture faculty, determine acquisition priorities for the year. Standing subscriptions to journal literature and databases make up the majority of purchasing. Online research guides for all UF disciplines and many specific topics are available from the library website http://library.ufl.edu. Many online tutorials for specific databases are also available. Additionally, the UF Libraries offer consultations, workshops, and events throughout the year.

B. Describe additional library resources that are needed to implement and/or sustain the program through Year 5. Include projected costs of additional library resources in Table 2 in Appendix A. Please include the signature of the Library Director in Appendix B.

No additional library resources beyond the current allocation and normal growth in holdings already in place to support current programs are necessary to implement or sustain the graduate program in Plant Breeding.

C. Describe classroom, teaching laboratory, research laboratory, office, and other types of space that are necessary and currently available to implement the proposed program through Year 5.

Facilities available to students in the Plant Breeding graduate program will be derived from the multiple academic units and Research and Education Centers participating, including the four UF/IFAS departments of Agronomy

units and Research and Education Centers participating, including the four UF/IFAS departments of Agronomy, Horticulture Sciences, and Environmental Horticulture, the School of Forest Resources and Conservation and the six REC units in Wimauma, Lake Alfred, Apopka, Homestead, Belle Glade and Marianna. Overall, these units include all the laboratory, greenhouse and field facilities of the Plant Breeding faculty, classrooms, computer facilities, and core laboratories of the Interdisciplinary Center for Biotechnology Research (ICBR), and Genetics Institute. It is important to mention that the proposed courses for this degree, including the new course, will utilize classrooms, teaching and research laboratories and other types of space that currently exist and are utilized by the above departments and research and education centers (RECs).

Among the proposed core courses, STA 6093 Introduction to Applied Statistics for Agricultural and Life Sciences is 100% online, and does not require any physical space. Similarly, AGR 5321C Genetic Improvement of Plants offered by Agronomy, is 80-99% online with some in-person exams or projects. Classroom space is readily available for AGR 5321C, when needed.

The four departments involved currently provide workspaces for each graduate student enrolled under the supervision of a faculty member in such department.

There are no specific needs for specially equipped classrooms for instruction in this program, except those that are required for students with disabilities. Non special-use classroom space is centrally managed at the University of Florida. Our requirements for classroom space are currently met and we do not anticipate additional needs.

D. Describe additional classroom, teaching laboratory, research laboratory, office, and other space needed to implement and/or maintain the proposed program through Year 5. Include any projected Instruction and Research (I&R) costs of additional space in Table 2 in Appendix A. Do not include costs for new construction because that information should be provided in response to X (E) below.

Two spaces are needed. First, an office for the program administrator large enough to conduct meetings with up to two students and/or faculty members. Second, a common office area for graduate students as they move between Research and Education Centers and the Main Campus, and/or for students housed in Main Campus programs, which have insufficient space to accommodate them. Options for internal reallocation of space within UF/IFAS will be considered to meet these needs.

E. If a new capital expenditure for instructional or research space is required, indicate where this item appears on the university's fixed capital outlay priority list. Table 2 in Appendix A includes only Instruction and Research (I&R) costs. If non-I&R costs, such as indirect costs affecting libraries and student services, are expected to increase as a result of the program, describe and estimate those expenses in narrative form below. It is expected that high enrollment programs in particular would necessitate increased costs in non-I&R activities.

At this point no additional research or instructional spaces are required to successfully implement and grow this proposed program.

F. Describe specialized equipment that is currently available to implement the proposed program through Year 5. Focus primarily on instructional and research requirements.

For instructional purposes our proposed program requires classrooms equipped with online delivery equipment. All classrooms being utilized for this degree are either already well-equipped for online delivery or are being promptly updated by the four departments involved. For research, all plant breeding faculty laboratories are well-equipped to instruct graduate students on techniques and methods used in plant breeding.

G. Describe additional specialized equipment that will be needed to implement and/or sustain the proposed program through Year 5. Include projected costs of additional equipment in Table 2 in Appendix A.

No additional specialized equipment will be needed to implement the program.

H. Describe any additional special categories of resources needed to implement the program through Year 5 (access to proprietary research facilities, specialized services, extended travel, etc.). Include projected costs of special resources in Table 2 in Appendix A.

None.

I. Describe fellowships, scholarships, and graduate assistantships to be allocated to the proposed program through Year 5. Include the projected costs in Table 2 in Appendix A.

It is anticipated that all doctoral students in this program will receive graduate assistantship or fellowship support since financial support is a critical element in recruitment of top applicants and maintenance of a Ph.D. program.

The plant breeders are envisioning a unique program that has continuous support from licensing royalties. Since 2010, the UF/IFAS Plant Breeders Working Group (PBWG) and UF/IFAS Research have funded 23 graduate student assistantships through the Plant Breeding Graduate Initiative (PBGI). The proposed program is expected to recruit top students with interest in plant breeding (maximum of 5-6 students per year in the first cycle). With continuing support of the Plant Breeders Workgroup (PBWG) and IFAS-Research, the PBGI will ensure assistantships for 3-4 students annually and thus 60-80% of the recruitment goal will be achieved with internal funding.

We also project an increase in the philanthropy endowments represented by the Plant Breeding Graduate Initiative (PBGI). The PBGI represents an annual funding opportunity provided by UF/IFAS Research and Florida Foundation Seed Producers, a Direct Support Organization (DSO) that supports the plant breeding research programs. IFAS Research currently funds $60,000 per cohort per year, while the plant breeders provide $60,000. We are predicting that with the success of the program the plant breeders will expand their support by Year 5 for a total of $90,000 per year. Furthermore, we are anticipating that the program will obtain support for one Graduate School Funding Award (GSFA) each year for the first five years.

The visibility provided by this new graduate program will increase UF/IFAS opportunities to obtain industry support targeting development of new plant breeders. Moreover, the plant breeding faculty have an excellent track record of obtaining extramural support and the number of grant-supported assistantships has grown steadily. The increased visibility of this new interdisciplinary program would enhance plant breeding faculty's chances of more successfully competing for extramural research project funding.

Also, the addition of this doctoral program will make us competitive for university-wide fellowships that are limited to doctoral students and we plan to take advantage of those opportunities.

J. Describe currently available sites for internship and practicum experiences, if appropriate to the program. Describe plans to seek additional sites in Years 1 through 5.

The UF/IFAS Plant Breeding Graduate Program is a field-based applied breeding program which provides students with hands-on experience and exposure to 50 crops that our faculty research and investigate. As part of their plant breeding education, both our on-campus or off-campus students are required to carry out extensive field work research. UF/IFAS provides research support for faculty members including facilities on the University of Florida campus plus off-campus facilities including 12 Research and Education Centers, five Research and Demonstration Sites (that include two biological stations) and a research forest. We therefore feel that we will be able to provide adequate sites for student research and experiential learning.

Even though we do not require an internship or practicum for doctoral students in the proposed degree program, students are encouraged to pursue an outside internship with industry, governmental agencies, and non-governmental organizations with the duration of at least one month. We have excellent collaborative relationships with industry and other organizations so our students will be able to gain experience in other applied breeding programs especially with potential future employers (private and public).

CITED LITERATURE

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