

# AG2PI COCONUT GRANT - PROJECT FINAL REPORT

PROJECT NAME	Delivering Resource Allocation Guidelines for Deploying High-Throughput Phenotyping and Geno-typing in Modern Breeding Programs
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PROJECT PRINCIPAL INVESTIGATOR	TODAY'S DATE	PROJECT START DATE	DATE OF COMPLETION
Mitchell J Feldmann	04/16/2024	03/01/2023	02/29/2024
TEAM MEMBERS (co-PI, co-I, personnel)	COLLABORATORS		
Daniel E Runcie, Hao Cheng	None		

**NOTE: A shortened version of this report will be made available on the AG2PI website after any sensitive items have been removed. You will have final approval of the website version.**

## ACCOMPLISHMENTS

Please provide a short summary of the conclusions (both successes and failures) made from your project. Include a description of how this project will provide benefits to the agricultural genome to phenome community and, possibly, to a broader audience. You should include both qualitative and quantitative details, as necessary, to support your conclusions. Include a short accomplishment statement in non-technical language and do not include names.

This is not a technical report. Please keep to no more than 6-8 sentences (e.g., 1-2 sentences per point, above).

There seems to be very little overlap in how breeding programs are managed and operated, even within the same crop. Close conversations between Steven Knapp (UC Davis Strawberry) and Vance Whitaker (UF Strawberry) informed us that trying to optimize for all programs at once was going to be impossible. However, we also learned through conversations at NAPB and NAPPN that the comparisons between genomic and phenomic prediction that people are making, are not appropriate comparisons as the two approaches are, in essence, "apples and oranges." This has led us to determine that to optimize a breeding program for "rate of gain", individual programs will need to work to compare appropriate predictions of the rate of gain using different selection strategies. There seems to be interest by researchers to produce appropriate comparisons between genomic and phenomic prediction, which we are delivering in an R package.

2 field day presentations (AG2PI and UC Davis).

4 submitted or in prep articles.

1 PhD student graduation (Aug 2024).

1 PhD QE exam.

2 undergraduates researchers were partially supported by this award. Both are presenting posters at the UC Davis Undergrad Research Conference.

(HINT: You can expand sections as necessary by pulling down on the square in the lower right corner of each box)

## Products

Please list any products from this project. This may include (but not limited to) publication, concept/white paper, workshop, conference presentation, website, publicly available data or pipelines, etc. Reminder: you are required to make your products available to the broader stakeholder community using standard USDA practices, open source, FAIR, or other models. Metrics may include number of participants or times accessed, etc. Include links to recordings, DOI, etc. when possible. For presentations and posters, provide authors, date, location and presentation title.

ACTIVITY / PRODUCT	DESCRIPTION (include URL, if applicable)	OUTCOME / METRICS
AG2PI field day	Daniel Runcie presented our work comparing genomic and phenomic prediction ( <a href="https://www.ag2pi.org/workshops-and-activities/field-day-2024-03-20/">https://www.ag2pi.org/workshops-and-activities/field-day-2024-03-20/</a> ).	We have had several interesting follow up conversations with researchers at TAMU and the Breeding Insight group at Cornell, the latter of whom want to adopt our approaches for comparing genomic/phenomic breeding in multiple underserved breeding programs.
UC Davis Field Day	Mitchell Feldmann presented some of our work to ~30 students, researchers, and extension specialists at UC Davis.	~30 scientists from UC Davis, UC ANR, California Seed and Plant, and Corteva were in attendance and we discussed how drone based phenotyping of plant disease symptoms has been useful for supplementing manual scoring.
In prep article	"Genomic Prediction Sheds Light on the Pleiotropic Tradeoffs Between Shelf Life, Sweetness, and Acidity in Strawberry"	His third dissertation chapter is in preparation "Genomic Prediction Sheds Light on the Pleiotropic Tradeoffs Between Shelf Life, Sweetness, and Acidity in Strawberry" in which we studied the ability to use genomic prediction to improve fruit quality in strawberry.
Submitted article	"Why is usefulness rarely useful"	Fangyi recently submitted an article title "Why is usefulness rarely useful" to G3. This study used simulations based on genetic data from real breeding programs to assess the usefulness of predicting the usefulness criterion.
In prep article	"How genomic and phenomic prediction complement and compete"	Daniel Runcie and Mitchell Feldmann are preparing a manuscript based on the research conducted and feedback from our AG2PI field day with the tentative title, "How genomic and phenomic prediction complement and compete." We learned over the course of the last year from our conversations with various public breeding programs that groups working on using phenomic prediction are wanting to <i>replace</i> genomic prediction. Our simulations suggest that this replacement strategy is ill-advised because the metrics used to compare the two approaches are not appropriate. We hope to have this article submitted in June. We provide an R package for properly estimating the prediction accuracy from both approaches to get appropriate comparisons.
In prep article	"Early Stage Genomic Prediction of Hybrid Performance Increases Breeding Speed and Expected Genetic Gains in Strawberry"	Mitchell Feldmann and Daniel Runcie are preparing a manuscript title "Early Stage Genomic Prediction of Hybrid Performance Increases Breeding Speed and Expected Genetic Gains in Strawberry." In this article we show that the way strawberry breeding

		has been conducted for the last 60 or more years is incredibly inefficient, with very long cycle lengths. We demonstrate that selection based on very early stage phenotyping leads to 2-4x higher rates of gain than intense phenotyping of few lines in later stages. We also show that genomic prediction models trained on less-reliable early stage phenotypes have the same/similar predictive ability as models trains on more-reliable, very expensive late state phenotypes.
Awarded follow up grant	USDA NIFA AFRI Foundational and Applied Science – Plant Breeding	Mitchell Feldmann and Daniel Runcie were awarded a grant to study resistance to multiple fruit rot pathogens in strawberry that is a direct follow up to this award. The theoretical findings that we have made over the last year went into the design of the experiments, the materials and methods, and the philosophy behind that, now awarded, proposal.
Graduation	Nico Jimenez is graduating	Nicolas Jimenez will be graduating with his PhD in August of 2024. AG2PI supported Nico's GSR, and the data generated are used in this article/chapter and will be acknowledged in paper and chapter.
QE	Fangyi passed her QE at UC Davis	Fangyi Wang passed her qualifying exam during this granting period. AG2PI supported Fangyi's GSR during the granting period. This will be on of Fangyi's dissertation chapters for her PhD.
Undergraduate researchers trained	Trained Ella Halberstadt and Noah Kulchin	AG2PI supported, in part, two URAs in the UC Davis Strawberry Breeding Program. Noah has been working on NIRS prediction of fruit quality traits and Ella on high-throughput image-based phenotyping for pollen viability. Both Ella and Noah are graduating and will present posters at the UC Davis Undergrad Research Conference at the end of April 2024. Ella will stay in the lab to continue to work on integrating genomic and phenomic approaches in to fruit quality prediction and improvement.

## Audience

With whom has this work been targeted to and shared? Please describe how this project and its products have been disseminated to a community of interest. Include any outreach activity or information sharing as well as training or professional development opportunities provided in this project.

The audience of this research broadly are researchers publically and privately investigating phenomic and genomic prediction in plant breeding programs. We have communicated with 30 students and researchers during the UC Davis Field Day. Dan's presentation in AG2PI field day #30 had 12 questions, not including follow ups, and has lead to conversations with Breeding Insight at Cornell.

## CONTINUATION OF WORK

## Next steps

How do you/your team plan to continue moving this project forward? Include how AG2PI can assist in your forward momentum.

Daniel Runcie and Mitchell Feldmann have been awarded a USDA NIFA AFRI grant to study and improve resistance to multiple fruit rot pathogens in strawberry using both genomic and phenomic prediction. The outcomes of this AG2PI coconut grant directly informed the new proposal. We will continue to move forward the initiatives from this AG2PI coconut grant, and hope to find ways to continue provide outreach, extension, and education opportunities through AG2PI.