FY2020 Research/Extension Capacity Funds
Team Science Concept Note

I. Title

Furthering the genetic understanding of macadamia and integrated pest management for new orchard establishment and expansion in Hawaii

II. Members of the team

University of Hawaii at Manoa, College of Tropical Agriculture and Human Resources

1. Michael Kantar, Tropical Plant and Soil Sciences
2. Alyssa Cho, Tropical Plant and Soil Sciences
3. Eli Isele, Tropical Plant and Soil Sciences
4. Mark Wright, Plant and Environmental Protection Sciences

External Partners

5. Tracie Matsumoto, USDA-ARS
6. Michael Gore, Plant Breeding and Genetics Section, School of Integrative Plant Science, Cornell University
7. Peter Thielen, Johns Hopkins Applied Physics Laboratory, Johns Hopkins University
8. Craig Hardner, Center for Horticultural Science, Queensland Alliance for Agriculture and Food Innovation, The University of Queensland, Australia
9. Catherine Nock, Plant Science, Southern Cross University, Australia

III. Indicate relevant Hatch and Extension POW project numbers

Michael Kantar
Hatch 8039-H "Resilience and nutrition: finding local value in global genebanks"
Multi-state Hatch SCC80 "Sustaining the future of plant breeding"
Alyssa Cho
*Hatch 8037-H "Evaluation of new macadamia nut selections for Hawaii production" (primary proposed Hatch)
POW 20-031 "Sustainable tropical fruit and nut farming systems"
Eli Isele
POW 20-025 "Sustainable agriculture in East Hawaii"

IV. Project scope

Problem

There is a lack of genomic information about Macadamia (*Macadamia integrifolia*; 2n = 2x =28 and *Macadamia tetraphylla;* 2n = 2x = 28) which limits the ability to explore breeding opportunities and understanding of applied field observations in commercial production in Hawaii.

Macadamia is one the largest agricultural land uses (17,100 acres in 2018-19) and highly valued ($42 million) (USDA-NASS, 2019). However, many factors threaten the livelihoods of the macadamia industry in Hawaii including pest and disease pressure, high costs (inputs, land, labor), and overall aging orchards. Most importantly, macadamia producers must apply costly IPM strategies to control the macadamia felted coccid, which causes economic yield loss at very low thresholds. As new orchards are planted and existing orchards replant with new germplasm, it's critical that scientifically sound recommendations for varieties are made.

Therefore, this proposal seeks to establish a foundation of genomic resources that will be leveraged for larger funding opportunities to establish a multi-disciplinary, multi-institutional, multi-national project to address the existing and emerging needs for macadamia production in Hawaii, with an underlying focus on the ***need for high quality, pest and disease resistant, highly productive macadamia selections***.

Goals

The overall goal for this proposal is to establish a multi-disciplinary team and foundation knowledge that will be leveraged into a larger USDA-SCRI proposal (FY2020).

Objectives

1. Improve genetic resources of macadamia by:
    a. Generating draft genomes
        i. *Macadamia tetraphylla* (1 pure *tetraphylla* and the selection '900')
    b. Low coverage sequencing on new and existing macadamia selections
        i. May include: 344, 508, 800, 835, 856, 862, 879, 887, 900, 932
2. Provide outreach and dissemination of results from objectives 1 and 2 via the Hawaii Macadamia Nut Association annual growers meeting (July 2020) and through the peer-reviewed publication of results.

Experimental approach

Objective 1: To create the reference genome, we will extract DNA from young tissue of a clonally-propagated individual from *Macadamia tetraphylla* accession 900. We propose to use a hybrid-sequencing method that includes both second generation (Illumina) and third generation (Oxford Nanopore) sequencing technology. Specifically, we will be using 50x small insert paired end (SIPE) Illumina library and 50x Oxford Nanopore coverage. We will then use low coverage (3-5x) short read sequencing on all current macadamia selections, couple this pedigree information and produce chromosome level genome structure for each accession.

Objective 2: A presentation will be given to report on the project findings at the annual growers meeting for the Hawaii Macadamia Nut Association in July 2020 and also will be published in a peer-reviewed publication.

Expected benefits and impact of the project

- Provide a genomic base to further evaluate existing and new macadamia selections for production in Hawaii.
- Potentially identify selections with tolerance and/or resistance to *E. ironsidei*.
- Increase understanding of the macadamia genome, especially as it relates to wild relatives.

Hatch and POW Links

Objectives 1 and 2 tie directly into 8037-H by evaluating the genetic and insect tolerance of new macadamia selections that have already been evaluated for yield and quality at two locations in Hawaii over 3.5 years.

Objective 3 ties directly into POW 20-031 by providing genetic information that will further the sustainability of macadamia orchards in Hawaii through use and planting of improved varieties to pest resistance (while maintaining yield and quality).

Hatch and POW projects most closely aligned with this proposal are highlighted with an asterisk in section III of this proposal.

V. Expected leveraging opportunities if capacity funds are invested

This project will be used to leverage larger funds. The results from this research will be used as preliminary results for applying for larger funding sources to conduct more comprehensive research on Macadamia genetics and pest resistance and management in Hawaii. Potential funding sources to continue Macadamia nut research in Hawaii include the Hawaii Department of Agriculture, USDA-SCRI, and USDA-NIFA.

VI. Estimated budget

$4,500 for Illumina and Oxford Nanopore sequencing library generation
$4,500 Illumina sequencing 50x SIPE (NextSeq 500 High Output 300bp PE)
$4,500 Oxford Nanopore Sequencing 50X (5 MinION R9.4 flowcells, ~1M reads/flowcell, read N50 >20kb)
$10,000 for informatics support to generate and annotate genome assembly
Travel ($5,000): these funds will be used to support travel for co-PIs and students to collect plant material.
Materials and supplies for other data collection: $4,000
Undergraduate Student to help with research experiment set-up, management, data collection, and data entry. $2000
Graduate students: $24,000 = $24,000
Total request =$58,500

References

[USDA-NASS] United States Department of Agriculture- National Agricultural Statistics Service. 2019. Pacific region- Hawaii macadamia nuts final season estimates. https://www.nass.usda.gov/Statistics_by_State/Hawaii/Publications/Fruits_and_Nuts/072019MacNutFinal.pdf Accessed 11 September 2019.