Department of Agriculture
State of Hawaii

STATE of HAWAII

SPECIALTY CROP BLOCK GRANT PROGRAM – FARM BILL FY 2012

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Final Report

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HAWAII STATE PLAN: To Enhance the Competitiveness of Fledgling Specialty Crops

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Breadfruit – From Tree to Consumer: Information Guidelines, Video and Workshop

Final Report

Hawaii Homegrown Food Network
http://www.agroforestry.net/hhfn/

Project Summary

Background: Due to recent efforts by the Breadfruit Institute to make trees available to farmers, combined with public education by the Hoʻoulu ka ʻUlu—Revitalizing Breadfruit project, production of breadfruit in Hawaiʻi is expected to increase dramatically over the next few years. This project will strengthen breadfruit markets through printed and online educational materials about harvest and postharvest, fruit handling and food preparation, and varieties. Instructional guides and videos will be produced for wide dissemination. Four workshops will provide hands-on training to breadfruit growers. The project will be conducted on Hawaiʻi Island, Oʻahu, Maui and KauaʻI, and will assist Hawaiʻi's growers in supplying grocery stores, restaurants, farmers markets, and other markets with high quality breadfruit, and help chefs and consumers become familiar with breadfruit handling in the kitchen and preparing delicious and nutritious dishes using breadfruit as the primary ingredient.

Importance and Timeliness: Breadfruit or ʻulu has been cultivated in Hawaiʻi for 1,000 years. Prior to Western contact and changing diets, breadfruit contributed significantly to the Hawaiian diet, making Hawaiians among the most self-sufficient and well-nourished peoples in the world (Meilleur 2004). Because of a shift towards cheap, imported starches, increasing urbanization, and changing lifestyles, until recently, breadfruit has all but disappeared from the diet in Hawaiʻi.

In recent years, breadfruit has become a promising fledgling crop for Hawaiʻi based upon rapidly increasing interest on the part of producers and consumers who are interested in traditional crops for economic development, food security, nutritional (Jones et al. 2011), and cultural reasons. Many visitors are also interested in trying breadfruit as part of their authentic Hawaiʻi experience. A large potential export market for breadfruit products also exists within the large communities of Pacific islanders who reside on the U.S. mainland. In addition, markets can be created in the food service industry where new cuisines have developed in recent years incorporating Asian/Pacific influences into themes such as Hawaiʻi Regional Cuisine.

Three main types of breadfruit are currently grown in Hawaiʻi: 1) the Hawaiian/Tahitian; 2) Micronesian; and Samoan/Maʻafala. Beginning in 2009, the Maʻafala variety propagated by a commercial partner of the Breadfruit Institute was made available via tree sales to farmers and homeowners through outreach programs and commercial nurseries on Kauaʻi, Maui, Oʻahu, and Hawaiʻi Island. The more than 5,000 trees distributed in Hawaiʻi in 2011 are expected to begin bearing fruit in 2015. A breadfruit tree in its prime productive age of 10–50 years can produce 150–250 fruit or 300–500 lbs/year or more (Ragone 2011). At an average retail price

of $2/lb., the 5,000 trees distributed in 2011 are capable of generating $3–5 million dollars in retail sales per year—if the market is properly developed. The current market value of breadfruit is estimated to be a small fraction of this amount. This project initiated the process of turning breadfruit into a high-quality marketable food with high consumer demand.

Despite increasing consumer demand and the imminent production surge in breadfruit, a number of barriers must be overcome in order to increase the market availability, distribution, and commercial competitiveness of breadfruit. Many growers have limited understanding of when a fruit is ready to harvest (Worrell et al. 1998; Ragone and Wiseman 2007) and how to best harvest and handle the fruit to ensure a high quality product is delivered to market. As with any perishable crop—producers must learn proper handling of breadfruit to optimize its value to consumers, and therefore its commercial value. Similarly, chefs and consumers also need essential information on handling and preparation of breadfruit. Without this information, much of the existing and future breadfruit crop will go to waste, either on farm, in transit, in the market, or in the consumer's kitchen.

This project was solely aimed at increasing the competitiveness of breadfruit, a specialty crop as defined by the USDA, to fill demand for locally grown starch.

This project was not submitted to nor funded by another Federal or State grant program.

Project Approach

Work Accomplished in Accordance with Work Plan:

1) **Harvest and Postharvest Guide**
   Write and publish a 24-page guide with color photographs for growers on best practices for harvest/postharvest handling to optimize value in the marketplace.

A) A 28-page harvest and postharvest guide *Breadfruit Production Guide: Recommended practices for growing, harvesting, and handling* was completed and is available for free download from the link:
http://hawaiihomegrown.net/images/stories/pdfs/Breadfruit_Production_Guide_web_edition.pdf

There are over 70 photographs and six diagrams illustrating the concepts presented in the text. Table of contents for the guide:

Preface iii
Introduction 1
Benefits of Best Practices..... 3
Pre-harvest..... 5
Harvest 12
Fruit Maturity Indicators..... 16
Postharvest 22
References and Recommended Reading..... 27

B) The *Breadfruit Production Guide* is also posted at breadfruit.info and breadfruit.org for free download.

C) 600 copies of the guide were printed and distributed as follows:

- To participants at *Breadfruit—From Tree to Table* statewide workshops (450 copies)
- Through the Breadfruit Institute to growers, and to HDOA (150 copies)

2) Handling and Preparation Fact Sheets

Write and publish breadfruit two-page fact sheets for chefs and consumers on how to handle and prepare breadfruit and its nutritional value and versatility as a food.

A) Brief Breadfruit Basics

Brief Breadfruit Basics, a two-page fact sheet that discusses the handling and preparation of breadfruit has been completed and available via the link:
http://hawaiihomegrown.net/images/stories/pdfs/Brief_Breadfruit_Basics.pdf

- The fact sheet is available for download at www.breadfruit.info and www.breadfruit.org.
- One thousand copies have been printed and distributed to participants at *Breadfruit—From Tree to Table* statewide workshops (see below) and other public events.

B) *Breadfruit—Nutritional value and Versatility*, a two-page fact sheet that discusses the nutritional qualities and ways to utilize breadfruit has been completed and available via the link: http://hawaiihomegrown.net/images/stories/pdfs/Breadfruit-Nutrition-Fact-Sheet.pdf

- The fact sheet is available for download at www.breadfruit.info and www.breadfruit.org.
- One thousand copies have been printed and distributed to participants at *Breadfruit—From Tree to Table* statewide workshops (see below) and other public events.

3) Information Cards on Varieties

Write and publish information cards for growers and chefs for each of the three common varieties in Hawai‘i (Hawaiian ‘ulu/Tahitian type, Micronesian, and Samoan/Ma‘afala variety).

Three two-page variety cards have been completed for: Ma‘afala, ‘Ulu, and Meinpadahk and are available via the links:
http://hawaiihomegrown.net/images/stories/pdfs/Breadfruit-variety-Maafala-card.pdf
http://hawaiihomegrown.net/images/stories/pdfs/Breadfruit-variety-Ulu-card.pdf
http://hawaiihomegrown.net/images/stories/pdfs/Breadfruit-variety-Meinpadahk-card.pdf

- The information cards are available for download at www.breadfruit.info and www.breadfruit.org.
- One thousand copies have been printed and distributed to:
  - University of Hawai‘i at Manoa, College of Tropical Agriculture Extension Offices on Maui, Kaua‘i, O‘ahu, and Hawai‘i.
  - The Breadfruit Institute of the National Tropical Botanical Garden

Conclusion and Recommendations about publications: These publications are the first of their kind to be produced in Hawai‘i. They will continue to be useful in years to come as the

breadfruit industry grows in Hawai'i. All publications should be updated periodically and should remain available in print and online.

4) Instructional Videos

Shoot, edit, and produce a 5–10 minute instructional video on best practices for harvest/postharvest handling and a 5–10 minute instructional video on how to handle and prepare breadfruit for chefs and consumers.

The two videos were produced and are available at the HIHomegrown YouTube channel (https://www.youtube.com/user/HIHomegrown) and through www.breadfruit.info and www.breadfruit.org. Videos have also been distributed through the Facebook pages of Hawai'i Homegrown Food Network and the Breadfruit Institute.

A. Video 1: *Harvest and Postharvest Best Practices (2886 views to date)*

The six-minute video highlights:

1. Stages of maturity
2. What to look for in a mature breadfruit
3. How to harvest
4. Draining latex
5. Storing fruit to extend shelf life

Link at: https://www.youtube.com/watch?v=4HflepyXZto

B. Video 2: *Handling and Preparation of Breadfruit with Sam Choy and Friends (3881 views to date)*

The 15-minute video highlights:

1. Sap issues and how to remedy
2. Different methods of cutting and peeling fruit
3. Steaming
4. Boiling
5. Frying
6. Baking
7. Variety of Dishes

Link at: https://www.youtube.com/watch?v=cgr3eF_-TKc

5) Workshops

A series of four workshops will be held throughout Hawai'i to provide hands-on instruction on the information covered in the guide and video.

A) Workshop 1: November 9, 2013, Kona, Hawai'i

The first workshop was held on November 9, 2013 in Kona, Hawai'i

Content

Participants were rotated every half hour through six different presentations as follows:

- Working with Variety: Introduction to three breadfruit varieties in Hawaiʻi: How to identify, when to pick, and distinguishing between green, mature and ripe breadfruit. Presented by Dr. Diane Ragone, Director, Breadfruit Institute of the National Tropical Botanical Garden.
- Tree to Table: Harvesting techniques, tricks and tools, and postharvest handling. Presented by Ian Cole, Collection Manager, Breadfruit Institute of the National Tropical Botanical Garden.
- Beyond Sticky—Basic Preparation and Handling: How to prepare breadfruit for use in a variety of dishes or for storage. Presented by Shirley Kauhaihao, Hoʻoulu ka ʻUlu.
- Some Like It Ripe: Making gourmet dishes from ripe breadfruit. Presented by John Cadman, Pono Pies.
- Going To Market: Where to sell breadfruit? How much to charge? What kinds of value added products are viable? Presented by Craig Elevitch, Hawaiʻi Homegrown Food Network and Hoʻoulu ka ʻUlu project.
- Food from the Gods: Breadfruit and the cultural importance in the Pacific Islands, presented by Kuʻulei Keakealani, Educational Coordinator, Kaʻūpūlehu Interpretive Center at Kalaemanō.

Publicity

Press releases were sent to the following media outlets: West Hawaiʻi Today, Hawaiʻi Tribune Herald, Big Island Weekly, North Hawaiʻi News, Hawaii247.com. The following print and online sources published editorial content or the press release:

- Big Island Weekly: http://bigislandweekly.com/sections/e/breadfruit-moves-deliciously-tree-table.html
- Hawaii247.com: http://www.hawaii247.com/2013/10/20/workshop-helps-increase-breadfruit-appetite-nov-9/
- DamonTucker.com: http://damontucker.com/2013/10/03/workshop-helps-increase-the-appetite-for-breadfruit/

Calendar listings were submitted to the above, as well as to KonaWeb.

Growers, buyers and chefs, as well as the general public, were targeted; the project staff utilized the email lists of project partners such as:

- Kona-Kohala Chefs Association/ACF
- Hawaiʻi Tropical Fruit Growers
- UH-CTAHR
- Hawaiʻi Homegrown Food Network
- Kamehameha Schools
- Hawaiʻi Island Landscape Association

- Amy B.H. Greenwell Ethnobotanical Garden
- National Tropical Botanical Garden

Additionally, the workshop was shared and viewed widely on Facebook through Hawaiʻi Homegrown Food Network, Breadfruit Institute, Diane Ragone, Andrea Dean, and Kamehameha Schools.

Attendance

One hundred-twenty people pre-registered and attended the event. This number exceeded the project goal of 40 participants by 200 percent.

B) Workshop #2: January 9, 2014—Maui, UH Maui College, Kahului

The second workshop was held on January 9, 2014, at UH Maui College in Kahului, Maui.

Content

Participants were rotated every 40 minutes through five different presentations as follows:

- Working with Variety: Introduction to three breadfruit varieties in Hawaiʻi: How to identify, when to pick, and distinguishing between green, mature and ripe breadfruit. Presented by Dr. Diane Ragone, Director, Breadfruit Institute of the National Tropical Botanical Garden.
- Tree to Table: Harvesting techniques, tricks and tools, and postharvest handling. Presented by Ian Cole, Collection Manager, Breadfruit Institute of the National Tropical Botanical Garden.
- Some Like It Ripe and Beyond Sticky: Basic Preparation and Handling: How to prepare breadfruit for use in a variety of dishes or for storage. Making gourmet dishes from ripe breadfruit. Presented by John Cadman, Pono Pies.
- Going To Market: Where to sell breadfruit? How much to charge? What kinds of value added products are viable? Presented by Craig Elevitch, Hawaiʻi Homegrown Food Network and Hoʻoulu ka ʻUlu project.
- ʻUlu and its Relationship to Hawaiian Culture: presented by Kalapana Kollars, Musician and Cultural Practitioner.

Breadfruit trees and cookbooks were available for sale at the event.

Publicity

Press releases were sent to the following media outlets: *Maui Time Weekly*, *Maui News*, *StarAdvertiser*, *Hawaii Public Radio*, *Pacific Radio Group*, KAOI, KPOA and County of Maui Communications Office. The following print and online sources published editorial content or the press release:

MauiTime News Blog: http://mauifeed.com/maui-news/january-workshop-aims-to-increase-appetite-for-breadfruit/

Maui Time Weekly: http://mauifeed.com/maui-news/breadfruit-tree-to-table-initiatives-on-maui-hooulu-ka-ulu/

Hawai'i State Department of Agriculture Blog: http://hdoa.hawaii.gov/blog/main/ulu-workshops/

MauiNews.com: http://mauinews.com/page/content.detail/id/580536/Workshop-all-about-breadfruit.html?nav=15

Calendar listings were submitted to the above. Growers, buyers and chefs, as well as the general public, were targeted, therefore project staff utilized the email lists of project partners such as:

- Hawaii State Department of Agriculture
- Whole Foods Markets
- John Cadman
- Hawai'i Tropical Fruit Growers
- Hawai'i Homegrown Food Network
- Kamehameha Schools
- National Tropical Botanical Garden
- MALP: Maui Association of Landscape Professionals
- UH-CTAHR
- Haiku Helen, who administers an email newsletter that is distributed to over 1,000 people on Maui.

The workshop was shared and viewed widely on Facebook through Hawai'i Homegrown Food Network, Breadfruit Institute, Diane Ragone, Andrea Dean, Kamehameha Schools, and others.

Attendance

Seventy-seven people pre-registered and attended the event. This number exceeded the project goal of 40 participants by about 90 percent.

C) Workshop #3: January 10, 2014—O'ahu, Bishop Museum, Honolulu.

The third workshop was held on January 10, 2014, at Bishop Museum, Honolulu.

Content

Participants were rotated every 40 minutes through five different presentations as follows:

- Working with Variety: Introduction to three breadfruit varieties in Hawai'i: How to identify, when to pick, and distinguishing between green, mature and ripe breadfruit. Presented by Dr. Diane Ragone, Director, Breadfruit Institute of the National Tropical Botanical Garden.
- Tree to Table: Harvesting techniques, tricks and tools, and postharvest handling. Presented by Ian Cole, Collection Manager, Breadfruit Institute of the National Tropical Botanical Garden.
- Some Like It Ripe and Beyond Sticky: Basic Preparation and Handling: How to prepare breadfruit for use in a variety of dishes or for storage. Making gourmet dishes from ripe breadfruit. Presented by John Cadman, Pono Pies.

- Going To Market: Where to sell breadfruit? How much to charge? What kinds of value added products are viable? Presented by Craig Elevitch, Hawaiʻi Homegrown Food Network, and Hoʻoulu ka ʻUlu project.
- Kū Mai Ka ʻUlu: Revealing the cultural significance of ʻulu in Hawaiʻi through moʻolelo and Cultural Collection items presented by the Bishop Museum Culture Education staff.

Breadfruit trees, breadfruit and cookbooks were available for sale at the event.

Publicity

Press releases were sent to the following media outlets: StarAdveriser, MidWeek, and *Hawaii Public Radio*. Paid ads were run in *MidWeek*. The following print and online sources published editorial content or the press release:

KHON: Ulu workshop emphasizes fruit's economic impact (link removed)

KITV4: http://www.kitv.com/news/hawaii/how-you-can-grow-and-use-breadfruit-in-your-meals/23858298

Flyers up: http://www.bishopmuseum.org/media/2014/pr14001.html

Examiner.com: http://www.examiner.com/article/breadfruit-workshops-on-maui-o-ahu-and-kauai

The Sustainable Leader: http://www.thesustainableleader.org/ai1ec_event/breadfruit-from-tree-to-table-oahu-workshop/?instance_id=

Calendar listings were submitted to the above. Growers, buyers and chefs, as well as the general public, were targeted, therefore staff utilized the email lists of project partners such as:

- Hawaii State Department of Agriculture
- Whole Foods Markets
- Hawaiʻi Tropical Fruit Growers
- Hawaiʻi Homegrown Food Network
- Kamehameha Schools
- Hawaii People's Fund
- Bishop Museum
- National Tropical Botanical Garden
- Pacific Gateway Center
- Hawaiʻi Food Policy Council
- Kanu Hawaiʻi
- Kualoa Ranch
- UH-CTAHR

The workshop was shared and viewed widely on Facebook through Hawaiʻi Homegrown Food Network, Breadfruit Institute, Diane Ragone, Andrea Dean, Kamehameha Schools and others.

One hundred sixtey-nine people pre-registered and 150 people attended the event. This number exceeded the project goal of 40 participants by 300 percent.

D) Workshop #4: January 11, 2014—Kaua'i, Breadfruit Institute of the National Tropical Botanical Garden, Kalaheo

The fourth workshop was held on January 11, 2014, at The Breadfruit Institute of the National Tropical Botanical Garden in Kalaheo, Kaua'i.

Content

Participants were rotated every 40 minutes through five different presentations as follows:

- Working with Variety: Introduction to three breadfruit varieties in Hawai'i: How to identify, when to pick, and distinguishing between green, mature and ripe breadfruit. Presented by Dr. Diane Ragone, Director, Breadfruit Institute of the National Tropical Botanical Garden.
- Tree to Table: Harvesting techniques, tricks and tools, and postharvest handling. Presented by Ian Cole, Collection Manager, Breadfruit Institute of the National Tropical Botanical Garden.
- Some Like It Ripe and Beyond Sticky: Basic Preparation and Handling: How to prepare breadfruit for use in a variety of dishes or for storage. Making gourmet dishes from ripe breadfruit. Presented by John Cadman, Pono Pies.
- Going To Market: Where to sell breadfruit? How much to charge? What kinds of value added products are viable? Presented by Craig Elevitch, Hawai'i Homegrown Food Network, and Ho'oulu ka 'Ulu project.
- Food From the Gods: Breadfruit and the cultural importance in the Pacific Islands, presented by Wayne 'Palala' Harada.

Breadfruit trees and cookbooks were available for sale at the event.

Publicity

Press releases were sent to the following media outlets: *The Garden Isle*, *StarAdvertiser*, *MidWeek*, *Hawaii Public Radio*, KKCR, KONG. Paid ads were run in *MidWeek*. The following print and online sources published editorial content or the press release:

The Garden Island: http://thegardenisland.com/lifestyles/food-and-cooking/from-tree-to-table/article_a8edeb4c-7293-11e3-b9d3-001a4bcf887a.html?mode=jqm

MidWeek: http://www.midweekkauai.com/mixing-breadfruit-new-years/

Calendar listings were submitted to the above. Growers, buyers and chefs, as well as the general public, were targeted, therefore project staff utilized the email lists of project partners such as:

- Hawaii State Department of Agriculture
- Whole Foods Markets
- Hawai'i Tropical Fruit Growers
- Hawai'i Homegrown Food Network
- Kamehameha Schools
- Hawaii People's Fund

- National Tropical Botanical Garden
- UH-CTAHR
- Malama Kauai

The workshop was shared and viewed widely on Facebook through Hawaiʻi Homegrown Food Network, Breadfruit Institute, Diane Ragone, Andrea Dean, Kamehameha Schools and others.

The workshop page at: http://hawaiihomegrown.net/breadfruit-workshop received 2807 hits between August 26, 2013 and May 5, 2014.

Sixty-six people pre-registered and 70 people attended the event. This number exceeded the project goal of 40 participants by about 75 percent.

Conclusion and Recommendations: The workshops on each island were sold out to the capacity of the rooms. The demand for increased knowledge about growing, harvesting and utilizing breadfruit as a commercial crop and for local food self-sufficiency is very strong. The workshop formats worked well to impart in-depth information in a relatively intimate setting.

Enhanced Competitiveness of Breadfruit

All of the above five activities enhanced the competitiveness of breadfruit as a crop by:

- Targeting growers, markets, and consumers
- Educating on proper harvest timing and methods, postharvest handling and storage, and the essential concepts of preparing breadfruit in various dishes.
- Highlighting market information and the potential for value-added products from breadfruit.

Contributions and Roles of Project Partners

All of the project partners assisted with disseminating information.

- Amy B.H. Greenwell Ethnonotanical Garden provided the venue and set-up at no cost.
- Bishop Museum partnered by providing the venue and set-up at low cost, as well as cultural practitioners and publicity support.
- Kamehameha School Land Assets Division provided support, as well as outreach and publicity on all islands.
- The Breadfruit Institute of the National Tropical Botanical Garden is a co-equal partner in the Hooulu ka ʻUlu project and as such provided logistical and outreach support, as well as content expertise.
- Hawaiʻi State Department of Agriculture provided outreach support through its email contacts as well as through the press office.

Goals and Outcomes Achieved

Goal: Specialty crop growers who attend one of the four workshops will learn best practices in harvest and postharvest handling of breadfruit.

Target: The project staff anticipates that a minimum of 40 attendees will attend each of the four workshops (total 160). These attendees will increase their knowledge of harvest and postharvest handling of breadfruit by 65 percent as a result of completing these workshops.

Establishing baseline: A pre-workshop survey designed by the presenters will be given to workshop attendees as part of the workshop enrollment process to assess their knowledge of key concepts, establishing their baseline knowledge.

Performance measure: A post-workshop survey of attendees will determine their increase in knowledge of the key concepts; results will be compared to pre-surveys for reporting.

Target	Expected	Actual	Conclusion
40 attendees for each of the four workshops. Attendees will increase their knowledge by 65 percent.	160 attendees 65 percent increase knowledge	417 attendees **Kona:** Pre-Survey: 73.5 percent with STDEV of 12.73 Post-Survey: 87.5 percent with STDEV of 8.45 **Oahu, Maui, Kauai:** Pre-survey: 77.2 percent with STDEV of 10.08. Post-Survey: 85.3 percent, with STDEV of 10.86.	Project goal of attendees exceeded by 160 percent Attendees increased knowledge by 10–19 percent, less than the target of a 65 percent increase. Given the pre-survey knowledge level, the 65 percent goal was not mathematically possible.

<u>Potential Economic Impact</u>

Economic impact is a long-term goal, however, the workshops resulted in:

- Whole Foods expanding the use of breadfruit in their ready to eat department, thereby increasing the market for breadfruit on Maui and O‘ahu.
- A number of participants considering the launch of value-added products.

Beneficiaries

Beneficiaries	Activity	Impact	Number

Breadfruit Growers, Chefs and Consumers	Workshops, Educational Materials, Instructional Videos	• Increased knowledge of when to harvest breadfruit at the optimum stage of development for the three most common breadfruit varieties in Hawai‘i
		• Increased knowledge of best practices for harvesting and postharvest handling of breadfruit to deliver a good quality product to markets.
		• Optimize the use of existing breadfruit crops by reducing waste through proper harvest and handling.
		• Increased acceptability and demand for breadfruit by markets and consumers through:
		  ○ Receiving good quality fruit
		  ○ Understanding of handling and preparation.
		  ○ Understanding nutritional benefits.
			417 participants
			600 guides printed
			1,000 views/year (estimated)

This project benefitted growers (commercial as well as backyard), markets, and consumers by educating them about proper harvest timing and methods, postharvest handling and storage, and the essential concepts of preparing breadfruit in various dishes. The project produced a farming guide of best harvest/postharvest practices, fact sheets for chefs and consumers, instructional videos, and four workshops to help interested farmers. These resources are available for free download, benefitting thousands of consumers (based on views). The project benefitted potential new markets by providing guidance and facts to maximize successfully growing and using breadfruit and prevent their becoming adverse to breadfruit if the product is poor quality and quickly spoils—new consumers who do not have a good first-time experience with the fruit will not want to purchase or consume it again.

Lessons Learned

Staff insight

- Farmers, consumers and chefs in Hawai‘i are very enthusiastic about breadfruit.
- Video production always takes more time and effort than one anticipates—allow more time for editing and revision.
- Having all of the printed materials for distribution online and at future events is a great benefit to the community.
- Measuring increased knowledge is difficult and time consuming.

Unexpected outcomes or results

- Project staff did not expect such an overwhelming positive response to the workshop. On all islands, the workshops had to close registration due to space limitations.
- The format used, when space permitted, of rotating between 5–6 concurrent workshop sessions was especially effective in addressing short attention spans and allowing people to learn in small groups where questions were encouraged.

If goals/outcomes not achieved

- All goals and outcomes were achieved.

Additional Lessons Learned

- Hold workshops in larger venues in the future.
- Allow for walk-ins to compensate for about 15 percent no-shows.

Conclusion and Recommendations: The workshops on each island were sold out to the capacity of the rooms. The demand for increased knowledge about growing, harvesting and utilizing breadfruit as a commercial crop and for local food self-sufficiency is very strong. The workshop formats worked well to impart in-depth information in a relatively intimate setting.

Contact Person

Project Leader

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Alternate Contact

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National Tropical Botanical Garden
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A New Strategic Plan for Hawaii Tea – Step One, the Propagation Initiative

Final Report

The Tea Chest
http://www.teachest.com/

Project Summary

Purpose of this project was to produce a significant number of plants and strategically distribute them to qualified farmers throughout the state to facilitate crop commercialization. This project sought to expand the footprint of tea around the state in addition to current locations.

This project also sought to create a network of growers with commercial farming experience and infrastructure to invest in the crop. For 14 years, tea has been grown and studied by the University of Hawaii. It has been cultivated in the private sector by small scale farmers and hobbyists for over a decade but has yet to become commercially viable.

Project Approach

To achieve the project purpose, the work plan included four tasks:

1. Produce 40,000 new tea plants
2. Cultivate 6+ new acres of tea statewide
3. Establish 24 new tea farmers statewide
4. Establish a program to educate and support tea farmers statewide

Produce 40,000 new tea plants

40,000 plants in two releases of 20,000 were propagated from seeds and distributed to 25 farmers on five islands: Maui, Oahu, Molokai, Lanai and the island of Hawaii. With the research conducted by the project staff, they have determined that this project represents one of the largest coordinated efforts to propagate tea statewide.

The propagation of each batch of the seedlings took place over a six to eight-month period. Big Island Tea proved to be a good Tea Propagator for the project and handled the production of the new plants. New plants were propagated from seeds and this encouraged natural variation within the batches that could potentially protect the crop when it was transplanted in other areas around the state. Rooted seedling propagation yield was over 95 percent survival.

Areas that naturally fit the pH and rainfall criteria are not common on all islands. Most soil in Hawaii has alkaline pH around 6.0-6.5 with less than average annual rainfall of 85 inches, which is ideal for tea. Project staff considered testing the tea plants in alkaline soil, to look for potential plants that might thrive in alkaline soil. This approach was left for a future field test.

The project worked with tea that already existed in Hawaii, varieties that had been cross-pollinated over time and which were acclimated to the microclimates of Hawaii. One test

conducted during the project was to take tea plants from Hawaii Island and monitor their growth on the other islands.

Cultivate 6+ acres of tea statewide

The project planted 5.3 acres of tea statewide, short of the goal to cultivate 6+ acres of tea statewide due to three factors.

1. The impact of Hurricanes Iselle and Julio in July and August 2014. Two farms on Maui lost some of their crops.
2. Plants designated for Lanai did not survive. Lanai was chosen as a farm site because the vision of the landowner (Ellison) was to create a sustainable, diversified agriculture community. However, the time line for development of the island's agricultural assets was delayed in order to concentrate on renovating the two hotels on the island. The tea plants did not survive the move to Lanai due to lack of proper care.
3. The logistics and protocols to ship plants from Big Island Tea to growers on other islands required the seedlings to be bare-rooted to reduce the threat of invasive species being transported and introduced to the other islands. This process negatively impacted the survival rate of the plants that were moved from Hawaii Island to Maui, Molokai and Oahu. The result was 30 percent mortality of the tea plants. The established protocol was:
   - Remove the seedling from the propagation tray.
   - Wash off all soil so the seedling is bare-rooted.
   - Wrap seedlings in layers of damp paper towels to keep them moist while in transit.
   - Pack wrapped seedlings in Ziploc bags to trap moisture and create some air cushion.
   - Pack these bags into cardboard boxes for shipment. Newspaper was used to ensure the seedlings were snug but not crushed.

The shipments were received in good condition and project staff determined this packing and shipping procedure should be followed in the future. However, for young seedlings, the process of bare-rooting at the young seedling stage was likely too much of a shock and resulted in 30 percent mortality and may stunt the growth of the plant. It is too early to tell if the stunted plants will grow large enough to be transferred to the field.

Establish 24 new tea farmers statewide

Twenty-four growers were selected for participation in the project based on location, experience and infrastructure. Farms within areas that have conditions suitable for tea growing – annual rainfall of 85 inches and soil pH of 4.5-5.5 -- were given first consideration. Farms with less than ideal annual rainfall with irrigation, were considered next.

A diverse group of growers participated in the project that included conventional, organic and biodynamic farms. Some farms intend to continue propagating using seedlings as germplasm, others indicated a preference for cuttings. Farmers in the project have commercial experience, growing crops that include coffee, cacao, macadamia nuts, koa trees, basil, avocados, mamaki and breadfruit, which provided revenue to the participating farmers during the start-up period, which is from one to five years.

Project staff also recruited growers in areas with the recommended conditions that might enhance the market value of tea as a future crop. Kona, Hawaii, with global brand recognition

due to the success of Kona Coffee, has been impacted by a 30 percent decline in annual yield due to the coffee borer beetle that affects the coffee bean quality. This decline in yield has increased the interest of the coffee growers to look for an alternative crop. Timing of this project and the impact of the coffee berry borer resulted in five farmers in Kona now growing tea. The Kona location should help the farmers' branding efforts when they produce Kona tea products.

The market has historically placed a premium on teas that are grown at high elevations. The project has four growers at or above the 4000-foot elevation on Maui and Hawaii Island.

Establish a program to educate and support tea farmers statewide

Project approach was to establish four to five growers within a geographic region to foster a working relationship among the growers with the intent that they could then work together to solve common issues like labor for maintenance, pest control and plant adaptation.
The ideal working group consisted of two or more growers willing to share information about crop development while maintaining independently owned and operated farms. Working groups have been formed on Oahu, Molokai, Maui and Hawaii Island. This community minded approach connected farmers to one another through shared information that in turn saved the participating farmers both time and money. Farmers shared information on growing techniques and technology. An example of this approach improved the pots used to raise the seedlings. The propagator established that the best protocol would be to grow the seedlings in 6-inch pots. A participating farmer in the group had experience raising koa trees in 9-inch tree pots. This group of farmers had great success with the tea plants using this method and many of the growers switched to the 9-inch tree pots because they found the 9-inch pot reduced the cost of potting soil and labor when transferring the plants to the field.

Discussions on future challenges to commercialization including the availability of adequate and affordable labor to harvest and process the tea have taken place in some working groups.

Two types of meetings were held to foster relationships and build community.

- Larger group training workshops were held with the University of Hawaii College of Tropical Agriculture and Human Resources. These workshops covered soil sampling and management, field planting, crop maintenance and pest control.
- Small-group meetings for growers within the same geographic area were also held to build get to know each other and share information. Farm tours on Maui, Oahu and Hawaii Island were also conducted.

The training curriculum provided information to grow tea to an audience of existing farmers with experience growing a commercial crop other than tea (for example, macadamia nuts or coffee). The program was broken down into three sections that coincided with the stage of crop development.

1. Transplanting and caring for the seedlings.
2. Soil preparation and field mapping
3. Soil management

The farmers learned how to care for the seedlings until they are ready to transfer to the field. Project staff also hosted farm tours on Maui, Oahu and the Big Island so growers could interact, discuss tea cultivation and see how other farmers were planning to expand to commercial scale. Project staff also hosted a tour at the University of Hawaii's Mealani Research station so the growers could see the most developed tea fields in the state. This experience provided perspective on crop planting and field mapping.

Two trials to overcome alkaline soil pH are in test phase. The first trial is to grow tea on agricultural land that has been acidified by years in pineapple production. The second is to grow tea in conjunction with aquaponic fish production and use the acidified wastewater produced by the fish to irrigate the crop. Both trials are taking place on Oahu.

Goals and Outcomes Achieved

Goals	Outcomes Achieved
1. Grow 40,000 new tea plants	40,416 distributed
	21,666 plants on Hawaii island
	6,250 plants for Oahu
	7,250 plants for Maui
	3,750 plants for Molokai
2. Plant 6 new acres of tea statewide	5.26 acres planted statewide by Spring 2016
21,666 of plants on Hawaii island	19,933 yield = 3.33 acres
6,250 plants for Oahu	4,187 yield = .70 acres
7,250 plants for Maui	4,857 yield = .81 acres
3,750 plants for Molokai	2,512 yield = .42 acres
1500 plants for Lanai	0 yield
3. 24 new tea growers statewide	25 new farm started growing tea
4. Program to educate and support farmers	Workshops conducted on Oahu, Maui and Hawaii
	Regional group meetings on Oahu, Maui and Hawaii
	Farm tours on Oahu, Maui and Hawaii
	Hubs/Co-ops in Kona, Maui, Molokai and Oahu

Propagation method proved successful. The 40,000 plants were successfully grown and distributed. Ninety-five percent survival rate was achieved. Losses were attributed to damage during shipping.

Eighty-four percent of the plants after year one were successfully transferred to the field. Loss was because some plants never reached adequate size for field transfer. This was likely caused by either variation due to propagation from seeds, or disruption to the growing cycle at the

time of shipping that stunted the natural growth pattern resulting in the plant never recovering before field transfer.

Growers with commercial operations have now joined the industry and are making investments into the crop. "Tea hubs" made up of multiple growers and multiple acres of plants to are discussing potential processing facilities for Oahu, Maui, Molokai and Hawaii Island (Mountain View and Kona). Project staff is hopeful that five to six processing hubs will form to help commercialize the crop.

This project also diversified the growing conditions of tea grown in Hawaii. The various project sites added branding value to Hawaii Grown Tea. These marketable attributes include tea being grown:

- At 4500 feet elevation
- Organic certification
- On a biodynamic certified farm
- Among cacao, macadamia nuts, and native koa trees
- In a pineapple field too acidic for most fruits and vegetables
- On an aquaponic farm to test use of water run off to acidify and fertilize the tea
- At 2500 feet elevation among coffee and other native plants

Post project, the staff expects that a total of 31,000 plants will be transferred to the field. Project staff will continue to work with the farmers to develop a consistent propagation method to continue to build out their fields.

Tea must go through value-added processing before its commercial value is determined. Therefore, it cannot be said at this stage that the crop is now proven to be a viable profitable specialty crop. What the project has expanded the footprint of tea to other parts of around the state. Therefore, this crop can help manage land and resources on small farms. Project sites now growing tea have proven marketable assets which can add market value to the crop including point-of-origin (Kona, Maui and Oahu), elevation (4000' on Maui and Hawaii which is the highest elevation of tea production to date), organic cultivation and biodynamic cultivation.

Beneficiaries

The 25 farms that participated in the project and propagated tea seedlings (listed).
The 30 tea growers that participated benefited from this project through hands-on planting experiences.

Hawaii Island, Oahu, Maui and Molokai are the four islands that now have additional tea production. The plants sent to Lanai did not survive, however, this project has increased the interest of the landowner to begin planting tea. The farms are listed below:

HAWAII ISLAND	OAHU
Hawaii Mountain Tea	Fat Law Farms
Island Princess	Mililani Agricultural Park, LLC

Kona Mountain Coffee Farm	Mari's Garden
Buddha's Sanctuary	Kakoo Oiwi
Dr. Paulo's Farms	
Kona Haven Coffee	**MAUI**
Moonstruck Organics	Na Liko Tea
Big Island Tea	JUSTinfusions LLC
Phil's Farm	Manawai Estate Chocolate
Kanakaukoa	Ulupalakua Ranch
Kau Green Mountain Coffee	
Alia River Farm	**MOLOKAI**
Waialae Falls Farm	Puu o Hoku Ranch
	Pualani o Molokai
LANAI	Bare Foot Farm
Pulama Lana'i	

Lessons Learned

In the case of Hawaii Island, where transporting the seedlings was not an issue, the process of keeping the seedlings in their propagation trays and then transferring to pots or similar vessels worked well with a survival rate of 92 percent.

Plan on more than one location for a field trial. In the case of Lanai, the plants destined for propagation on that island did not survive because the landowner decided to concentrate on other ventures for the island, which resulted in the plants being lost to lack of proper care.

Plan on inter-island shipping protocols affecting the condition of the seedlings. To reduce the threat of invasive species being transported from Hawaii Island to growers on Maui, Molokai and Oahu, the seedlings had to ship bare-rooted, which was a shock to the seedlings and resulted in a 30 percent mortality. The lesson learned is to either grow the seedlings in soilless media or to transport them at a later stage of growth, when they can withstand the bare-root preparation. Some plants appear to be stunted in growth. It is too early to tell these plants will grow large enough to be transferred to the field.

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Additional Information

Project Propagator Eliah Halpenny of Big Island Tea. Seeds with coverings removed.

Seedlings being propagated under shade

Rooted seedlings

Interisland shipments of bare-rooted seedlings shipped to Oahu, Molokai and Maui

Grower workshops held on Oahu and Hawaii Island

Seedlings at 6 months old

Tea plants at 1 year in the ground

Hawaii Organic Program Office: Research and Development

Final Report

The Kohala Center
http://www.kohalacenter.org/

Project Summary

Background: Organic agricultural producers operating in the State of Hawaii currently do not have an organic program office where Hawaii-specific information on infrastructure, production, post-harvest processing, marketing, certification, and business development can be obtained. The Hawaii organization that served the organic agricultural industry in the past, Hawaii Organic Farmers Association (HOFA), turned over certification operations to other programs accredited by the USDA National Organic Program (NOP) as of August 1, 2011, due to lack of sufficient funding. There has been little programmatic capacity on the part of HOFA since that date, leaving Hawaii's existing, new, and beginning organic farmers with limited technical and certification support.

By 2012, there was sufficient interest among organic producers and agricultural support organizations such as the University of Hawaii, College of Tropical Agriculture and Human Resources (CTAHR) and the Hawaii Farm Bureau Federation (HFBF) Organic Committee to reconstitute a hub for services to the industry. The Kohala Center (TKC) conducted a feasibility study to determine the best vehicle and mix of services for such a central information and service hub. The proposed one year feasibility study process incorporated: (1) a stakeholder assessment of the industry derived through archival data and a series of advisory committee meetings, (2) a state-wide organic industry conference, and (3) the preliminary development of a new organic program office informed by the feasibility study findings.

Importance and Timeliness: The lack of organic production and marketing support services in Hawaii were a disadvantage to the state's organic growers and detracted from their competitive advantage in several areas, including research and development, production, processing, and the marketing of organic products locally, nationally, and internationally.

With HOFA inactive for almost two years, representatives from the organic farming industry expressed interest in reviving HOFA or creating an alternative. The project staff consulted with the National Organic Standards Board, UH CTAHR, and the Hawaii Department of Agriculture (HDOA). There was agreement that a thoughtful and inclusive statewide process was necessary to bring industry leaders together to design an organizational structure that will be acceptable and useful to as many people as possible, which was the goal of this project.

This project solely enhanced the competitiveness of organic specialty crops and was not submitted to nor funded by another Federal or State grant program.

Project Approach

Summary of Activities and Tasks: TKC convened an Organic Industry Advisory Group (OIAG), comprised of 10 organic agricultural producers and professionals from across the state, to:

1. Determine the key issues and barriers faced by Hawaiʻi's organic stakeholders;
2. Develop a series of six public surveys and analyze collected data;
3. Plan a one-day statewide conference to present preliminary findings and secure input from industry members;
4. Translate collected data into a list of recommendations to be considered and carried out by various entities across the state; and
5. Recommend an organizational structure to address the issues and needs of Hawaiʻi's organic industry.

Project findings were primarily gleaned from the six public surveys (Producers, Processors, Distributors, Agricultural Professionals, Buyers and Sellers, Consumers) deployed in July 2013. Based on the initial issues and assumptions identified by the members of the OIAG, the surveys were developed to test these assumptions and to garner additional data to achieve greater clarity about the issues of greatest importance to Hawaiʻi's organic stakeholders. Among the project's findings:

- The significant, growing demand for locally grown, certified-organic produce and products in Hawaiʻi greatly exceeds supply.
- Inconsistent supply and quality of local, certified-organic produce are primary barriers to production, distribution, and consumption.
- Hawaiʻi consumers who prefer certified-organic food perceive its benefit (1) to be better for their families' health, (2) to be free of synthetic pesticides and toxins, and (3) to be free of genetically modified organisms (GMO).
- Consumers who prefer food choices to be both certified organic *and* local are equally split between those who would choose local, non-organic vs. those who would choose organic, non-local when both options are not available.
- The perceived—and real—financial and paperwork requirements associated with obtaining and maintaining organic certification are significant deterrents to farmers and producers obtaining and/or maintaining certification.
- Hawaiʻi's past, current, and prospective organic producers indicate a strong desire for a local, independent organic certifier based in Hawaiʻi.
- As new food safety requirements and regulations go into effect, organic producers indicate a preference for a combined organic and food safety certification service, as well as a government cost-share program to defray costs.
- There is ample demand for locally produced fertilizers and other input materials specially formulated for Hawaiʻi's unique environments to reduce importation/transport costs.
- Education is needed to help non-certified producers and distributers understand the consequences of inaccurately promoting their products as "organic" and to comply with laws governing the use of the term.

Through its members' own experiences, the input of organic industry leaders, and data gathered from a series of public surveys, the OIAG identified 57 issues and barriers inhibiting organic food production and distribution in Hawaiʻi, and 93 potential opportunities and solutions to address them. The issues and barriers that the group felt could realistically be addressed and potentially solved were carried forward and assigned to one or the following categories:

- Representation
- Certification
- Land
- Inputs
- Supply
- Economic Viability
- Processing
- Distribution
- Marketing
- Research, Education, and Enforcement

Categories and draft recommendations were presented at the "Growing Organics: Moving Hawaiʻi's Organic Industry Forward" conference in Kailua-Kona on October 28, 2013, and discussed in roundtable sessions with conference attendees. Based on attendee input and feedback, the OIAG further refined the recommendations.
Of the 58 final recommendations developed by the OIAG and included in this report, seven were deemed by OIAG members to be of greatest importance:

Representation

- Create and recognize an independent, representative organic industry association (OIA) to provide advocacy, education, marketing, and support to Hawaiʻi's organic industry members.
- Allocate new and/or existing staff at HDOA to provide organic information, education, technical assistance, marketing support, and explore offering local organic certification services.
- Create an Organic Industry Advisory Council comprised of organic industry representatives to advise the department on issues relevant to organic production, distribution, procurement, education, and policy.

Certification

- Allocate annual state-level funding to maintain a 75 percent cost-share level for organic certification in the event national cost share is discontinued.

Land

- Create county-level land classifications for "certified organic" with a lower tax rate to incentivize ecologically responsible land management practices.

Inputs

- Fund additional state-level research and extension outreach activities on the following priority areas: (1) nitrogen-fixers and cover crops; (2) NOP-compliant inputs suitable for Hawaiʻi; (3) local organic seed breeding and production; and (4) organic pest and disease control.

Distribution

- Create food hubs on each island, for both conventional and organic marshaling and distribution, to provide consistent, high-quality supply of local product.

The full list of Key Findings and Recommendations can be found in the full published report *Growing Organics: Moving Hawai'i's Organic Industry Forward* and available for download at http://www.kohalacenter.org/archive/laulima/oiag/HiOrganicIndustry_FinalReport_2014.pdf.

No commodities other than specialty crops received benefits: To ensure that all grant funds solely enhanced the competitiveness of specialty crops, conference and meeting costs for attendees who are not affiliated with specialty crops was paid with cash and in-kind cash match from The Kohala Center. Funds were reinvested in the project.

Significant contributions and role of project partners: A project steering committee was formed and has met in person five times during the past year, one additional time in terms of what was originally outlined in the work plan. The Organic Industry Advisory Group (OIAG) consists of the following 10 project partners, representing important sectors of the industry and four of the major islands:

ONO Organic Farms (Kipahulu, Maui)
Kanalani Farm (Hōnaunau, Hawai'i Island)
Hāmākua Agricultural Cooperative (Pa'auilo, Hawai'i Island)
Hawaii Department of Agriculture
Down to Earth (Kailua, O'ahu)
Kuaiwi Farm (Captain Cook, Hawai'i Island)
Waioli Farm (Hanalei, Kaua'i)
MA'O Organic Farms (Wai'anae, O'ahu)
Farmer and former State Senator (Hilo, Hawai'i Island)
College of Tropical Plant and Soil Sciences, University of Hawai'I (Honolulu, O'ahu)

Data from this group about the challenges and opportunities for Hawaii's organic agriculture industry was been collected and discussed by the OIAG. A questionnaire about these issues was circulated to the public in six categories: producers, buyers-sellers (retailers), distributors, processors, agricultural professionals, and consumers. Preliminary findings from the 345 surveys returned were presented to the OIAG for discussion. Feedback and careful analysis of this data was undertaken by the CTAHR staff.

Category	Number of Respondents
Producers	104
Processors	24
Buyers and Sellers	16
Distributors	6
Agricultural Professionals	60
Consumers	135
TOTAL NUMBER OF RESPONDENTS TO SURVEY	345

An open meeting and conference was held on October 28, 2013, to both solicit additional information about the needs, challenges, and opportunities for Hawaii's organic food industry,

to share information about the process of organic certification and food safety certification, to facilitate connections between organic food producers and distributors-buyers, to discuss policy issues with representative decision-makers at the county and state levels, and to elicit input about the form that industry representation should take within the state government and in the private sector. One hundred forty people from around the major Hawaiian Islands attended this one day meeting.

Goals and Outcomes Achieved

Activities Completed to Achieve Performance Goals and Measureable Outcomes

There were two primary objectives of this project, with associated sub-objectives:

1. Conduct an Organic Program Office Feasibility Study
   Gather and synthesize market and industry analyses for increasing supply of organic products from farm to table in the State of Hawaiʻi. Obtain stakeholder input (agricultural agencies and organizations, organic producers, organic food purchasers) via five advisory committee meetings and a statewide organic industry conference, through in-depth focus group sessions and meetings concerning: (1) the establishment of a statewide organic program office, (2) USDA certification, (3) food safety certification, (4) educational needs, (5) marketing, and (6) policy support.
2. Recommend a structure and host organization or organizations for an organic program office in Hawaiʻi based on stakeholder input that would:
   a. Provide a neutral venue to facilitate communication among the various agencies and groups currently serving organic growers;
   b. Support the educational needs of organic food producers, manufacturers, and purchasers; and
   c. Address the production, business, and marketing needs as they relate to agriculture and organic policies for organic producers, food manufactures, and purchasers. This could include a food safety certification program for organic producers.
   d. Be a united voice for Hawaiʻi's organic industry to facilitate a working relationship with HDOA and the Hawaiʻi State Legislature.

Comparison of Actual Accomplishments to Established Goals: The immediate goal of the funded project was to inform the Hawaiʻi Department of Agriculture and members of the organic food industry as to what needs for industry organization and success are unmet and what types of organizational structures might be needed to meet the long-term impact of an expanded and profitable economic sector. This project goal was met.

Baseline vs. Current Data: Members of the organic products industry originated this project because they needed facilitation to reorganize to create a unified voice and to develop organizational structures that would serve and strengthen the industry. The published report provides a roadmap for establishing needed structures and created an avenue for industry advocacy. The full report is available online:
http://www.kohalacenter.org/archive/laulima/oiag/HiOrganicIndustry_FinalReport_2014.pdf

Major Successful Outcomes in Quantifiable Terms: Over 300 organic industry members participated in the project, a published report was completed, and concrete actions for reviving the Hawai‘i Organic Farming Association were implemented.

Beneficiaries

Description of Groups and Operations Benefited: As noted above 10 organic industry members benefited from extended participation in an advisory committee process; 354 industry members participated in an industry survey; 140 organic industry members benefited from an organizational and educational conference.

Number of Beneficiaries Affected/Potential Economic Impact: Organic production and consumer demand in Hawai‘i has followed national and international trends in the organic industry. An industry analysis by *Radovich et al.* (2009) used data from the 2007 Agriculture Census to show that the farm gate value of Hawai‘i's organic crop production increased from $5 to $8 million between 2005 and 2007, an increase of 60 percent. The analysis found a similar increase in the total acreage under organic production between the same time period: from 1,465 to an estimated 1,950 acres, an increase of 30 percent, with approximately 200 growers certified (*Radovich et al.* 2009). Additionally, the USDA reports that retail sales of organic food in the United States increased 20 percent annually between 1990 and 2002 ("Recent Growth Patterns in the U.S. Organic Foods Market," USDA Economic Research Service, 2002) and 11 percent from 2011 to 2012, and estimates this rate to hold steady year-to-year through 2014 (*Nutrition Business Journal,* 2013).

To ensure that production meets rising demand for organic agricultural products, it is imperative that support services are accessible to Hawai‘i's organic producers including knowledge and training needs associated with infrastructure, production, post-harvest processing, marketing, and business development. The arrival of three Whole Foods Markets on the islands of O‘ahu and Maui created a new avenue for the sales of organic, locally grown products and revived interest among producers in growing organically (*Radovich et al.* 2009). As consumer demand continues to rise for organically grown food, and the costs of imported fertilizers climb, the industry will likely see an increase in the number of producers growing organically and seeking organic certification. This anticipated rise in the total number of producers and acreage under organic production will likely spur an increase in employment opportunities for rural communities.

Lessons Learned

Insights by Project Staff: The process and activities described above took far more time and resources than were originally budgeted. Bringing together stakeholders from around an island state and creating an inclusive planning process is expensive. However, extended face-to-face meetings are important when trying to create consensus among people with different viewpoints and backgrounds.
Unexpected Outcomes: NA
Goals not achieved: NA
Positive and Negative Experiences: Project staff was pleasantly surprised at the level of engagement and commitment among the members of the Organic Industry Advisory Group.

Busy farmers and other stakeholders devoted more than eight full days to the project with no compensation provided. In addition, the face-to-face meetings among people with differing views resulted in obtaining important points of agreement in moving the organization of the industry forward. There were no negative experiences to report.

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Additional Information

Published report entitled *Growing Organics: Moving Hawai'i's Organic Industry Forward* is available for download at:
http://www.kohalacenter.org/archive/laulima/oiag/HiOrganicIndustry_FinalReport_2014.pdf

Establishing a Breadfruit (Ulu) Orchard Incubator

Final Report

Mililani Agricultural Park, LLC

Project Summary

Hawai`i's agriculture industry has changed dramatically from large mono-crop industries (sugarcane and pineapple) to small, diversified farms producing many different types of crops. Although Hawai`i farmers do produce many crops, the state is also importing 85 percent of its food from outside the islands, and food security has become a major issue, especially with the threat of increasing fuel prices, natural disasters, and transportation interruptions.
Breadfruit has received media coverage as a possible new superfood as it is high in protein, gluten-free and has potential to bring Hawaii closer to food self-sufficiency.
Mililani Agricultural Park (MAP) currently manages 75 producing breadfruit trees and proposed to expand upon that production and provided information to growers statewide to maximize their success with propagating breadfruit. The project goal was to revitalize breadfruit production through an incubator showcasing successful growing methods.

This project was solely aimed at increasing the competitiveness of breadfruit and was not submitted to nor funded by another Federal or State grant program.

Project Approach

To start the project, 504 tissue cultured plugs of Ma`afala variety and 72 plugs each of two new varieties, Pua`a and Pii`piia, were purchased in the Spring of 2013 and shipped to MAP. The plugs were transferred into one gallon pots containing a sterile growing media, and raised in the shade house constructed on site.

While the seedlings were growing to transplant size in the nursery, 10 acres dedicated to the orchard were cleaned, grubbed, and disked multiple times. Soil tests were done in each block to determine what amendments were needed and in what quantity.
Dolomite was applied at 500 lbs. per acre and incorporated in each block. Sixty cubic yards of well decomposed compost was also applied for incorporation at the time of planting and for top dressing.

The in-field planting was completed in August 2013.

In an effort to provide an array of information for potential growers, different breadfruit varieties were planted to establish a new orchard at MAP. Three different varieties of ulu were planted, Ma`afala, Pua`a, and Pii`piia. Agronomic data on row spacing, crop density, nutrient management, rainfall and irrigation needs, and soil temperature was collected. This information will be valuable for new growers to assist them in determining the variety of breadfruit to grow based upon their location and growing conditions.
Data collected from the beginning of this project has been collated into a Breadfruit Planting Guidelines document for interested growers to refer to when they begin propagating

breadfruit. The document is available for download at http://sustainpromgmt.com/wp-content/uploads/2014/04/Breadfruit-Planting-Guide-Mililani-Agricultural-Park.pdf and was provided to participants at the field day held at MAP on February 7, 2014. Project investigator Dr. Mark Nickum expanded on the guidelines as more data was collected during the growth of the orchard. Additional information on pruning and yield could be added over time.

The field day conducted at MAP on Friday February 7, 2014, attracted 49 interested growers and professionals who learned how they can grow breadfruit. The field day was very successful. Despite some rain, all attendees learned from experts through presentations and from in-field demonstrations and observations. Presentations were given by the president of MAP, Wayne Ogasawara, soil scientist Pete Bunn, and University of Hawai`i CTAHR Assistant Professor Dr. Mark Nickum. The field day topics included information on planting, fertilization techniques, propagation, pruning, and equipment.

Dr. Mark Nickum presenting at the field day

Partners in the project and their contributions were as follows:
Department of Public Safety -- partnered with MAP to coordinate efforts in an inmate farm worker program. The inmates provided labor for clearing and prepping the fields for planting.
Department of Health, Waipahu Aloha Clubhouse – partnered with MAP to coordinate efforts in a mentally challenged farm worker program. Members of the clubhouse were involved in the project by providing labor for clearing and prepping the fields for planting.

Mark Nickum, Ph.D., Assistant Professor in Sustainable Fruit and Nut Crops – provided the design for prepping and planting the breadfruit as well as gathering the data for the Breadfruit Users' Manual.

Sustain Pro Management, LLC – provided project oversight and grant management.

Goals and Outcomes Achieved

The goal of this project was to increase grower, community member, and stakeholder understanding of the production of breadfruit, which was to be completed through a field day for these groups in which the project staff anticipated that at least 25 individuals would attend. It was anticipated that 75 percent of the attendees would increase their understanding of breadfruit production and 50 percent would implement this knowledge after the field day. An increase in understanding would be measured through pre- and post-tests taken during the field day. Surveys had not been conducted previously; the pre-test would serve as the benchmark.

Outcome: A field day was executed and allowed growers to observe and discuss the plantings with experts. A planting guide was produced and distributed to field day attendees that outlined the steps to obtaining, nursery-ing, and planting breadfruit successfully.
Long term monitoring and data collection will contribute more information to the planting guide, such as drought tolerance, fertilizer regimes as the trees mature, and harvest data. The goals for the reporting period, to expand upon the production of breadfruit at MAP, create a user guide that provided detailed information to growers, and conduct a field day attracting at least 25 attendees with at least 75 percent increasing their understanding and 50 percent implementing what they've learned, have been realized.

Field day attracted 49 attendees, exceeding the goal by 96 percent.

Based on analysis of the pre- and post-field day surveys, 92 percent of the attendees increased their understanding of breadfruit and how it is grown. Project staff found that 29 of the 31 respondents for the post survey, or 93 percent, said that the information presented at the field day would be helpful to them as a grower to implement a successful planting.

Dr. Mark Nickum demonstrating growing techniques of breadfruit (L) and
Dr. Pete Bunn demonstration using fertigation for breadfruit management (R)

A 10 acre breadfruit orchard has been established at MAP, which will contribute to the revitalization of breadfruit production in Hawaii. Trials with different varieties of breadfruit growing in the orchard are available for researchers to collect data from and data collected so far has been made available to the public. The planting plan at MAP is a rectangular model with 30 feet between all rows (oriented with the rows running N/S).

In-field examples of planting was another outcome of the project. Within row tree spacing was divided so that trees in the North half were planted at 15' spacing and those in the South half planted at 20' spacing in the rows. These two different configurations for in-row spacing provide options for interplanting and some experimental flexibility to provide relative planting density comparisons:

1 acre (43,500) / (15×30) = 97 trees
1 acre (43,500) / (20×30) = 73 trees

Beneficiaries

The growers and other interested community members (49) benefited from this project as they were able to see a successful, large scale breadfruit planting early in production, and to learn how this was achieved. Field day attendees were also provided with written planting guidelines that gave instructions on how to achieve the same results.
Other beneficiaries include value added processors, who will be able to utilize additional breadfruit for various processed items, also markets who currently experience difficulty obtaining fresh breadfruit, and consumers for whom breadfruit is a traditional part of the diet. Breadfruit production on a small scale will provide a nutritious staple for subsistence farmers. Large scale production will help to offset the seasonal harvest, which can make processing difficult if not enough varieties are producing at the same time or if all are available simultaneously. Also larger scale production allows for some loss which is inevitable given the challenges to handling breadfruit at harvest.

Economically, increasing breadfruit production in the State of Hawaii may provide a substantial boost if the right value added product is chosen. For example, breadfruit can be used to produce gluten free flour, and the demand for gluten free products is rising rapidly. Estimates in 2012 showed that US consumers could spend as much as 3.31 billion dollars in gluten free food and beverage items; in 2016 that projection is expected to rise to 15 billion dollars in sales (UH Pacific Business Center Program briefing paper on Pacific Gluten Free Breadfruit Flour Regional Industry Development Initiative).
Even capturing just a third of the value added gluten free product projection would bring a boost of several billion dollars to Hawai`i. With the retail price of fresh breadfruit close to $2/lb, there is potential for growers to tap into this market that includes over 100,000 Pacific Islanders in the State that consider breadfruit a staple to their diet. Using conservative numbers, if half of the Pacific Islanders in the State were to consume one 2lb breadfruit every other month at a price of $2/lb that would create a $1.2 M industry.

Lessons Learned

The project staff learned that in order to collect robust data on various agronomics of the crop, a longer timeframe would have allowed the staff to collect more data than the scope of time proposed. For example, determining which breadfruit varieties exhibit better drought tolerance will take several years of study and data collection. Similarly the identification of which varieties meet specific yield criteria will also take years until the trees begin to produce fruit.

The project staff learned that it was not possible to quantitatively state that attendees were going to implement the information they were shown in the field day unless the field day can be scheduled towards the beginning of the project and the attendees agree to allow project staff to conduct on-site visits. To rely on participants' self-reporting that the learned information would be put to use assumes implementation will take place. Project staff considered follow up to see if the implementation took place, but decided to include that follow up for a future project. However, the surveys showed that the field day information was useful to the attendees in supporting them to grow breadfruit themselves.

The project staff learned that the data collected was of immediate use to growers, and as the trees continue to mature, more information will be gathered and made available. Also, the field day event created many contacts between those interested in growing or already growing breadfruit, and useful networking occurred between growers and the experts who provided presentations on soil testing, pruning, and propagation. In the future it would be advantageous to provide a longer grant period for study of slower maturing crops so that a long view can be realized in terms of data collection.

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Photo of seedlings to be part of the field trials study

Hawaii Natural Honey Challenge, Expansion and Development

Final Report

Big Island Beekeepers Association
http://www.bigislandbeekeepers.com/

Project Summary

The Hawaiian Natural Honey Challenge is an annual statewide competition to promote "natural" (raw) honey. Natural honey is what the majority of Hawaii's beekeepers produce. In 2011 and 2012, the Challenge, sponsored by the Big Island Beekeepers Association (BIBA) was the signature event for BIBA, however, the event had not been promoted, except on a small scale with only two competition categories, solid and liquid. BIBA decided to expand statewide outreach for the Challenge and include more competitive categories emphasizing varietal honeys and honey in the comb (chunk honey). This expansion had the potential to place Hawaiian Natural Honeys into a variety of niche markets and increase awareness of the varietal honeys unique to Hawaii.

The project goal was to promote Hawaiian natural honey. Hawaii beekeepers have faced catastrophic losses in recent years due to the introduction of honey bee pests. Increasing local honey sales through the promotion of local honey can help address this problem, keep beekeepers in business, encourage more people to take up a profession vital to Hawaii agriculture in general (pollination services), and set the stage for further development of this market sector through the promotion of unique varietal honeys found only in Hawaii.

This project was solely aimed at increasing the competitiveness of honey, a specialty crop as defined by the USDA, to increase awareness of Hawaii's natural varietal honeys.

This project was not submitted to nor funded by another Federal or State grant program.

Project Approach

The Big Island Beekeepers Association (BIBA) contracted a coordinator in conjunction with the University of Hawaii, Hilo Campus Tourism Marketing Program (UHH), to assist with the 2013 Hawaiian Natural Honey Challenge. The university community offered opportunities for collaboration on obtaining speakers for presentations, demonstrations, as well as venues for activities, volunteers, promotions, and as a source of attendees. The collaboration added value to the project as well as to the University and students and resulted in a successful and well-attended event. The Project Manager and the UHH selected the Challenge Committee and assigned tasks to complete the project. The BIBA 2013 "Hawaiian Natural Honey Challenge, Expansion and Development" project emerged as a branding event for BIBA with added value as a student training and involvement activity.

Activities performed from March 2013 to February 2014:

Preparation for the Challenge • Contract Event Coordinator • Recruit Challenge Committee • Select web designer	March 2013
Implementation of Work Plan • Challenge Committee sets dates for Public Tasting and Judging, creates logo and artwork for t-shirt; • Select venue • Event Coordinator sends samples to Dr. Bryant for analysis • Challenge Committee Chairpersons begin work on registration, publicity, challenge coordination, and liaison to American National Honey Queen	April 2013
• Website completed • Entry packets distributed • Events confirmed; itinerary for Honey Queen completed • Publicity via print, website begins statewide	May – June 2013
• Ticket sales conducted • Create online survey	July – November 2013
The Hawaii Natural Honey Challenge	**November 23, 2013**
• Retrieve and tally survey results	November - December 2013
• Final Meeting for Challenge Committee • Submit final report	January – February 2014

Activities included:

- Appearances by The American National Honey Queen, who promoted the Hawaii Honey Festival and rare Hawaiian Honeys on television and radio and was featured in news articles.
- Reports from Dr. Vaughn Bryant of Texas A&M University, who provided much valued information on the current "state of the art" of pollen identification research as relates to varietal honeys. Dr. Bryant was provided with numerous samples of unique Hawaiian varietal honeys entered into the Honey Challenge for potential pollen analysis.
- Distribution of results of the Natural Honey Challenge Awards as shown below. Refer to the link for the schedule of events, rules of the challenge and complete list of awards:

http://www.bigislandbeekeepers.com/2013/12/2013-hawaii-natural-honey-challenge.html

Examples of Category	Company
Best Appearance – Liquid Honey (Macadamia)	Beeing Aloha Honey
Best Appearance – Solid Honey (Lehua)	Daddy's Stolen Honey
Best Aroma – Liquid Honey (Macadamia)	Honey Bees Forever

Best Aroma – Liquid Honey (Tropical multifloral – dark)	Don Reeser Beekeeper
Best Taste – Liquid Honey (Tropical multifloral – dark)	Miki Macs LLC
Best Taste – Liquid Honey (Christmas Berry)	Beeing Aloha Honey
Best Solid Honey – Keawe (Molokai)	Marshall Joy Beekeeper
Best Solid Honey – Tropical multifloral (Hawaii Island)	Lotus Buddhist Monastery
Best in Show Liquid – Tropical multifloral (Hawaii Island)	Peggy Beckett Beekeeper
Best in Show Solid – Tropical multifloral (Hawaii Island)	Rare Hawaiian Honey Company

SCBGP funds were not used for the Ribbon Awards presented to the winning Honeys in the Hawaii Natural Honey Challenge. As matching support for the project, BIBA expended cash funds from the association to purchase the Awards, Lei, and Thank You Gifts for winners and speakers. BIBA income is derived from association sponsored events such as silent auctions and honey sales.

Following completion of the event, the list of duties and activities were refined and an event management structure and activities timeline was developed by the BIBA Event Coordinator to facilitate future years' planning and implementation.

Attendees at the Festival were able to choose among a variety of demonstrations and educational symposiums led by renowned beekeepers and honey producers and were able to sample natural varietal honey entries, enter a ballot in the Peoples' Choice categories and purchase Hawaii Natural Honey.

Prior to the main events, throughout the month of November, honey-focused activities were featured, sponsored, and initiated on Oahu and Hawaii Island that provided honeybee awareness, partnership building, improved production practices, and value added hive product development know-how. BIBA promoted and helped to coordinate these preliminary activities, and also sponsored a gala dinner and silent auction at the Nani Mau Gardens as a promotional event and fundraiser for the Hawaii Natural Honey Challenge. These promotions also incorporated presentations at seven local schools, farm visits, and outreach at the Natural Foods store by the American Honey Queen, Ms. Caroline Adams. Caroline represented and was sponsored by the American Beekeeping Federation, the national trade and marketing organization of the beekeeping industry.

While not funded by this project, there were additional activities that helped promote the Challenge and part of the activities performed. For example, the Honey Queen also represented state beekeepers by helping BIBA members staff an informational booth at the annual "Hilo Black & White Night", where she met hundreds of community members, assisted with the distribution of 500 promotional fliers, oversaw honey tastings and answered questions about honey, and extended invitations to attend the Hawaii Natural Honey Challenge. The festive evening gala was attended by 80 community members and leaders, and featured a multiple course meal of dishes that incorporated honey as an ingredient into each recipe and beverage. The Honey Queen spoke at this dinner reception, lending a great deal of support to BIBA's efforts in promoting bees and honey. As a result, the Governor provided a proclamation commending the BIBA, their successful progress, and encouraging them to continue. In

addition, with the media exposure and outreach success of the Honey Queen visit, BIBA was contacted regarding the potential for the Honey Queen attending the 2014 events.

Goals and Outcomes Achieved

The Hawaii Natural Honey Challenge, held on November 23, 2013, at the Nani Mau Gardens in Hilo, Hawaii attracted nearly 2,000 attendees, with adult ticket sales totaling 930, as well as 585 children under age 12, BIBA members, and 35 volunteers. The event attracted 37 product, business and educational booths (with at least two representatives staffing each). The Hawaii Natural Honey Challenge featured a honey competition judged by professional judges and a "Peoples' Choice" competition, voted upon by attendees, that was designed not only to identify additional award-winning honey, but even more importantly, to further the awareness of the different varietal honeys produced by beekeepers in the State of Hawaii.

Goal and Outcome #1

Goal: To expand and develop the Hawaiian Natural Honey Challenge
Performance Measure: To double the number of entries, contestants and tickets purchased on behalf of the 2013 Hawaiian Natural Honey Challenge.
Benchmark: In 2012, there were 43 entries submitted by 12 beekeepers with 80 tickets sold on behalf of the Challenge.
Target: For the 2013 Hawaiian Natural Honey Challenge, the target is 86 entries submitted by 24 beekeepers and 160 tickets sold.
Outcome: 132 honey entries - nearly triple the prior year's number of entries
970 paid attendees - nearly six times as many tickets as the prior year's event.

The project staff was aggressive in soliciting entries to meet this goal. As a result, the Challenge received entries from all counties of the state:

- Entries (individual jars): 132 (23 Solid/Crystallized, 18 comb, 91 liquid)
- Entrants (multiple entries per entrant were permitted): 40 (15 Hobbyist, 25 associated with apiary or other enterprise (e.g., farm, orchard))
- Distribution of Entries/Entrants
  - Molokai: 3/1
  - Kauai: 5/3
  - Oahu: 1/1
  - Maui: 3/2
  - Big Island: 120/33 (Big Island Districts Represented: Hamakua, N/S Hilo, N/S Kohala, N/S Kona, Kau, Puna -Upper and Lower)
- Floral Varietal Categories recognized in the 2013 Hawaii Natural Honey Challenge: 10 (Tropical Multifloral, Keawe, Lehua, Macadamia, Rambutan, Eucalyptus, Albezia, Coffee, Christmas Berry, Avocado). A complete list of awards can be found at the link:

http://www.bigislandbeekeepers.com/2013/12/2013-hawaii-natural-honey-challenge.html

Goal and Outcome #2

Goal: Increase the sale or increase the number of inquiries for Hawaiian Natural Honey in the month following the 2013 event.

Performance Measure: At least 80 percent of the Challenge competitors will complete an online survey within two months following the 2013 event with 50 percent of them reporting an increase in sales or an increase in the number of inquiries for Hawaiian Natural Honey.
Benchmark: No benchmarks exist; will use the results for the 2013 event as the benchmark to determine changes for future measurement.
Target: To complete the survey within two months after the event.
Outcome: A Participant Survey was developed and implemented to establish a baseline and to evaluate and refine the survey instrument. The Performance Measure goal to have 80 percent of the competitors complete an online survey and 50 percent reporting an increase in sales was nearly met. Twenty-seven surveys were returned, which reflected 60 percent completion, with 23 of the 27, or 85 percent, reporting products offered were sold out, added products for sale and/or had an increase in sales. The results of the Surveys returned are shown below:

Seven key factors ranked producer perceptions as to what is most important to consumers who purchase Hawaiian Natural Honey Products. The results show that "locally produced" is the most important factor and "environmental benefits" is the least important factor in influencing consumer purchase.

_1__Locally Produced
_2__Naturally Processed
_3__Health Benefits
_4__Presentation, Design/Style of Packaging
_5__Product Quality Recognition
_6__Award Winning Identification
_7__Environmental Benefits

Sixty percent of the participants have been producing honey for two years or less, with 40 percent responding they have been producing for less than one year.

How long have you produced Natural Honey Products?
40% - Less than one year
20% - 1 year to two years
10% - 5 to 10 years
30% - Over 10 years

How often have you participated in the Natural Honey Challenge?
60% - 1 year
30% - 2 years
5% - 3 years
5% - 4 years

How likely are you to participate in the Natural Honey Challenge again?
90% - Definitely
10% - Probably

Would you recommend the Natural Honey Festival to others?

100% Definitely

What recommendations would you offer for future improvement of the Hawaii Natural Honey Challenge?

More Educational Presentations	Longer Day 9am to 5pm
Conference of presenters	More Youth Group involvement
More affiliated event	Expand to Island-wide Events
Photo or Art Contest	Cooking Classes or Demos
Honey Movies in local theaters	Judge Training

Did you receive any awards for your Natural Honey Challenge Entrants?
100% - Yes

If yes, did winning this award allow you to display the Natural Honey Challenge Award Winning Sticker on your products?
100% - Yes

If Yes, Do you expect the display of this sticker to influence an increase in recognition for your products in the market place?
90% - Yes
10% - No

If Yes, Do you expect the display of this sticker to result in an increase in your future product sales?
100% - Yes

If Yes, have you already experienced increased recognition or sales based on your award and/or winning sticker displayed?
90% Yes, I have noticed an increase in customer recognition based on the winning award sticker displayed
10% - I have not noticed an increase in product sales based on the winning award sticker being displayed.
Reason: Have not sold honey since the event

Based on the survey results, participants were satisfied with the event and reported there was value to them as a producer of Hawaii Natural Honey. The responses regarding event were very positive and showed an intent to participate again. Results also indicated that the promotions surrounding the event strongly support their ability to sell products both at the event and in the future, and that most felt the sticker of quality would have a positive influence on purchaser perceptions. Those producers who vended at the event mostly sold out of all products available. Comments were generally for continuation and expansion of the event.

Beneficiaries

The 62 BIBA members, 56 on Hawaii Island and 6 off-island members, and producers of Hawaii Natural Honey benefited from the project through creating increased consumer awareness of varietal natural honeys that contributed to increased sales.

The many new honey producers as well as the more established producers benefited by the Hawaii Natural Honey Challenge through the establishing of benchmarks through the survey results and through the competition results that showed what the consumers and industry consider the best of the varietal natural honeys that are unique to Hawaii.

Lessons Learned

Project staff learned the need for membership and committee development to ensure sufficient participation and learned the importance of establishing and following a timeline in order to conduct a successful event. With the new site selected for the event, the project staff has been able to determine an efficient layout for activities and attendees and by continuing the event at this location it will be easier to determine the need for volunteers and improve on the layout and scheduling and increase activities and presentations.

Success for the organization came in the areas of improved management systems, financial management, informed decision making, and better planning that in turn translates to improved member confidence in the organization. BIBA intends to continue to produce the Hawaii Honey Festival and Hawaii Natural Honey Challenge in future years and will pursue additional support to fortify the organization and event's foundation and ensure its continued success. Partnerships established during this year's event will be further developed and additional partnerships and sponsors sought.

The BIBA 2013 "Hawaiian Natural Honey Challenge, Expansion and Development" Project emerged as a major branding event for BIBA, with added value as a student training and involvement activity. It also provided an extensive opportunity for beekeeping and natural honey production outreach and education through ongoing promotions, editorials, activities, presentations, and social media. Early outreach and promotions stimulated far more submissions to the competition than was expected, and has stimulated several new producers and expansion of production by many others.

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Hawaii-Grown Cacao Month Including the Third Annual Hawaii Chocolate Festival

Final Report

Hawaii Chocolate Association
http://www.hawaiichocolate.org/

Project Summary

Hawaii-Grown Cacao Month (February) was designed to inform and educate the public regarding the emerging cacao industry in Hawaii, the only state in the U.S. currently growing chocolate. The Hawaii Chocolate Festival was created as a focal point to stimulate interest in Hawaii's chocolate industry positioning Hawaii-grown Chocolate as Hawaii's newest ambassador of Aloha. In its third year, the Hawaii-Grown Cacao month festivities culminated with the Hawaii Chocolate Festival held on February 23, 2013, showcasing and celebrating all things chocolate with Hawaii-grown Cacao and Chocolate spotlighted in particular. The Festival accomplished this by focusing on promoting local culinary talents and products specifically linked to Hawaii's chocolate industry and its related creations to generate, media coverage, interest in and support for Hawaii-grown Cacao crops. The Hawaii-Grown Cacao month's intention is to raise awareness of the high quality of Hawaii-grown Cacao and the chocolate created with it as well as develop the market for its unique products in which it can be utilized.

The activities promoted the fledgling cacao industry in Hawaiʻi and 1) created unique and educational events for locals and visitors to explore and celebrate cacao in its many forms from the pods and trees to the processing and taste testing; 2) educated the public as potential consumers and supporters about Hawaii's cacao and chocolate industries as green, sustainable, high-quality, and economically viable; 3) allowed local growers and producers a venue to showcase their products to consumers, test market new products, and grow brand awareness; 4) gave local growers and producers the opportunity to make connections both among themselves and with local and international buyers and business interests; and 5) highlighted Hawaii-grown chocolate as a specialty product, creating a niche market comparable to that for Kona coffee.

The project goal was to stimulate interest in Hawaii-grown cacao and chocolate. When value-added products were promoted, the Project Manager's goal was to promote products that were 100 percent Hawaii-grown cacao, however, this product would be bitter and would have an "elite" and very limited demand from consumers. Participating companies were aware of the goal and supported the goal by using Hawaii-grown cacao in their products, featuring 70 to 55 percent cacao content with sugar, vanilla bean and soy lecithin comprising most of the other ingredients. Project staff monitored the booths and products and report that chocolate products were 55 to 100 percent Hawaii-grown cacao by content, however, under the Specialty Crop Block Grant Program's definition of a processed product, a product must constitute greater than 50 percent of the specialty crop by weight, exclusive of added water. The 100 percent product (which would be 100 percent cacao by weight) and the 70 percent product

would qualify by weight. However, the 55 percent Hawaii-grown cacao products promoted, which would include the weight of the vanilla bean, were assumed to qualify as a specialty crop processed products under the USDA definition.

This project solely enhanced the competitiveness of Hawaii-grown cacao and chocolate and was not submitted to nor funded by another Federal or State grant program.

Project Approach

The Festival was the culmination of a month-long calendar of activities spotlighted in celebration of Hawaii-Grown Cacao month as decreed by the Legislature. During the month of February, the Hawaii Chocolate Festival Road Show literally took the show on the road by producing a series of outreach events to educate the community about the budding cacao industry in Hawaii. The road show events provided professional educational information and displays to explain the history of chocolate in Hawaii and show the process of transforming the cacao bean into locally grown chocolate. In addition, there was Hawaii-grown chocolate tasting, pod and tree samples and literature about chocolate, along with recipes cards for distribution. The calendar of events included the following that culminated with the Hawaii Chocolate Festival:

February 3, 10, 14, 17, & 22 -- Classes - Madre Chocolate
February 9 -- Roadshow - Kahala Mall
February 10 -- Roadshow - Windward Mall
February 23 – Event - Hawaii Chocolate Festival
February 23 -- Classes - Hawaii Chocolate Festival Classroom
February 24 – Hawaii Chocolate and Cacao Industry Conference
February 28 – Roadshow - The Pacific Club
February 1-28 — Tours - Foster Botanical Garden Tour
February 1-28 – Tours, Classes and Farm Tours -- Manoa Chocolate Hawaii Factory Tour
February 1 – 28 – Tours - Hilo Shark's Cacao Plantation
February 1 – 28 – Tours – Menehune Mac Chocolate Factory Tour
February 1 – 28 – Tours – Original Hawaiian Chocolate Factory

<u>The following activities were created and conducted to promote the event:</u>

- August 2012 -- Secured venue, insurance, security, janitorial, and parking; Met with venue property manager to determine requirements and secured certificates of insurance, security guards and janitorial services for the event; Met with parking company to secure parking arrangement that ensured access for all participants as well as free parking for attendees to encourage participation.
- September 2012 -- Invited all local cacao farmers, Hawaii-grown cacao manufacturers, chocolate retailers, agricultural, educational and culinary organizations and other interested parties to a pre-planning meeting; Contacted the stakeholders to encourage feedback and participation from interested parties as to how the festival and industry should be promoted; Contacted potential partners and encouraged local farmers and

producers to consider expanding their production to meet the increased demand generated by the Festival; Contacted stakeholders including local farmers, retailers, manufacturers and other interested parties to advise them of activities related to this program and generated high profile media coverage and great awareness in the community; Finalized the event plan and layout.

- October 2012 -- Finalized ticketing, signage, entertainment, decor and activities; Designed and printed tickets; Completed on-line ticket sales program; Created directional and educational event signage; Designed décor plan and created on-site activities for the festival; Secured sponsorships; Continued outreach to stakeholders to pursue and secure participation; Finalize partnership agreements; Met with partners and secured cross-promotional opportunities to support the events; Coordinated marketing, advertising, public relations plans; Met with stakeholders and media to develop programs that were appropriate for each stakeholder and media outlet; Continued to implement marketing, advertising and public relations plans; Strategized marketing opportunities, advertising venues and public relations opportunities to promote the event.
- November 2012 -- Finalized exhibitors, secured deposits; Contacted exhibitors by phone, email and hard copy mail to provide details about the event; Updated website to promote festival and add educational information and photos.
- February 2013 – Media launch via print and social media channels; Print ads placed in Honolulu Magazine, Honolulu Star-Advertiser, and This Week Magazine; Distributed posters, flyers and banners; Social media launched via Facebook.
- February 23, 2013 – Hawaii Chocolate Festival conducted.
- March 2013 -- Prepared post- event evaluation materials for exhibitors and sponsors; Secured evaluation forms from the exhibitors to determine level of satisfaction; Gathered data on the impact and success of the event in a qualitative format which suggested that by 2018 the state would have 113 acres in cacao; Secured commitments to sponsorship for the following year for participation in the annual event.

Throughout the planning, the project staff coordinated with the shareholders to create learning opportunities at the Festival that were supported by displays and the distribution of educational materials.

Goals and Outcomes Achieved

The primary goal of the Hawaii-Grown Cacao Month and the Hawaii Chocolate Festival was to create increased awareness of the specialty crop, cacao. The project achieved this by providing opportunities for chocolate enthusiasts and local chocolate producers to meet together in a celebration of cacao and chocolate in their many forms. The focus on the industry raises awareness of the growers about the stakeholders in the industry and new consumer groups.

The project goal was to connect with 100 percent of the local growers. The project manager has determined that 100 percent of the local cacao growers were contacted and were aware of the opportunities to learn and grow their business as they were invited to participate in the Hawaii-Grown Cacao month and Hawaii Chocolate Festival. This outcome is based on efforts to

contact every grower on a list provided by a vast group of resources including: the University of Hawaii College of Tropical Agriculture and Human Resources, information found on the internet and phone book, via referrals from industry leaders, contacts that reached out to the association looking for information from the previous years and list of attendees from a one-day industry conference, attended by more than 50 industry stakeholders.

The attendance goal for the event was exceeded with approximate attendance at the 2013 festival of 1,400 visitors, a 40 percent increase in number of ticketed visitors. In 2013, there were 40 vendors and 9 industry representatives, meeting and exceeding the goal to increase the previous year's numbers by 10 percent. Of note, is that the industry representatives, for purposes of this report defined as buyers, out-of-state entities, that are currently part of the industry – were from China, Dominica, and the West Coast – which the project manager found to be a measure of success demonstrating the impact of the festival as a catalyst to encourage buyers to come to Hawaii during the targeted time period.

The goal to ensure 15 outreach events was met, as shown in the list above and featured in the month long calendar of events. The goal to reach more than a million media impressions was also met. The project goals of 800 hits projected on the festival website and 250 projected likes on the festival's Facebook page were achieved with 1,176 hits on the website and 429 Facebook followers. Also, Hawaiian Airlines ran the in-flight video promoting the festival for the second year to an estimated 900,000 viewers onboard, and an additional 2,575 views to the video posted on YouTube. Also the event was featured in a major print publication on the cover of the Midweek Newspaper and in an article inside distributed to 285,000 households on Oahu and Kauai. The project successfully informed and educated the public regarding the emerging cacao industry in Hawaii, the only state in the U.S. currently growing chocolate.

The festival, with focus on Hawaii-grown cacao and chocolate, was also promoted via local and visitor print publications, online, radio and television, which added to the media impressions. According to our Dateline Media Tracking report media coverage made over 198,938 impressions promoting Hawaii-grown cacao and chocolate in broadcast coverage.

The goal to realize a 10 percent increase in retail sales at the 2013 Hawaii Chocolate Festival could not be confirmed and therefore unable to substantiate whether the goal was met. This result is because the vendors would not disclose their sales numbers in writing due to the competitive nature of their business and the small market, but some reported a 12 – 17 percent increase in sales over the 2012 Festival. In addition, project staff were able to secure verbal reports from several companies advising that they had in some cases up to 6 new business leads from the event. Their interest to return to the 2014 festival is validation that they are securing prospects and generating revenue from their participation. One vendor, Paradise Chocolates, disclosed for the second year that their sales during the 2013 Festival was the most of any festival in which they have participated. All 40 vendors were asked to complete the surveys, however, 20 were returned.

The survey asked for a score of 10 -8 for Superior / 7 – 5 for Good / 4 -3 for Fair and 1 – 2 for Poor. Aggregate results follow:

1. The festival resulted in securing at least 3 new business leads.
   Superior 15 / Good 3 / Poor 2
   Poor responses were likely due to presentation, booth display or lack of interest in the product promoted.
2. This festival raised our awareness about stakeholders in the industry and new consumer groups.
   Superior 18. / Good 2
3. This festival provided me with an opportunity to help build better relationships with other industry members and the public.
   Superior 19 / Fair 1
4. This festival has raised interest in the Hawaii Cacao Industry.
   Superior 19 / Fair 1
5. I am interested in participating in the 2014 Hawaii Chocolate Festival
   Superior 19 / Good 1

The high number of "Superior" responses shows the project was successful in increasing awareness of the Hawaii-grown cacao and chocolate products.

The results are unprecedented for growth in the industry in the months since the festival, project staff have seen the expansion of the Manoa Chocolate production facilities which doubled in size (http://manoachocolate.com/about/), Madre Chocolate opened a second retail location in Chinatown (http://madrechocolate.com/Home.html), Malie Kai Chocolate opened a retail store in the Royal Hawaiian Shopping Center (http://www.maliekai.com/) and Kokolani Chocolates opened a retail and production facility in Kailua (website coming soon), Sweet Paradise Chocolatier has planted 7 new acres of cacao and opened a new location in the Maui Tropical Plantation (http://sweetparadisechocolate.com/) as well as a second location named Manawai Estate Chocolate in which they will have farm tours and a museum; The Big Island Cookie Company has entered into an agreement to use Waialua Estate Chocolate for their cookies (http://www.waialuaestate.com/our-chocolate.html). In addition, Cacao Services an agricultural and scientific consulting company has been formed. These results normally would take multiple years but have been achieved in just one year. All of these industry stakeholders participated in the Hawaii Chocolate Festival.

The roadshows at Kahala Mall and Windward Mall provided an opportunity to sample Hawaii-grown chocolate, get free chocolate recipe cards and learn about this diversified and sustainable agricultural crop. The events featured Hawaii-grown chocolate sampling, provided educational displays including plants, pods and beans and distribution of information on this specialty crop and distribution of information. At Kahala Mall an estimated 3,000 people were exposed to the event and at Windward Mall there were an estimated 1,700 in attendance. At the Pacific Club, there were 250 diners who were served a dinner created from chocolate recipes and featured Hawaii-grown chocolates. The project provided educational displays about cacao at all roadshow activities.

Educational Classes were also conducted at the Hawaii Chocolate Festival featuring world-class expert guest speaker Art Pollard from Amano Chocolate and Ed Sequine from Mars Global who

came to address the Hawaii audience to share their industry experience with potential growers as well as doing comparison chocolate tastings among the islands to showcase the range of flavors and quality. They participated in the festival as well as the chocolate conference the following day providing guidance on how to further build the cacao industry in Hawaii. Funding for their travels was privately financed.

A trade show element was included in the Hawaii Chocolate Festival allowing farmers, producers and buyers of Hawaii cacao and cacao-based value added products to showcase their goods for sale to local, national and international buyers who were invited to attend the event. Additionally, the project provided vendors with the opportunity to have a guest list at the door for other buyers they wished to invite. Consumers were also able to purchase during the event further enhancing sales opportunities. In addition, exhibitors reported that they have had repeat visitors to their stores or purchasing their products on-line throughout the year as a direct result of the festival where attendees had sampled and/or purchased product. This created further ongoing stimulus to the specialty crop.

Beneficiaries

Direct beneficiaries of the project activities are the 86 members of the Hawaii Cacao and Chocolate Association (https://hawaiichocolate.org/) that includes farmers who participated as well as producers and friends of the industry as they benefit from the increased interest and exposure from the events promoting Hawaii-Grown Cacao and Chocolate. Chocolatiers benefited as they have a venue to showcase their locally made products and an opportunity to directly educate people about the difference in this specialty crop and other foreign chocolates such as why it may cost more is because of the quality and benefits of being locally grown.

Potential growers will benefit from the increased awareness of Hawaii-grown cacao. In 2013, the industry estimated that 16 acres of cacao were planted in the state; 12 on Oahu, two on Maui, and one each on Kauai and Hawaii. By 2018, industry respondents predict an additional 51 acres will be planted; 30 on Oahu, 12 on Hawaii, nine on Maui, and one on Kauai. The prediction is that Hawaii will have 113 acres in cacao production by 2019.

The consumers who gained knowledge about this emerging industry and had the opportunity to meet the chocolatiers of locally grown cacao benefited from this project as they were able to sample chocolates made from Hawaii-grown cacao.

Lessons Learned

One lesson learned is the importance of outreach and education about this fledging crop as people are extremely interested to know more as they find it interesting and unique. When consumers are informed of the attributes of this crop, they support the industry either by word of mouth or choosing to purchase the locally produced product.

The project staff also learned the importance of publicity, either perceived negatively or positively, as a tool to educate. The Hawaii Chocolate Festival was included in a report by Senator Colburn that intended to show that the funding supporting the event might not be

meaningful. This recognition from the report received national exposure in media outlets and provided an opportunity to educate on a national scale. Inclusion on the list turned out to be a catalyst that started widespread interest in the Hawaii-grown cacao industry in national publications and media outlets. As a result of this report the project staff were able to have a platform to provide informational outreach to many national media outlets to "set the record straight" on this emerging crop and its' value to Hawaii. This was a lightning rod to extensive coverage and in particular an editorial piece that was the cover story in highly coveted Midweek publication distributed to 285,000 households on Oahu and Kauai that educated the public about the emerging Hawaii-grown cacao industry. The publicity, coupled with advertising and marketing pieces, also helped to boost the industry and has resulted in the long-term benefit of more interest from the public and farmers to convert existing crops to cacao plants or plant new fields as they feel there is an emerging market with momentum.

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Revealing the Hidden Health Benefits of Hawaii-Grown Avocado

Final Report

University of Hawaii
http://www.ctahr.hawaii.edu/site/

Project Summary

Avocados are a nutritious fruit that are rich in unsaturated fats (the "good" fats), protein, and dietary fiber. The common misconception is that high fat content found in avocados is undesirable. However, the fats found in avocados have been correlated to reduced risk of cardiovascular disease, decreased rates of obesity, decreased inflammation, decreased blood pressure, and improved overall health. Currently, much of Hawaii may be unaware of the nutritional benefit of locally grown avocados (Nagao, 2009). Few nutrition resources communicate the health benefits of Hawaii-grown avocados. The "Hawaii Foods" website provides a single entry in their consumer database for "local avocados"; however, the nutritional data for individual local varieties is absent (Hawaii Foods, 2011). Sensory properties of Hawaii-grown avocados, such as taste, texture, and appearance, are appealing to the consumer, so these fruit have excellent market potential (Barber et al. 2008). With much of society shifting towards a more "locavore approach", the market for Hawaii grown avocados is in a prime position for growth through focused consumer education.

Variety and growing conditions affect nutrient content of fruits and vegetables, so data on mainland-grown avocados cannot be applied to Hawaii-grown avocados. Recently, our research laboratory at the University of Hawaii at Manoa has characterized the fatty acid content of local avocados (USDA Agriculture Diversification Grant: Hawaii Tropical Specialty Fruits, Iwasaki et al. 2012). Hawaii-grown avocados provide more omega-3 fatty acids than mainland grown avocados. Omega-3 fatty acids have many health benefits, and are linked to a reduced risk of cardiovascular disease. These data are currently available to the scientific community, but not to the consumer.

The purpose of the proposed project was to enhance the competitiveness of Hawaii-grown avocados by improving the consumer's nutrition knowledge of Hawaii-grown avocados through the development and dissemination of educational materials (brochures, website, and demonstrations). These educational materials were developed based on current scientific knowledge of Hawaii-grown avocados. This project's target audience was consumers who currently buy imported avocados and consumers who do not currently buy any avocados. The project manager expects that, with enhanced knowledge, sales and market share for Hawaii-grown avocados will increase, thus stimulating Hawaii Agriculture. Fruits, tree nuts are berries are the state's largest agricultural commodity, which includes avocados (USDA 2007). However the majority of avocados sold in the state are imported avocados. This provides an opportunity to increase sales and market share of Hawaii-grown avocados. This projected is modeled after the very successful "Hand Grown in California" campaign to promote California-grown avocados (http://www.avocado.org).

Project Approach

The project contract was approved in March 2013 and the project funding was released in April 2013. The project manager hired a research assistant to work on the project. The research assistant and project manager developed a consumer survey. Feedback was solicited and from professionals in the field and the survey was refined. The project received ethical approval (University of Hawaii at Manoa Institutional Review Board CHS #21407) to conduct the consumer survey in July 2013. Project staff then conducted the survey in the Fall 2013. Based on the survey data, an educational brochure was developed. The draft educational brochure was reviewed by three consumers and a registered dietitian for clarity and accuracy. The Office of Communication Services at the University of Hawaii at Manoa College of Tropical Agriculture and Human Resources assisted with formatting the final brochure. The project staff tested and published 2 recipes using avocados in non-traditional ways (avocado banana bread and avocado chocolate cake). An educational poster was developed to augment the educational display.

February 2014 through April 2014, project staff promoted Hawaii-grown avocados at local retailers, farmers markets and the Avocado Festival. The specific sites are listed in the Goals and Outcomes Achieved section below. Project staff distributed over 450 brochures, over 200 recipes and over 200 informational flyers about fat at the aforementioned demonstrations. The demonstration at the Avocado Festival were particularly successful. The project provided the only educational display at the festival and was located on the main walk-way into the festival grounds, so nearly all festival attendees passed the educational display. In addition to the educational materials and samples, there were 15 different varieties of avocados displayed, all of which were grown in the Kona district. The project prepared a very attractive display that gained a lot of attention at the festival.

Along with the demonstrations, the project staff contacted local media outlets and other retailers to provide the promotional materials, met with avocado producers on Big Island and communicated progress with the Hawaii Avocado Association. The promotional and educational websites were launched Spring 2014, and project staff continue to add content as new information becomes available. The brochures and nutritional information is available at: http://choosehawaiiavocados.org/about/ with sections for nutrition information, recipes, types of avocados and where to buy Hawaii-grown avocados.

Goals and Outcomes Achieved

- Six demonstrations with avocado tastings and educational materials to promote Hawaii-grown avocados (February 2014-April 2014):
    - Whole Foods, Kailua, Oahu
    - Whole Foods, Honolulu, Oahu
    - Whole Foods, Kahului, Maui
    - Kauai Community Market, Lihue, Kauai
    - Avocado Festival, Kona, Big Island
    - Hilo Farmers Market, Big Island

- Educational materials distributed to 4 additional retailers and 2 media outlets and 2 organizations:
    - Island Naturals (3 locations: Kona, Hilo, Pahoa)
    - Living Foods Market and Deli (Poipu, Kauai)
    - Edible Aloha (parent site of Edible Hawaiian Islands publication)
    - Garden Isle News (Kauai)
    - Hawaii Avocado Association
    - Hawaii Tropical Fruit Growers Association
- Newspaper article in Garden Isle News, Kauai promoting Hawaii-grown avocados (http://thegardenisland.com/lifestyles/opinion/advantage-avocado/article_d6f7df18-bd55-11e3-af8e-001a4bcf887a.html)
- Meetings with local growers (Kauai and Kona), local chef/market manager (Michael Simmons at Living Foods Market on Kauai) and communication with Hawaii Avocado Association
- Development of educational and promotional website for Hawaii-grown avocados http://choosehawaiiavocados.org/about/

The goal of improving nutrition knowledge of local avocados and increase awareness of Hawaii-grown avocados was met through community events such as nutrition displays at local farmers markets, at local grocery stores, and at the Hawaii Avocado Festival in Kona, Hawaii. Over 400 promotional and educational brochures were distributed to the community through these activities. The project also provided samples at these events to promote Hawaii-grown avocado's premier taste and textural qualities. Prior to this project, nutrition information specific to Hawaii-grown avocados was not available to the consumer. Many consumers commented that "they didn't know Hawaii-grown avocados were so good." Additionally the website http://choosehawaiiavocados.org/ provides an easily accessible resource to consumers seeking nutrition information and locations selling Hawaii-grown avocados. These events and website improved nutrition knowledge and increased consumer-awareness of Hawaii-grown avocados.

Beneficiaries

The consumers in Hawaii benefited from the project because nutritional information is now available on the website and provides consumers with accurate information about Hawaii-grown avocados, including nutritional properties, recipes, and a listing of farmers markets and local grocery stores. This will encourage and enable consumers to buy local.

The members of the Hawaii Avocado Association (HAA) and Hawaii avocado industry stakeholders benefited from this project. This project collaborated with the Hawaii Avocado Association, which has 76 avocado farmers as members. The project also collaborated with the Hawaii Tropical Fruit Growers Association which has 600 members, with 112 members attending the annual conference where the information produced by this project was presented.

The USDA has approved the export of Hawaii Sharwil avocados to the 32 Northern States from November 2014 through March 2015, lifting a ban that has been in place since the early 1990s. The information produced from this project can benefit the exporters and HAA members by increasing consumer demand on the US Mainland and improve the market share of Hawaii-grown avocados in the domestic market.

Lessons Learned

The proposed project start date was February 1, 2013, but funding was not available until April 2013, which accounted for two months of the delays. The ethical approval, which typically takes two weeks, took six weeks to obtain. Despite these delays, the project still attained the goals of the project. The lesson was to allow more time for approvals in the timeline.

The project staff planned to meet with more growers, but learned that scheduling meetings was difficult. In the future, more emphasis should be placed on establishing contacts with producers on all the neighbor islands.

The original project planned for 14 demonstrations. Some retailers declined a demonstration at their location, preferring to meet with the project director instead. The materials were delivered to a total of 14 sites/organizations which met our goal for publicity, however, in the future, the work plan should confirm meeting sites to minimize the time taken to determine demonstration locations.

The project manager had expected to make a presentation at a meeting of the Hawaii Avocado Association. However, due to the irregularity of the organization's meetings, was unable to speak with the group and maintained communication via phone and email, so the avocado producers could stay abreast of the project. A presentation was made at the Hawaii Tropical Fruit Growers Association Conference, where many avocado growers were in attendance.

Whole Foods agreed to provide sales data of Hawaii-grown avocados so the project staff could determine the efficacy of our demonstration. However, even after repeated inquiries, the staff were not able to obtain the sales data; this is a significant weakness in the project reporting. At the Whole Foods demonstrations, project staff were allowed to provide samples and promotional literature about Hawaii-grown avocados, but was requested to refrain from interfering with "regular shopping" activities. This prevented the project staff from obtaining more information from the shoppers, particularly follow-up data to indicate efficacy of the educational materials.

The challenges faced when working with retailers stemmed from two issues: over-commitment from the retailer during project planning and lack of clarity from the project director with regards to the extent of the retailers involvement. The managers at the retail locations were very enthusiastic about supporting our project. This enthusiasm continued as the staff conducted their project; however, the ability for the retailer to support the project depended on the location. For example, the space provided for demonstrations was adequate for a small display and product samples, but it was not large enough to engage the consumer in discussion. At one location, the project display was placed near the main entrance. This provided great

visibility, but it discouraged consumers from spending time at the display because they blocked the store entrance if they stopped too long at our display. A contract outlining project involvement by the retailer may help alleviate these issues in the future. Such a contract should include commitment from the retailer in terms of space, product, and data. It should also include a statement of expected benefit provided by the project to the retailer. Careful development of such a contract would demonstrate the value of the project and the involvement of the retailer and hold the retailer accountable for deliverables such as sales data.

Maria Stewart and the display of 15 avocado varieties on display for "show and tell"
Fresh samples available for tasting

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Additional Information

Hawaii avocado website: www.choosehawaiiavocados.org

Garden Isle News article on avocado project:
http://thegardenisland.com/lifestyles/opinion/advantage-avocado/article_d6f7df18-bd55-11e3-af8e-001a4bcf887a.html
Video on Avocado Festival: http://www.bigislandvideonews.com/2014/04/09/video-hawaii-avocado-festival-held-kona/

From Chemistry to Consumption *Capsicum frutescens*

Final Report

University of Hawaii
http://www.ctahr.hawaii.edu/site/

Project Summary

Hot peppers (*Capsicum spp*.) are an important, worldwide grown, and high value commodity. The three species of greatest importance are *C. annuum* (e.g. jalapeño), *C. chinense* (e.g. habanero) and *C. frutescens* (e.g. Tabasco). Although all species originated in tropical and subtropical America, **the Asia/Pacific region is considered a "Center of Diversity" for *C. frutescens* where it has been widely planted for generations** (Rubatzky and Yamaguchi, 1999). *C. frutescens* is often called the "Tabasco" pepper in much of the U.S., but is known as the "Hawaiian Chili pepper" in the 50th State, and "donne'sali" in Guam. Habanero, Thai Serrano and other peppers have gained wide acceptance in Hawaii. Pungency is determined by capsaicinoid concentration. Fruit of *C. fructescens* are typically considered more pungent and are easily distinguished visually from the small-fruited *C. annuum* marketed as "Thai" peppers and sometimes substituted for *C. fructescens*. Recent analysis of peppers grown at the Waimanalo experiment station on Oahu supports previous reports of greater pungency in *C. fructescens*. However, these results represent data from a single year, small number of varieties, and single location, and do not include other human health compounds such as sugars (Bingham, Radovich unpublished results). Additional trials must be conducted in multiple environments to quantify the independent and interactive effects of genetics and environment on important traits of tropic-grown peppers. **Successful "chemical fingerprinting" combined with identification of high yielding varieties in Hawaii grown peppers is expected to result in improved differentiation among types, increased demand among consumers and improved profitability of small diversified growers in the tropics.**

The perception of flavor is a complex interaction of tastes, textures and aromas. Many of these flavor attributes have a chemical basis that can be objectively measured, including pungency in hot peppers (Crosby et al. 2009; Jarret et al. 2007). Flavor and human health potential is now being used in the marketing and promotion of vegetables as mundane as cabbage to transform them from low-value field crops to high-value horticultural products (Radovich 2010). This approach is expected to be even easier for commodities as colorful, flavorful and nutrient rich as pepper, but has not yet been attempted for vegetables in the U.S. Pacific. This represents tremendous potential for market development and income generation for under-served farmers in the region. The importance of *Terroir* in marketing high-end, value-added agricultural products (e.g. wine, chocolate, coffee) is based on the fact that the crop environment can significantly influence the chemical foundation of taste, aroma and human health potential. In peppers it is well established that the chemical constituency of hot peppers is strongly influenced by location and season (Estrada et al. 1999; Robi and Sreelathakumary 1996). Efforts to replace imports and market locally grown peppers are hindered by a lack of

understanding of how the chemical quality of peppers are influenced by the extreme variability in pepper genotype and the environment of this region.

Specific issues, problems, or needs that were addressed by this grant are illustrated by:
Addressing the lack of comparative chemical data on Hawaii grown chili peppers – specifically their chemical properties involving taste, which include: (i) **Hotness:** capsaicinoid concentration/content; (ii) **Sweetness:** Carbohydrate/sugar content;
The need to promote the economic potential for establishing a niche market for Hawaiian chili peppers.
Importance and timeliness of the project are seen with:
That there is a need to provide clarity to both farmers and consumers in defining what makes a Hawaiian chili peppers uniquely Hawaiian – "it's all in the taste";
The absence of statistical data regarding how many farmers in Hawaii are growing chili peppers, the varieties grown, or the amount that they produce;
The current absence of a commercial cost analysis for growing chili peppers in Hawaii.

Project Approach

Three (3) primary objectives were performed during the granting period, as defined in Table 1.

Table 1. Primary Objectives for grant duration:

	Task
Objective 1	Rank the relative yield, and capsaicin content of fruit from 30 Capsicum accessions at four locations in Hawaii.
	Chemical analysis of 30 Capsicum accessions at four locations in Hawaii.
Objective 2	Determine costs of production for four major types of Hawaii grown chilies (Hawaiian, Thai, jalapeño and habanero).
Objective 3	Disseminate project results to growers, Agricultural professionals, and industry members.

The proposal included an Objective 4 which was to provide advanced instrumental training to graduate students in bioanalytical chromatography, specifically for value-added promotion in specialty crops. This Objective was not met during the time of the grant period, however, is planned for completion when the project continues.

In respect to tasks in the Work Plan, the majority of tasks were achieved successfully. However, project staff were unable to undertake the proposed 30 Capsicum accessions at four locations in Hawaii, due to time constraints and changed this to 15 Capsicum accessions (examples illustrated in Fig. 1) at two locations in Hawaii.

A brief summary of Work Plan objectives, Significant Results and Accomplishments are detailed below for each objective:

Objective 1. Quantitative High-Performance Liquid Chromatographic (HPLC) analysis and measurement of capsaicinoid concentration/content and Carbohydrate/sugar content within Capsicum accessions

Significant Results:
Quantitative survey of 15 varieties of capsicum, as listed in Table 2., indicated that the top five (5) concentrated capsaicinoid containing capsicums are *C. chinense* (Ghost Pepper), *C. frutescens* (Bird Pepper), *C. frutenscens* ('Hawaiian'; ripe and unripe), *C. annuum* (Thai hot, ripe). *C. frutenscens* ('Hawaiian'), a newly reported hybrid species, interestingly does not vary greatly in capsaicinoid concentration during ripening process, while other varieties can vary greatly – compare ripe and unripen varieties.
Carbohydrate/sugar content – not available at the time of report submission, these will be integrated with our peer-reviewed publication.
Vitamin C analysis demonstrated in most, an absence in the varieties of capsicum examined, except for *C. chinense* (Ghost Pepper), which demonstrated 9 mg/Kg. This amount does not represent a significant source of Vitamin C, with the recommended daily intake being ~75 mg/day.

Fig. 1. Examples of Hawaii grown Chili peppers – fruits and plants

Chili Pepper Planted in Waimanalo Experimental Research Station

Mild Habanero - mild *Capsicum chinense* (Habarnero) from TAMU

Habanero (*Capsicum chinense*)

Bhut Jholokia (Ghost Pepper) - hybrid of *Capsicum chinense* and *Capsicum frutescens*

Rooster Spur (*Capsicum annuum longum*)

Tobasco (*Capsicum frutescens*)

Table 2. Reported concentrations of Capsaicin and Vitamin C in Hawaii grown chili peppers, as determined by Quantitative High-Performance Liquid Chromatography (HPLC).

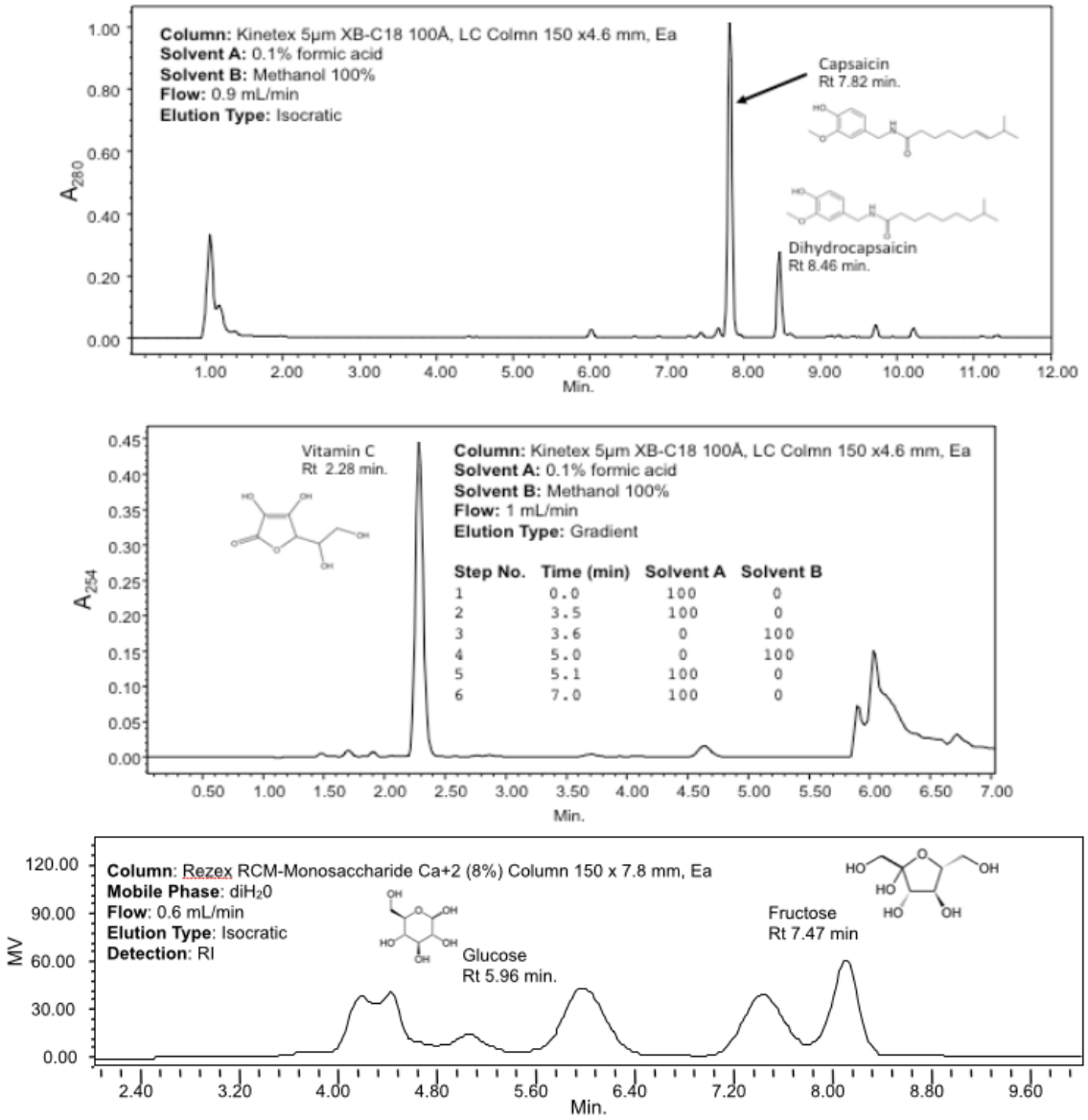
ID	Variety	Capsaicin concentration (mg/kg) ǂ	Vitamin C concentration (mg/kg) ǂ
1	*Capsicum frutescens* (Hawaiian,unripe)	45.73 ± 3.98	Undetected
2	*Capsicum frutescens* (Hawaiian, semi-ripe)	38.18 ± 15.44	2.00 ± 0.29
3	*Capsicumfrutescens* (Hawaiian, ripe)	44.68 ± 5.93	Undetected
4	*Capsicum annuum* (Thai hot, unripe)	30.60 ± 9.62	Undetected
5	*Capsicum annuum* (Thai hot, semi ripe)	32.72 ± 4.27	Undetected
6	*Capsicum annuum* (Thai hot, ripe)	40.49 ± 14.07	Undetected
7	*Capsicum chinense* (Adjuma Round, Ripe)	33.18 ± 6.45	3.57 ± 1.5
8	*Capsicum annum* (Sweet Pepper Fushimi, unripe)	0.42 ± 0.00	Undetected
9	*Capsicum chinense* (Ghost Pepper, ripe)	287.79 ± 144.22	8.96 ± 0.87
10	*Capsicum frutescens* (Bird pepper, unripe)	75.85 ± 22.27	Undetected
11	*Capsicum eximium* (Bird pepper, unripe)	26.26 ± 12.01	Undetected
12	*Capsicum baccatum* (Aji crystal, unripe)	4.70 ± 0.54	Undetected
13	*Capsicum annuum* (Fish pepper, unripe)	12.09 ± 0.43	Undetected
14	*Capsicum annuum* (Ka'ala, unripe)	0.42 ± 0.00	Undetected
15	*Capsicum annuum* (Waialua, unripe)	10.62 ± 4.49	Undetected

ǂValues are mean ± standard deviation, n=3.

Accomplishments:

We have successfully developed and established novel and rapid techniques in (HPLC) chromatographic analysis for capsaicinoids, carbohydrates, and Vitamin C within capsicum samples. These methods greatly improved upon present published methods and are adapted to high throughput automation and analysis. The established methods for carbohydrate, and Vitamin C have equal application to other fruits and vegetables and now add an additional and accessible quantitative resource for agricultural researchers with Hawaii. Illustration of these techniques and outputs are provided in Fig. 2.

Fig. 2 Analytical High Performance Liquid Chromatographic methods used for the analysis of capsaicinoid, Vitamin C and carbohydrate, within Hawaii grown Chili peppers



Objective 2: Determine fruit production rates, and determine costs of production for four major types of Hawaii grown chilies (Hawaiian, Thai, jalapeño and habanero). Conduct taste test and stakeholders surveys to gage present and future interests in the commercialization of Hawaii grown chili peppers.

Significant Results:

(i) Production Yields: Project staff have demonstrated various yields of chili peppers (numbers/plant and weights) in various plant varieties, as listed in Table 3. Here, *Capsicum annuum* demonstrated the most weight/fruit (18-30 g), but the lowest consumer perceived

pungency (see below) and retains an average, capsaicinoid content, varying with degrees of ripeness, as determined by chromatographic methods (see above).

Midrange fruits (4-9 g) correlated well with consumer perception, as being both stronger and more pungent, then its counterparts Midrange fruits are reflected in both the *C. chinense* ('Ghost Pepper'/Habanero) and *C. frutescens* ('Hawaiian') varieties. This correlates well to capsaicinoid concentrations, as determined by chromatographic methods. Notably *C. chinense* ('Ghost Pepper'/ Habanero) has the highest capsaicinoid concentration (specifically capsaicin 287.79±144.22 mg/Kg), BUT represents the most variable capsaicinoid content (Table 3). *C. frutescens* ('Hawaiian') demonstrated both pungency and an upper range in capsaicinoid content, with a limited variability in capsaicinoid/capsaicin content (45.73± 3.98 mg/Kg).

Table 3. The varieties of Chili peppers examined in this study, using the established in-house analytical methods previously reported.

Variety	A	B	Average fruit weight (g) (A/B)
	Average fruit weight (g)/plant	Number of Fruits/plant	
Capsicum chinense (Habanero)	932.40	81.40	11.45
Capsicum chinense (mild) (Mild Habanero)	854.22	98.33	8.68
Capsicum annuum (Jalapeño I)	696.45	23.50	29.63
Capsicum annuum (Jalapeño II)	475.16	16.60	28.62
Capsicum annuum (Waialua)	572.16	31.25	18.30
Capsicum annuum (Rooster Spur)	293.03	138.00	2.12
Capsicum annuum (Thai Red)	332.67	129.50	2.56
Capsicum annuum (Thai hot)	43.00	19.00	2.26
Thai Bur	174.29	74.50	2.33
Bhut Jholokia (Ghost Pepper)	612.48	110.60	5.53

Bird eye	448.91	135.67	3.30
Hawaiian Ghost Pepper (hybrid of *C. chinense and C. frutescens*)	122.11	29.60	4.12
Trinidad Scorpion	384.42	45.33	8.48
Capsicum frutescens (Tobasco)	312.17	78.33	3.98

(ii) Taste Survey: 10 participants undertook the tasting of the commercially prepared Chili sauces, as illustrated in Fig. 3., results were determined as follows:

Perceived Pungency:

- *chinense* ('Ghost Pepper'/ Habanero) (3B) > *C. frutescens* ('Hawaiian') (3C) > *C. annuum* ('Thai'/ Rooster Spur) (3A).

Preference:

- *chinense* ('Ghost Pepper'/ Habanero) (3B) = *C. fructescens* ('Hawaiian') (3C) > *C. anunum* ('Thai'/ Rooster Spur) (3A).
- Evaluators consistently identified *C. chinense* ('Ghost Pepper'/ Habanero) (3B) as most pungent and *C. anunum* ('Thai'/ Rooster Spur) (3A) as least pungent[1]
- Evaluators were split between *C. chinense* ('Ghost Pepper' / Habanero) (3B) and *C. fructescens* ('Hawaiian') (3C) and most preferred. *C. annuum* ('Thai'/ Rooster Spur) (3A) was less preferred than the other two species.

[1] Differential detection by taste for 'hotness' can represent a process of conditioning and may skew perceived levels of pungency.

(iii) Stakeholder Survey:

- Stakeholders are already engaging in chili pepper production in Hawaii (~60% of respondents were farms; n=22).
- 70% of all respondents are presently using Hawaiian chili peppers in their organizations (Farm, restaurant, value added processor, retailer and other)
- Majority of Chili peppers grown in Hawaii are disturbed amongst the 'Hawaii' *(C. fructescens*) and Mild Jalapeno (mild *C. annuum*) varieties, but with many farmers growing multiple varieties at once [Hawaiian, Thai, Jalapeno (mild), Jalapeno (hot), Habanero (mild), Habanero (Hot) Ghost/Scorpion and others].
- High preference for locally grown chili peppers, over imported is clearly apparent.
- Order of stakeholder preference for chili pepper varieties are: Hawaiian = mild *C. anunum > other (Hatch Green Chilis, Italian Frying Peppers, Bell peppers; espellete type) > C. annuum (Thai).*

(iv) Cost of production: Organic Hawaiian Chili Pepper Costs and gross margin per acre per crop demonstrates a potential of a 73.70% gross margin return/acre/crop. Labor costs demonstrates the one of the largest considerations, and may increase with the choice of chili pepper variant given the number of Fruits/plant (Table 3.). Cost analysis is a generic analysis independent of chili pepper variant.

Accomplishments:

- The project has conducted the first fruit yield survey of Hawaiian grown chili peppers encompassing 15 different varieties, indicating that Hawaiian Hybrid (*Capsicum chinense* and *Capsicum frutescens)* is a local favorite, with pungency and desirable attributes both in taste and present agricultural activities.
- The project has undertaken the first cost of production analysis of Hawaii grown chili peppers, indicating its feasibility as a profitable crop, with a potential to supply local and domestic market demands and possibly entry for exportation.
- The project has developed stakeholder surveys and have initiated contact with stakeholder groups. Details gathered from nine (9) survey questions provide the basis for additional analysis of 'other' chili varieties that have present local market share. Results of survey are attached (Appendix A).

Table 4. Organic Hawaiian Chili Pepper Costs and gross margin per acre per crop

Organic Hawaiian Chili Pepper
Costs and gross margin per acre per crop

GROSS REVENUE	Quantity	Unit	$/unit	Gross revenue	% of gross revenue
TYPICAL yields & prices	10,000	pounds	######	$100,000	100.00%

PRODUCTION COSTS (by activity)	Quantity	Unit	$/unit	Cost	% of gross revenue
1 Land Preparation					
Fertilizer: Meat and Bone meal	3,000.00	pounds	$0.25	$750	0.75%
Plastic mulch	4,000.00	feet	$0.04	$160	0.16%
Labor to prepare land	15.00	hours	######	$152	0.15%
Total land preparation cost =				$1,062	1.06%
2 Planting					
Pepper seeds	1.00	pound	$6.80	$7	0.01%
Plant medium	25.00	cubic feet	$9.00	$99	0.10%
Seedling trays	222.00	each	$1.25	$278	0.28%
Labor to raise & plant seedlings	63.00	hours	$7.98	$503	0.50%
Total planting cost =				$886	0.89%
3 Pest Control:					
Labor to handweed	100.00	hours	$7.98	$798	0.80%
Pyganic application*	3.00	application	######	$150	0.15%
Trilogy*	3.00	application	######	$135	0.14%
M-Pede application*	3.00	application	######	$72	0.07%
Labor to apply pesticides	20.50	hours	$7.98	$164	0.16%
Total pest control cost =				$1,319	1.32%
4 Irrigation					
Water	11.00	acre inches	######	$206	0.21%
Labor to apply water	22.00	hours	$7.98	$176	0.18%
Total irrigation cost =				$382	0.38%
5 Harvesting					
Labor to harvest*	1,000.00	hours	######	$10,150	10.15%
Bags	800.00	each	$0.55	$440	0.44%
Total harvesting cost =				$10,590	10.59%
6 Marketing					
Labor to transport to market	9.00	hours	$7.98	$72	0.07%
Total marketing cost =				$72	0.07%
7 Mechanized Operations					
Fuel, oil & lube	1.00	acre	######	$446	0.45%
Total machinery cost =				$446	0.45%
8 Operating Overhead					
Operating interest	10.00%	annually		$48	0.05%
Excise tax	0.50%	of gross revenue		$500	0.50%
Commissions	5.00%	of gross revenue		$5,000	5.00%
Management	5.00%	of gross revenue		$5,000	5.00%
Office overhead	1.00%	of gross revenue		$1,000	1.00%
Total operating overhead =				$11,548	11.55%
TOTAL VARIABLE COSTS OF PRODUCTION =				$26,305	26.30%
GROSS MARGIN (Gross revenue minus variable costs) =				$73,695	73.70%

* Sources:
http://www.ctahr.hawaii.edu/RadovichT/downloads/Pepper_size_labor.pdf
http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SA-4.pdf

Objective 3. Dissemination of project results to growers, agricultural professionals, and industry members.

Significant Results: Project staff are presently working to compile a research paper reporting the modernization of rapid chromatographic techniques suitable for the analysis of plant chemicals such as capsaicinoids, carbohydrates, and Vitamin C. This work in part represents the Master Thesis research topic of a Molecular Biosciences and Bioengineering student at the University of Hawaii, Manoa. Additional materials have been shared with community members via:

Community and public interactions: Field day in Waimanalo Research station on July 26, 2014, 9:00 am to 1:00 pm
Media coverage; Hana Hou! – The magazine of Hawaiian Airlines:

- The Tropic of Capsicum http://www.hanahou.com/pages/magazine.asp?MagazineID=79&Action=DrawArticle&ArticleID=1283&Page=1

Research Poster:

- Wen J.*, Pant A., Radovich T., Wang K-H, and Bingham J-P. (2014) Ay caramba! Advanced chemical analysis of chili peppers and tomatoes. Abstract #67. 26th CTAHR and COE Research Symposium, University of Hawaii, Honolulu, April 11-12. (MS. Student; Poster).
- Wen J.*, Pant A., Radovich T., Wang K-H, and Bingham J-P. (2015) *Ay caramba*! Advanced chemical analysis of chili peppers and tomatoes. Abstract #88. 26th CTAHR and COE Research Symposium, University of Hawaii, Honolulu, April 10-11. (MS. Student; Poster).
- E-Bulletin: CTAHR alumni & Friends http://www.ctahr.hawaii.edu/e-notes/02_28_2014.html

Favorable or unusual developments for tasks performed during the granting period are illustrated with:

Objective 1. Established rapid high throughput analysis for various plant chemical attributes specifically for chili peppers. This approach has equal applicability to other areas of Hawaiian agricultural research, which demonstrated the demand for the modernization of chemical detection techniques. The establishment and maintenance of these analytical instruments is an evolving commitment for local agricultural researchers, and enables the provision for a potential competitive edge in marketing/publicity.

Objective 2. Realization that other chili pepper varieties, not covered in this initial survey, may provide an additional niche market in Hawaii; Economic viability for profit margin demonstrates feasibility for additional studies to examine mainland/export market. Numerous individuals are willing to share their personal experience with growing chili peppers in Hawaii.

Objective 3. Broadcasting of information has generated interest in exploring a stronger focus to boosting present activities within the fledgling Hawaiian chili pepper industry, including chili

products, local supply and consumption. This diverts from the previous perception that chili peppers in Hawaii are a secondary or minor cash crop.

Table 5. Significant contributions and role of project partners in the project.

Project partners	Contributions and role
CTAHR Cooperative extension	Field day coordination, information dissemination
Rex Moribe http://www.dasecretsauce.com	Provided input regarding producer needs before and during project
Tim Parsons http://adoboloco.com	Provided input regarding producer needs before and during project
Merrimans cafe	Provided input regarding chefs needs
Mohala farms	Provided input regarding producer needs before and during project
Honolulu burger company	Provided input regarding chefs needs
Cafe Laufer	Provided input regarding chefs needs
12th Avenue grill	Provided input regarding chefs needs
Kokua Market	Provided wholesale and retail marketing information regarding peppers
Eat Cafe	Provided input regarding chefs needs

Goals and Outcomes Achieved

The proposed project achieved its target goals for the established Objective 1-3, as illustrated in Table 6:

Table 6. Activities completed in order to achieve performance goals and measureable outcomes

	Goals	**Outcomes**	**Comments**
Objective 1	Basic chemical analysis of chili peppers	Capsaicin analysis – All Field samples/trials	Completed
		Carbohydrate analysis – All Field samples/trials	On-going*

Objective 2	Cost production analysis; seek stakeholder and consumer input	Cost production analysis	Completed
		Stakeholders survey	Completed
		Taste test survey	Completed
Objective 3	Disseminate findings	Publish peer review paper	In progress
		Public interactions/education	On-going

* to be completed for review publication

We expect the impact of this work to stimulate both discussions and actions that focus on increasing current chili pepper production in Hawaii. This is established in an effort for longer-term expansion of chili pepper related products, both for local, domestic and international consumption.

Completion of our outcomes is illustrated by:

- Photographic database of chili pepper varieties;
- Database of fruit production;
- Database of capsaicinoids, Vitamin C and carbohydrate (on-going) profiles for 15 varieties of Hawaii grown chili peppers;
- Base-line data analysis for the cost of production/acre/crop, as it stands for 2015;
- Preliminary analysis for current (2015) chili pepper production in Oahu, Hawaii.

These quantifiable measurements, demonstrates our progression toward achieving set goals.

The major successful outcomes of the project in quantifiable terms, as seen as:

- Enhanced co-operation between field researchers and analytical chemists in the analysis of plant materials
- Development of novel high throughput chromatographic methods, which advance previous analytical techniques
- Quantification of capsaicinoids, Vitamin C and carbohydrate (on-going) for 15 varieties of Hawaii grown chili peppers;
- Cost analysis of chili pepper production in Hawaii
- Survey of present chili pepper producers
- Preliminary input from chili pepper sauce consumers

Beneficiaries

Beneficiaries include Growers, processors, consumers and retailers of chili peppers in Hawaii. An estimated 150 beneficiaries in Hawaii were directly engaged by this project through field days and electronic communication. That number is expected to at least double in the next year through continued outreach efforts beyond the life of this project via web-based dissemination and continued field days. Although direct and indirect economic impact of this project is hard to determine, the project manager estimates that contribution of this project to

improved production and marketing of hot peppers to significantly exceed $20,000 during the period 2013-2018.

Lessons Learned

Insights into the lessons learned by the project staff as a result of completing this project, are as follows:

- The development of cross-disciplinary expertise to achieve the goals of the project by a single person is impossible. A combined and collaborative approach using local agricultural expertise, together with an analytical/chromatographic chemist, together with stakeholder input, provides a highly productive platform to achieve and meet the necessary goals. Yet to achieve this, key players need to be in close contact and in close proximity (laboratories) – this, the project staff sees as a major advantage in this project (Bingham and Radovich Laboratories are a few doors apart).
- Planting and harvesting activities can provide important lessons in time management and provide unexpected hurdles in coordinating analytical analysis. Not everything grows or matures at the same rate. These efforts need to be well coordinated with sample preparation and analysis.
- Analytical instruments typically fail at the most critical point of batch analysis.
- Many published methods for chemical analysis in agriculture are outdated, and typically do not encompass the most advance instrumentation and analytical methods available (maybe for the above reason).
- Some analytical methods are more sensitive than others, and the necessary controls and standards need to be in place to ensure accuracy and reproducibility.
- Chili peppers clearly have significant impact on local cuisine, which provides an avenue for a unique taste and products.

Unexpected outcomes or results that were an effect of implementing this project came about with stakeholder input from the survey. This indicated that additional varieties of chili peppers, that have present commercial usage in Hawaii, should have been included in this analysis. These variants may represent an additional niche market.

One particular outcome that will need to be addressed is the effect of soil type of chili pepper production and chemistry – this requires a greater in-depth and structured analysis. Yet with analytical methods and instrumentation now in place this becomes a highly achievable task.

Color forms, particularly red chili peppers, have a highly attractive status, which leads to the possibility of breeding chili peppers to enhance capsaicinoids, Vitamin C and carbohydrate content, together with anthocyanin analysis (color), to create a truly unique and desirable market form.

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Additional Information

Table 7. Fresh and dry weight of chili pepper that were analyzed for Capsaicin and Vitamin C.

			A	B	
ID	**Variety**	**Maturity**	**Fresh weight per fruit (g)**	**Dry weight per fruit (g)**	**% Moisture (A-B/A x100)**
1	*Capsicum frutescens* (Hawaiian)	Unripe	0.98	0.16	83.6
2	*Capsicum frutescens* (Hawaiian)	Semi-ripe	0.84	0.23	72.6
3	*Capsicum frutescens* (Hawaiian)	Ripe	1.08	0.28	74.1
4	*Capsicum annuum* (Thai hot)	Unripe	1.95	0.30	84.6
5	*Capsicum annuum* (Thai hot)	Semi-ripe	1.87	0.45	75.9
6	*Capsicum annuum* (Thai hot)	Ripe	2.13	0.48	77.5
7	*Capsicum chinense* (Adjuma Round)	Ripe	6.10	0.88	85.6
8	*Capsicum annum* (Sweet Pepper Fushimi)	Unripe	7.83	0.69	91.2
9	*Capsicum chinense* (Ghost Pepper)	Ripe	9.10	1.20	86.8
10	*Capsicum frutescens* (Bird pepper)	Unripe	0.20	0.07	65.0
11	*Capsicum eximium* (Bird pepper)	Unripe	0.16	0.06	62.5
12	*Capsicum baccatum* (Aji crystal)	Unripe	4.32	0.47	89.1
13	*Capsicum annuum* (Fish pepper)	Unripe	2.59	0.31	88.0
14	*Capsicum annuum* (Ka'ala)	Unripe	36.55	4.38	88.0
15	*Capsicum annuum* (Waialua)	Unripe	18.43	2.20	88.0

Fig. 4. Some of the chili pepper varieties that were analyzed for Capsaicin and Vitamin C.

A. *Capsicum frutescens* (Hawaiian) Unripe, B. *Capsicum frutescens* (Hawaiian) Semi-ripe, C. *Capsicum frutescens* (Hawaiian) Ripe,

D. *Capsicum annuum* (Thai hot) Unripe, E *Capsicum annuum* (Thai hot) Semi-ripe, F. *Capsicum annuum* (Thai hot) Ripe,

G. *Capsicum chinense* (Adjuma Round) Ripe, H. *Capsicum annuum* (Sweet Pepper Fushimi) Unripe, I. *Capsicum annuum* (Sweet Pepper Fushimi) J. *Capsicum chinense* (Ghost Pepper) Ripe.

Fig. 2. Chromatographic conditions for running mono- and disaccharides/carbohydrate analysis by HPLC/UV

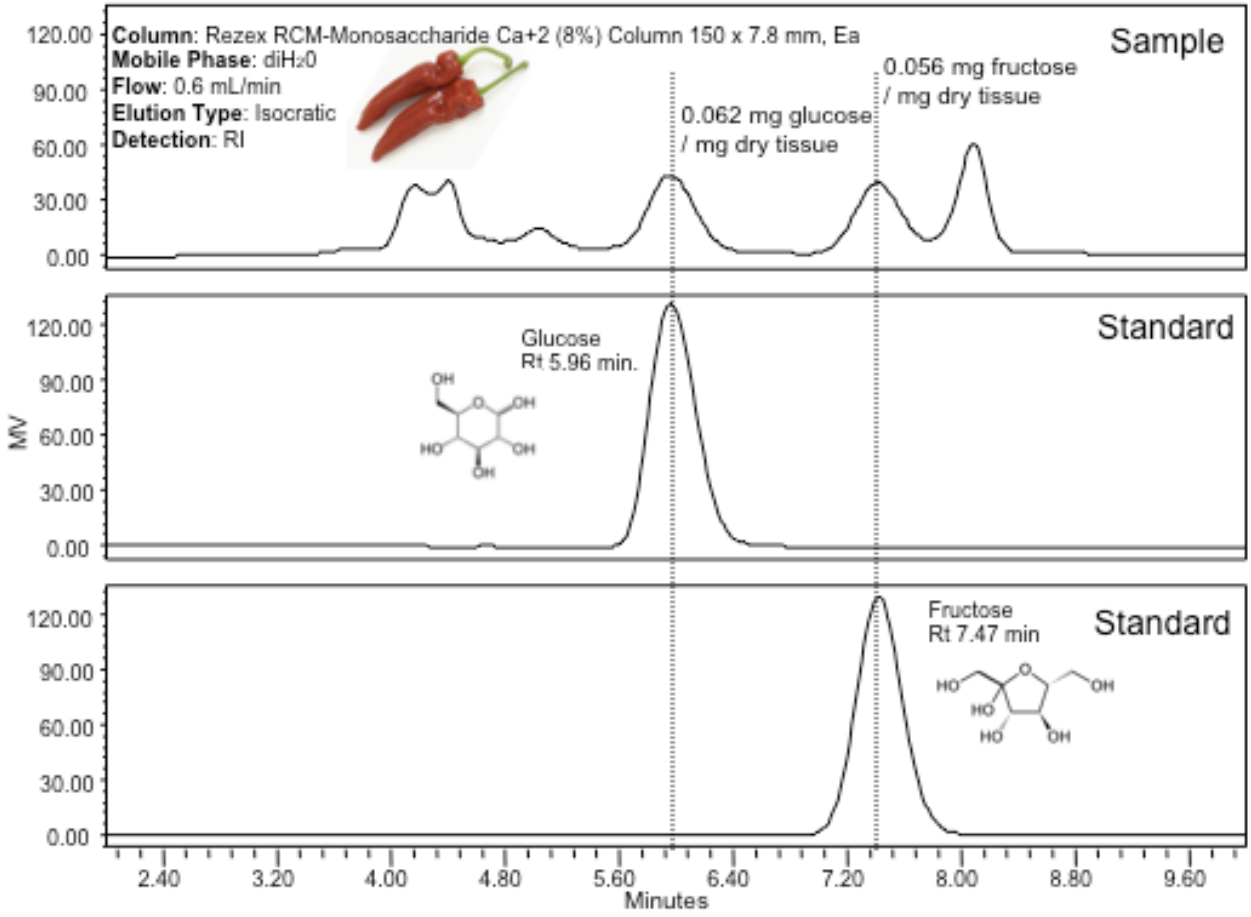
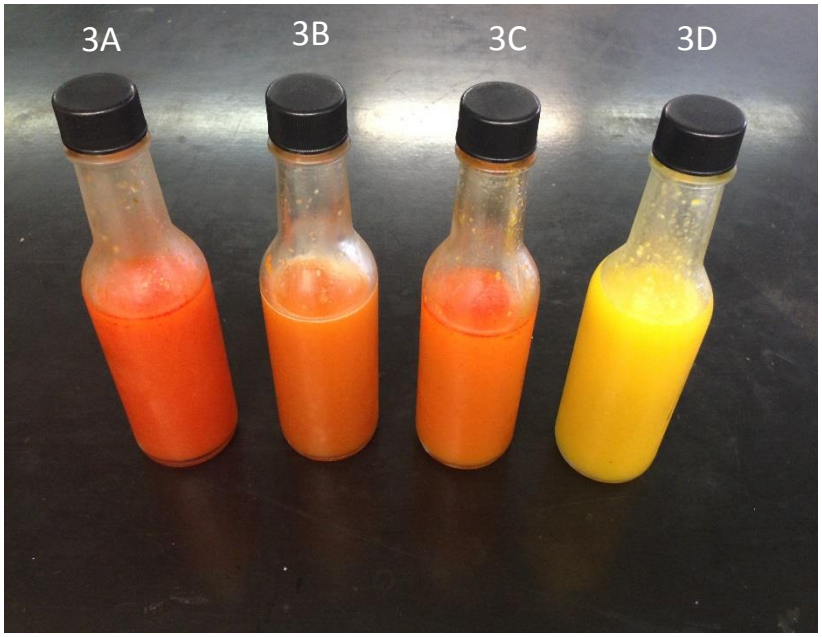


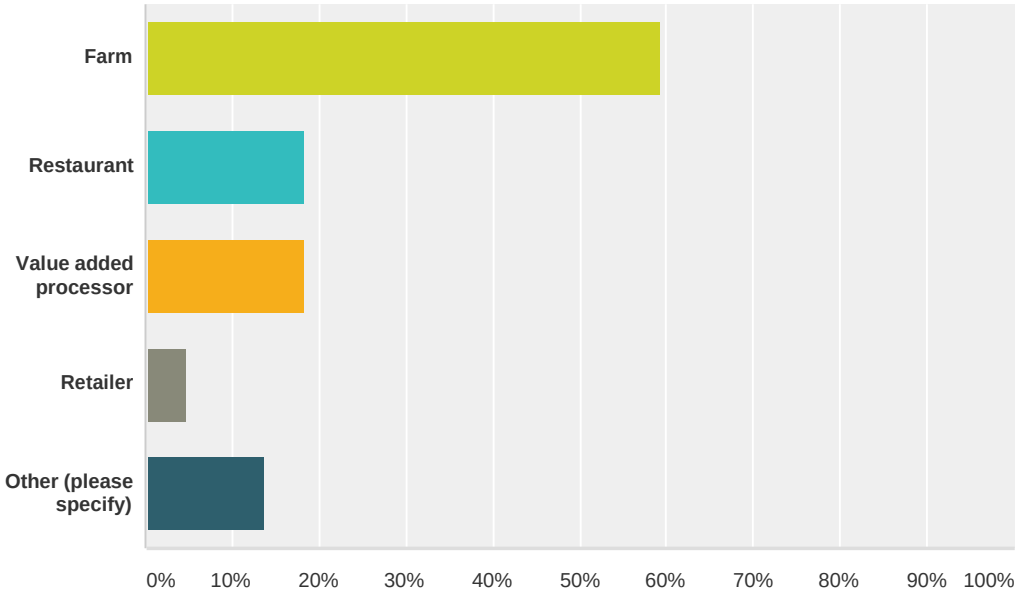
Fig 3. Commercially prepared Chili sauces using *Capsicum anuum* (Rooster Spur) (3A), *Capsicum chinense* (Habarnero) (3B), *Capsicum frutense* (Tobasco) (3C) and mild *Capsicum chinense* (Habarnero) from TAMU (3D), these were used in the taste testing survey.



Appendix A – 2014 Survey of Chili pepper stakeholders

Q1 What type of operation are you?

Answered: 22 Skipped: 1

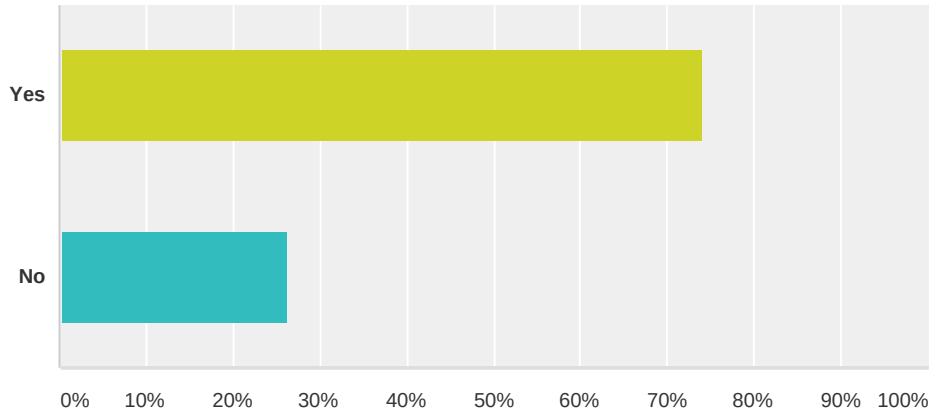


Answer Choices	Responses	
Farm	**59.09%**	13
Restaurant	**18.18%**	4
Value added processor	**18.18%**	4
Retailer	**4.55%**	1
Other (please specify)	**13.64%**	3
Total Respondents: 22		

#	Other (please specify)	Date
1	Manufacturer of Da Secret Sauce	3/10/2014 3:39 PM
2	Individual	1/19/2014 8:42 PM
3	Wholesale	1/7/2014 3:20 PM

Q2 Do you currently use chilies in your operation?

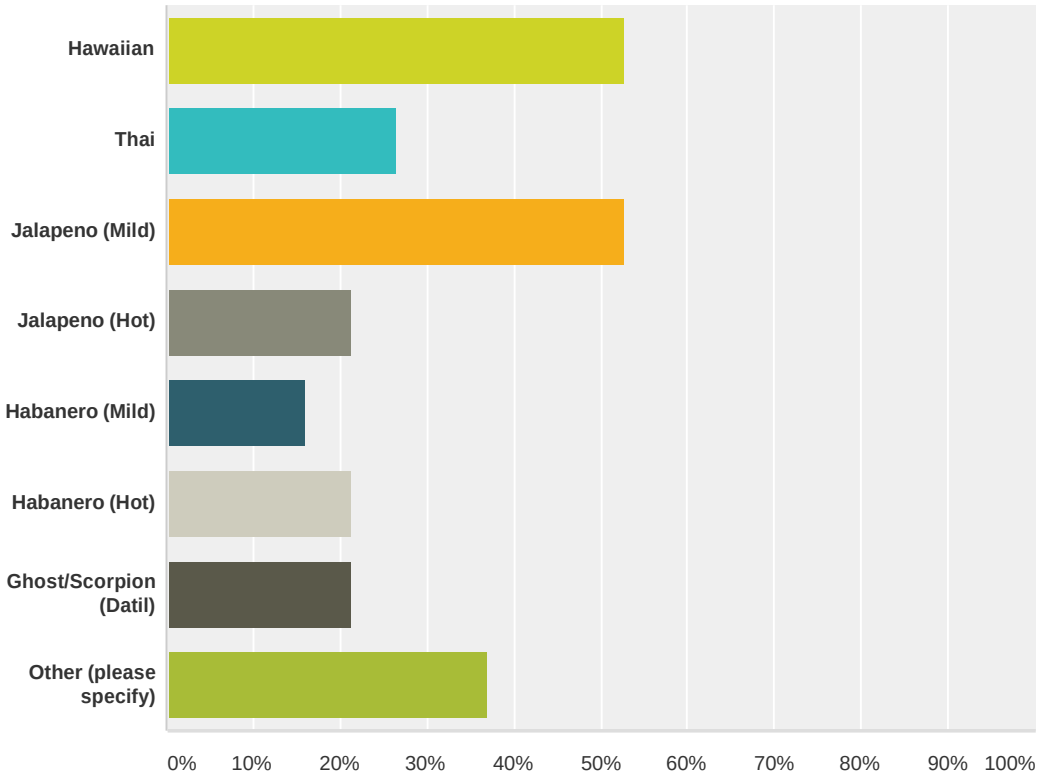
Answered: 23 Skipped: 0



Answer Choices	Responses	
Yes	**73.91%**	17
No	**26.09%**	6
Total		**23**

Q3 Which type of chili pepper do you use in your business?

Answered: 19 Skipped: 4



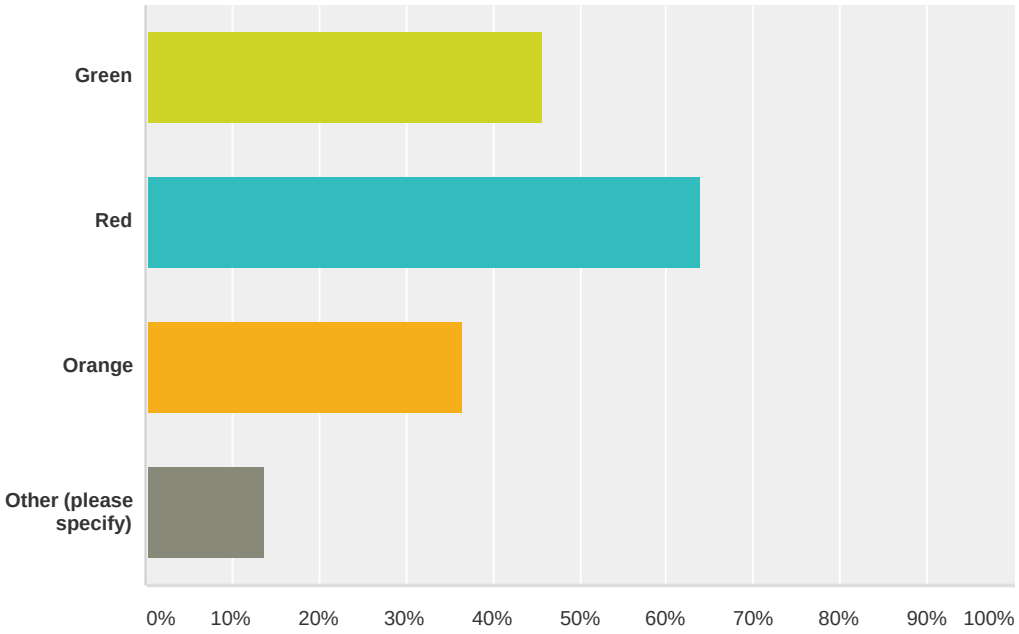
Answer Choices	Responses	
Hawaiian	**52.63%**	10
Thai	**26.32%**	5
Jalapeno (Mild)	**52.63%**	10
Jalapeno (Hot)	**21.05%**	4
Habanero (Mild)	**15.79%**	3
Habanero (Hot)	**21.05%**	4
Ghost/Scorpion (Datil)	**21.05%**	4
Other (please specify)	**36.84%**	7
Total Respondents: 19		

#	Other (please specify)	Date
1	Hatch green chilies	1/23/2014 6:44 PM
2	Italian Frying Peppers, Bell peppers	1/19/2014 8:42 PM
3	espellete type	1/15/2014 1:28 PM

4	Trinidad	1/15/20141:16 PM
5	Serrano	1/7/2014 10:17 PM
6	Carolina Reaper	1/7/2014 3:20 PM
7	Serrano	1/7/2014 2:55 PM

Q4 What color peppers do you prefer?

Answered: 22 Skipped: 1

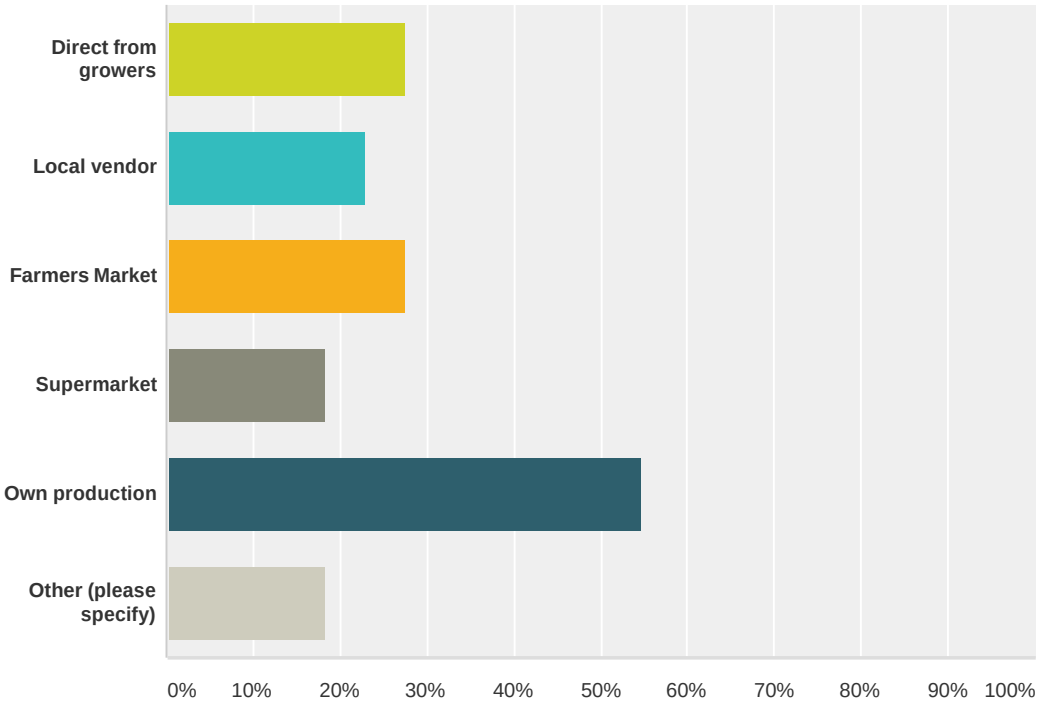


Answer Choices	Responses	
Green	**45.45%**	10
Red	**63.64%**	14
Orange	**36.36%**	8
Other (please specify)	**13.64%**	3
Total Respondents: 22		

#	Other (please specify)	Date
1	all colors	1/19/2014 8:42 PM
2	does not matter	1/15/2014 1:16 PM
3	Delicious	1/7/2014 10:17 PM

Q5 Where do you purchase chili pepper for your use?

Answered: 22 Skipped: 1

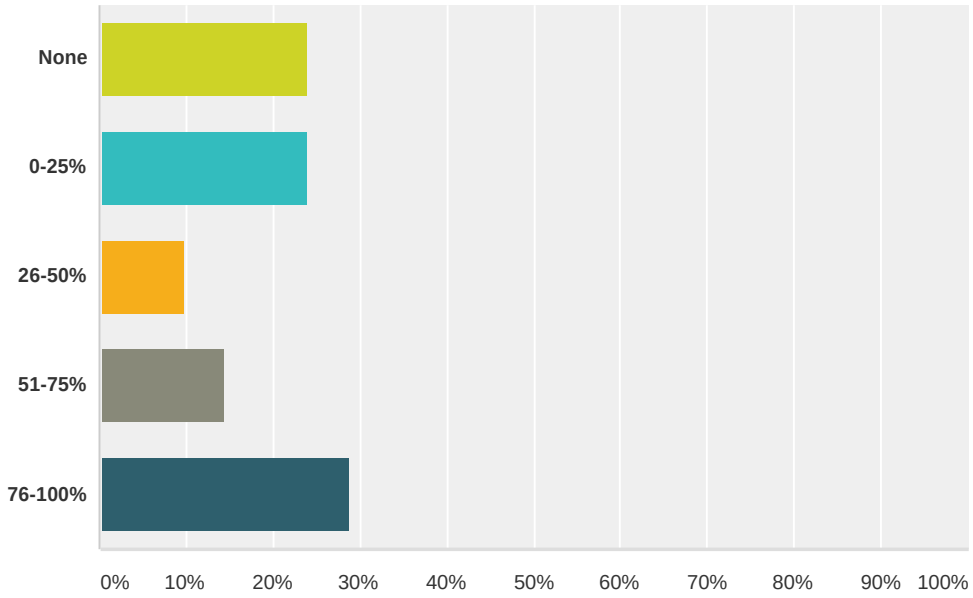


Answer Choices	Responses	
Direct from growers	**27.27%**	6
Local vendor	**22.73%**	5
Farmers Market	**27.27%**	6
Supermarket	**18.18%**	4
Own production	**54.55%**	12
Other (please specify)	**18.18%**	4
Total Respondents: 22		

#	Other (please specify)	Date
1	Online mainland organic seed supply and UH	1/23/2014 6:44 PM
2	Costco	1/19/2014 8:42 PM
3	online Spice Mart	1/15/2014 1:34 PM
4	online	1/15/2014 1:16 PM

Q6 If you purchase peppers, what proportion is locally grown?

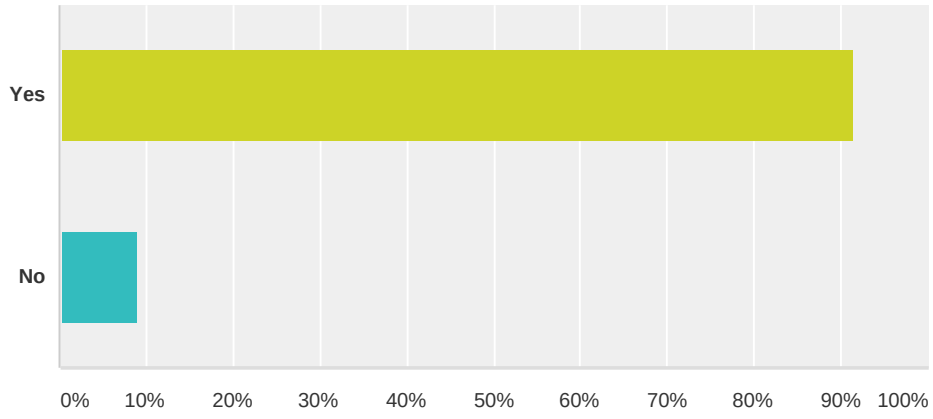
Answered: 21 Skipped: 2



Answer Choices	Responses	
None	**23.81%**	5
0-25%	**23.81%**	5
26-50%	**9.52%**	2
51-75%	**14.29%**	3
76-100%	**28.57%**	6
Total		**21**

Q7 Do you have preference for locally grown chili peppers over imported ones?

Answered: 23 Skipped: 0



Answer Choices	Responses	
Yes	**91.30%**	21
No	**8.70%**	2
Total		**23**

Q8 Do you have suggestions for specific types of chili pepper to be tested for Hawaii?

Answered: 14 Skipped: 9

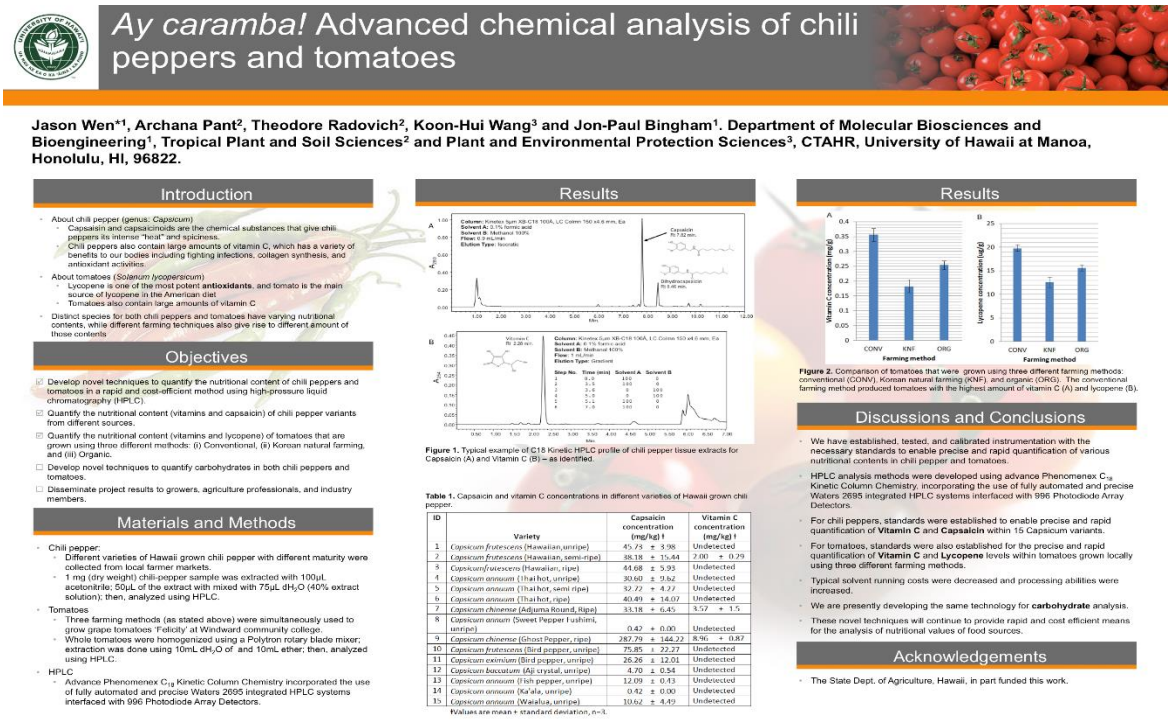
#	Responses	Date
1	Hawaiian.	3/10/2014 3:39 PM
2	Hatch green chilies, espellete, padron	1/23/2014 6:44 PM
3	Just get seed out.	1/16/2014 9:49 PM
4	Anaheim's, other green chili varieties	1/16/2014 7:38 PM
5	My scotch bonnets do really well at 300' level windward Molokai. Grown in a protected valley, they reach 4-6' with hundreds of peppers per plant. 2-3 flushes per year Some plants are 7 years old and still producing fruit. There is some fruit fly damage during the peak of fly season.	1/16/2014 8:41 AM
6	habanero	1/16/2014 8:01 AM
7	no	1/15/2014 1:40 PM
8	Espellete is a mild pepper, not real common in the US. From the basque region of France. Name is protected. Hence espellete type.	1/15/2014 1:28 PM
9	NO, diversify with many types is best	1/15/2014 1:16 PM
10	I would like to experiment with hotter chilies gown locally. the problem is that D. Otani does not bring in locally produced chilies	1/12/2014 9:44 AM
11	Serrano, banana,Anaheim,shishito,piquillo, peppadew	1/7/2014 10:17 PM
12	For us having a good variety on a consistent basis is key. When given the choice our customers choose local and organic first, then just local and finally mainland organic.	1/7/2014 4:14 PM
13	We already grow, Thai, Jalapeno, Habanero, Hawaiian, Ghost Pepper Bhut Jolokia, Trinidad Moruga Scorpion and currently germinating Carolina Reapers. We know they will grow fine, once grown they just have to be sold at a competitive price in bulk.	1/7/2014 3:20 PM
14	Jalapenos	1/7/2014 2:55 PM

Q9 Anything else you'd like to tell us regarding your use of chilies?

Answered: 7 Skipped: 16

#	Responses	Date
1	The more people, restaurants, Manufacturers, retailers demand Hawaiian Chili Peppers the more farmers will be willing to grow them. Also the health factor of Chili's are amazing.	3/10/2014 3:39 PM
2	Would like to make a value added product out the chilies I produce on the farm.	1/23/2014 6:44 PM
3	We use them for organic pest control and this includes deer deterrent. We blend chiles with water and a bit of dish soap and spray on plants and grass in the evenings. A lot of work, but it usually works unless there is a lot of rain.	1/16/2014 8:41 AM
4	you're on the right track	1/15/2014 1:40 PM
5	People need to learn correct processing for peppers. Just because it's hot doesn't mean its good or its safe in an improperly processed value added product.	1/15/2014 1:16 PM
6	I'm thinking of a hotter bbq sauce and would like more information regarding locally produced chilies.	1/12/2014 9:44 AM
7	Our business is growing and we could really use more locally grown chili peppers. Been working with other farms on expanding for us along with our own grow areas.	1/7/2014 3:20 PM

Appendix B – Masters Student Research Poster, presented at 26th CTAHR and COE Research Symposium, University of Hawaii, Honolulu, April 11-12.



Ay caramba! Advanced chemical analysis of chili peppers and tomatoes

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Introduction

- About chili pepper (genus: *Capsicum*)
  - Capsaisin and capsaicinoids are the chemical substances that give chili peppers its intense "heat" and spiciness.
  - Chili peppers also contain large amounts of vitamin C, which has a variety of benefits to our bodies including fighting infections, collagen synthesis, and antioxidant activities
- About tomatoes (*Solanum lycopersicum*)
  - Lycopene is one of the most potent **antioxidants**, and tomato is the main source of lycopene in the American diet
  - Tomatoes also contain large amounts of vitamin C
- Distinct species for both chili peppers and tomatoes have varying nutritional contents, while different farming techniques also give rise to different amount of those contents

Objectives

- ☑ Develop novel techniques to quantify the nutritional content of chili peppers and tomatoes in a rapid and cost-efficient method using high-pressure liquid chromatography (HPLC).
- ☑ Quantify the nutritional content (vitamins and capsaicin) of chili pepper variants from different sources.
- ☑ Quantify the nutritional content (vitamins and lycopene) of tomatoes that are grown using three different methods: (i) Conventional, (ii) Korean natural farming, and (iii) Organic.
- ☐ Develop novel techniques to quantify carbohydrates in both chili peppers and tomatoes.
- ☐ Disseminate project results to growers, agriculture professionals, and industry members.

Materials and Methods

- Chili pepper:
  - Different varieties of Hawaii grown chili pepper with different maturity were collected from local farmer markets.
  - 1 mg (dry weight) chili-pepper sample was extracted with 100µL acetonitrile; 50µL of the extract with mixed with 75µL dH_2O (40% extract solution); then, analyzed using HPLC.
- Tomatoes
  - Three farming methods (as stated above) were simultaneously used to grow grape tomatoes 'Felicity' at Windward community college.
  - Whole tomatoes were homogenized using a Polytron rotary blade mixer; extraction was done using 10mL dH_2O of and 10mL ether; then, analyzed using HPLC.
- HPLC
  - Advance Phenomenex C_{18} Kinetic Column Chemistry incorporated the use of fully automated and precise Waters 2695 integrated HPLC systems interfaced with 996 Photodiode Array Detectors.

Results

Figure 1. Typical example of C18 Kinetic HPLC profile of chili pepper tissue extracts for Capsaicin (A) and Vitamin C (B) – as identified.

Table 1. Capsaicin and vitamin C concentrations in different varieties of Hawaii grown chili pepper.

ID	Variety	Capsaicin concentration (mg/kg) †	Vitamin C concentration (mg/kg) †
1	*Capsicum frutescens* (Hawaiian,unripe)	45.75 ± 3.98	Undetected
2	*Capsicum frutescens* (Hawaiian, semi-ripe)	38.18 ± 15.44	2.00 ± 0.29
3	*Capsicum frutescens* (Hawaiian, ripe)	44.68 ± 5.93	Undetected
4	*Capsicum annuum* (Thai hot, unripe)	30.60 ± 5.62	Undetected
5	*Capsicum annuum* (Thai hot, semi ripe)	32.72 ± 4.27	Undetected
6	*Capsicum annuum* (Thai hot, ripe)	40.49 ± 14.07	Undetected
7	*Capsicum chinense* (Adjuma Round, Ripe)	33.18 ± 6.45	3.57 ± 1.5
8	*Capsicum annum* (Sweet Pepper Yushima, unripe)	0.42 ± 0.00	Undetected
9	*Capsicum chinense* (Ghost Pepper, ripe)	287.79 ± 144.22	8.96 ± 0.87
10	*Capsicum frutescens* (Bird pepper, unripe)	75.85 ± 22.27	Undetected
11	*Capsicum eximium* (Bird pepper, unripe)	26.26 ± 12.01	Undetected
12	*Capsicum baccatum* (Aji crystal, unripe)	4.70 ± 0.54	Undetected
13	*Capsicum annuum* (Fish pepper, unripe)	12.09 ± 0.43	Undetected
14	*Capsicum annuum* (Ka'ala, unripe)	0.42 ± 0.00	Undetected
15	*Capsicum annuum* (Waialua, unripe)	10.62 ± 4.49	Undetected

†Values are mean ± standard deviation, n=3.

Results

Figure 2. Comparison of tomatoes that were grown using three different farming methods: conventional (CONV), Korean natural farming (KNF), and organic (ORG). The conventional farming method produced tomatoes with the highest amount of vitamin C (A) and lycopene (B).

Discussions and Conclusions

- We have established, tested, and calibrated instrumentation with the necessary standards to enable precise and rapid quantification of various nutritional contents in chili pepper and tomatoes.
- HPLC analysis methods were developed using advance Phenomenex C_{18} Kinetic Column Chemistry, incorporating the use of fully automated and precise Waters 2695 integrated HPLC systems interfaced with 996 Photodiode Array Detectors.
- For chili peppers, standards were established to enable precise and rapid quantification of **Vitamin C** and **Capsaicin** within 15 Capsicum variants.
- For tomatoes, standards were also established for the precise and rapid quantification of **Vitamin C** and **Lycopene** levels within tomatoes grown locally using three different farming methods.
- Typical solvent running costs were decreased and processing abilities were increased.
- We are presently developing the same technology for **carbohydrate** analysis.
- These novel techniques will continue to provide rapid and cost efficient means for the analysis of nutritional values of food sources.

Acknowledgements

- The State Dept. of Agriculture, Hawaii, in part funded this work.

Field Trial Introduction of Cashews as a New Crop for Hawaii

Final Report

The Hawaii Department of Agriculture (HDOA)
http://hdoa.hawaii.gov/

Project Summary

Hawaii has a long and vibrant agricultural history that is linked to the rise and fall of sugar cane and pineapple, crops that are known as representing agriculture in Hawaii. However, with the decline of these agricultural monocrops, a great deal of land has become vacant, fallow, unusable, or has been dedicated for real-estate development. It is well-known that Cashew trees are extremely resilient and hardy. With the great deal of vacant Class C and D lands as well as vacant land, cashews is a crop with a great deal of potential to fill the void left by the departure of sugar cane and pineapple. As a result, this project intends to introduce an alternate crop that could avoid soil erosion, promote the utilization of vacant land for a better sustainable economy for the state, as well as maintain a level of self-sufficiency for the islands. Hawaii's economy is largely dependent on revenue contributions from the military and tourism. Establishing an alternate economic strategy emphasizing agriculture would move the state toward economic stability. The introduction of cashews as an alternate crop in the Hawaiian Islands was a project the HDOA decided to pursue.

The HDOA, implementing the Request for Proposals method, per state procurement rules, contracted AMES International (AMES) as the Project Manager to bring high yielding varieties of cashew plants from the Indian Cashew Research station at the Agriculture University of Kerala, India to conduct the field trial introduction of cashews as a new crop for Hawaii.

In this field trial, the primary goal was to import 3,000 seedlings from Kerala, India to Hawaii and determine both whether cashews could grow in Hawaii and if they could be a viable agricultural crop for the islands. The cultivation of cashew nuts in Hawaii as a new crop was tested by seven volunteer farmers whose farms were located on Hawaii Island, Oahu, Maui, and Kauai and featured a wide variety of different locations, microclimates, and elevations ideal for conducting a well-rounded field trial.

Project Approach

AMES proposed a comprehensive 24 month project utilizing a cross functional team of knowledgeable Industry experts to introduce the cashew as a viable agricultural commodity in Hawaii. Two (2) phases were proposed for the Cashew Field Trial. A summary of the work plan and their outcomes follows:

PHASE 1:

Sourcing and Preparing: Proper sourcing of the cashew seedlings was essential to the success of the project. AMES identified the Cashew Research Station at the Kerala Agricultural University Research Center (CRSKAU) in Anakkayam, Kerala, as the ideal source for seedlings.

Project staff, both from AMES in the United States and the AMES branch office in India, met with Dr. P. Rajenderan, Director of the CRSKAU, toured the facilities, and made subsequent visits to their facility and determined that CRSKAU would be the best facility for the project since they had the technology and resources to support the project's unprecedented and complex request for cashew seedlings that would be introduced to Hawaii.

The work then continued with the following:

- Established a general timeline for the growth and shipping of the seedlings.
- Started the selection of the logistics provider to move the shipments from CRSKAU to Hawaii.
- Established a general plan for the packing media and the processes for preparing the cashew seedlings for shipping based on suggestions made by the HDOA and USDA APHIS office in Honolulu.

Purchasing and Permits: Purchased the seedlings from the CRSKAU and secured the necessary permits and paperwork needed for export to Hawaii.
The project proposal acknowledged that the Indian Government could be difficult to work with and slow to act on requests, which impacted the permitting process. Project staff learned that the main permit required would be an export license for plants, cashews specifically, from the Government of India's Directorate General of Foreign Trade (DGFT) as cashews is listed as an endangered species and export is restricted.

It was during this pursuit of the permits needed for export, that AMES learned that the project was unprecedented and that it would take more than an application to secure the permits and licenses needed to legally export the seedlings to the US.

The CEO of AMES and the Managing Director AMES India, the AMES subsidiary based in India, traveled to New Delhi, the capital of India and seat of the executive, legislative, and judiciary branches of the Government of India to explain the project, present their case, and appeal to the DGFT. Approval from a 16-member committee was required for AMES and AMES India to proceed with the project on behalf of the HDOA. Project staff learned that because of the nature of the request, additional information and approval from the National Biodiversity Authority (An Autonomous and Statutory Body of the Ministry of Environment and Forests) would be required in order to obtain the export license.

After months of tedious, detailed work, meetings in both Delhi and Chennai, persistent efforts of the AMES India team coupled with the networking by AMES, the perseverance and dedication of the AMES team resulted in AMES successfully securing the permits and permissions to export the seedlings to the US! AMES then commenced with selecting, securing, purchasing, and growing the 3,000 cashew seedlings.

Shipping and Shipment Preparations: The action plan timeline was reset and the tasks listed resumed for completion of the project. AMES India would pick up and pack the seedlings for their transport to the US. Customs clearance and permits were obtained. After obtaining the Government permits, the grafted seedlings were moved from the facility in Anakkayam and brought by truck to AMES India's facility for final visual inspections, disinfection, and packing. In order to

meet customs and USDA specifications, the growing media was removed and the plants were further disinfected with approved disinfectants to eliminate possible infestations. The bare-rooted plants were thoroughly washed and wrapped in wet newspaper to ensure the plants had water, a common practice in International plant transport. They were further bundled in groups of five and each seedling was given a unique serial number describing its varietal, the farmer to whom it was going, and a unique number to monitor its progress over time.

An initial Hawaii site visit in June of 2014 with the HDOA representative and AMES representatives was conducted to meet with each of the farmers and brief them of what to expect and how to best prepare for the arrival of the seedlings.

The project staff selected a logistics team consisting of a freight forwarder and a customs clearance agent to transport the seedlings, selecting the fastest elapsed time for transit and selecting first point of entry in the US as Seattle, WA, where AMES is headquartered. From Kochi, Kerala, India, the shipment of seedlings was forwarded to Seattle, WA for clearance via Dubai, U.A.E. This route included arrangements for special attention from Emirates Airlines on the longest segment of the transport, the 15-hour nonstop flight from Dubai to Seattle. The seedlings began their transit to the US on July 23, 2014.

Upon arrival in Seattle, the AMES logistics specialist inspected the plants and reported that they appeared healthy and were alive. A shipment from India of 3000 cashew seedlings of different varieties, is unusual and unprecedented. A thorough inspection at the point of entry for possible insects and pathogens was necessary. This process took many days including a fumigation process with Methyl Bromide was conducted to ensure no insects were admitted into the U.S via this shipment. Additionally, the field trial would require the seedlings to be under a one year quarantine in which the participating farmers would host them, but would not be able to sell, propagate, or move them from their property, unless with the written permission of the HDOA. These are standard procedures for Plant Protection and Quarantine (PPQ) in the US.

The delay in customs that included the customs inspection and fumigation, took several extra days in addition to the long journey and hostile climate the seedlings experienced during the shipping process. By the time the seedlings were cleared to continue transport to Hawaii, the seedlings were stressed and showed signs of leaf loss and wilting, however, despite their condition, the seedlings needed to be further handled to move to Hawaii. AMES staff members assisted PPQ personnel with various tasks during the inspection process to help expedite the release of the shipment. Unfortunately due to the approximate 10 days until release, the seedlings had deteriorated. The fine root systems of the plants, naturally intended for moisture absorption, started decaying due to prolonged exposure to the wet newspaper, which was selected as for good packing material and not suited for longer storage.

The release of the seedlings and shipping to the farmers coincided with Hurricane Iselle and her tracking to make landfall in Hawaii. Hurricane Iselle was causing flight cancellations and weight restrictions for aircraft going to Hawaii and emergency alerts for Hawaii residents to stay off the roads and recommending that everyone stay safe in their homes. Despite numerous cancellations and tentative scheduling, the freight forwarder was able to move the seedlings to the farmers on

Oahu, Maui, Kauai and Hawaii Island, with the shipment to Hawaii Island experiencing further delays due to the forecast that the hurricane's strongest winds would hit that island. All seedlings were eventually picked up by the participating farmers by August 4, 2014, 12 days after leaving the nursery.

PHASE 2:

Monitoring: After the plants arrived at their field trial locations, AMES monitored the seedlings at their respective locations and provided on-farm guidance to the field trial participants. Once the field trial began, the proposal was for the AMES representative to conduct three to six visits during the course of the 18 month field trial. During this time, the representative was to compile notes and media for the documentation and a reference guide intended for future farmers interested in growing cashews as a new crop for Hawaii. The AMES representative, as requested in the proposal guidelines, was to conduct at least one meeting at each field trial location with the HDOA representative and ideally, with the USDA APHIS post entry coordinator. The project was to survey the participating farmers at the end of the field trial for their recommendation and intent to continue with the project should the project continue beyond the field trial phase.

The trees arrived at the field trial sites during the week of August 4th, 2014. The first site visit was made between August 20-27, 2014 during which each farmer was given a temperature and humidity data logger called a "LogTag™" with the intent that staff could make correlations confirming whether cashews could grow on a larger scale basis in Hawaii. Each received seedlings and ID tags were logged and pictures were taken to document the condition of the seedlings. At this time, their condition was poor. Over a period of about a month, the farmers reported on the status of their plants and eventually, reported that none of the seedlings survived. The participating farmers, as part of the field trial agreement, were to contact the HDOA/USDA APHIS for removal and further study. Surprisingly, several months later in December, 2014 the project manager heard from one participant that one or two seedlings actually put leaves out below the grafting point, but were unusable because the portion above the graft had died. Given the nature of the journey the seedlings had taken, this demonstrated how resilient and hardy the trees can be.

Due to the outcome of the seedlings after the initial site visit, the project manager felt additional site visits should be postponed until further notice. AMES and HDOA kept in contact to discuss next steps for the field trial introduction of cashews project. A closing site visit was made from September 21 -25, 2015 to collect closing data on the project and pick up temperature and humidity LogTags™ for review. AMES also informed participants that AMES was still very much committed to this project and its success and that AMES was seeking approval for and planning a second shipment of seedlings with the support of the HDOA.

Second Attempt: Although the first trial conducted was unsuccessful, due to various issues and natural calamities which delayed the delivery of the seedlings to the participants, the parties involved have agreed that a second try is justifiable if the issues related to international transportation and prolonged quarantine procedures can be resolved. There is agreement that the reasons for the field trial to determine whether cashews can be grown in the Hawaiian Islands are still pertinent and justifiable.

AMES is committed to this project and its success, however, was intimately familiar with the challenge of obtaining the permits and approvals for a second shipment. While the project partners agreed to try for a second approval, this effort was delayed until the new government officials elected in the February 2015 General Election were in place. Then, following several months of perseverance by AMES and AMES India -- AMES India received an extension of the approvals to export additional cashew plants!

The HDOA Post entry Liaison to the USDA APHIS and the USDA APHIS Plant Pathologist and Post entry Liaison Officer have both met with AMES and HDOA to review the recommended procedures for a second trial. These Post entry Liaison staff from HDOA and USDA APHIS and have taken a more active role by meeting with interested farmers in early December 2015 and briefing them on the forms they would be required to sign and what the responsibilities of participation would include. This cooperation will contribute to the success of a second trial. The group discussed a revised post quarantine program for the plants after arriving in Hawaii. Project staff believe these precautionary measures taken together with the advice received from many research scientists in India will result in a successful second trial. AMES is committed to making sure that the revised post entry guidelines are followed. Project staff are working closely together with AMES to help ensure this second project will be successful in introducing cashews to Hawaii.

Final Presentation: In lieu of a final presentation, project staff – AMES, HDOA, and Post Entry Liaisons from HDOA and USDA APHIS conducted two joint informational sessions (one in Honolulu and one in Hilo) where the first field trial was reviewed and the rules and regulations involved in participating in the second field trial were explained. AMES then presented information on Cashews, the Field Trail, and their potential in the Hawaiian Islands to interested parties. Conference calls were conducted with the farmers that could not attend either informational sessions. Pending paperwork, our efforts resulted in two potential new participants in the project. Formal permits to bring an additional 2000 seedlings were received on December 16, 2015, and the next shipment is slated to arrive before the end of January 2016.

The presentations and guidelines will be attached to this report and available online.

Goals and Outcomes Achieved

In the proposal for the Cashew Field Trial, AMES projected that if capable participants were utilized during the duration of this project and if properly planned, monitored and executed, there would be the following measurable outcome:

GOAL: To increase the knowledge of the appropriate conditions to grow cashews on Class C and Class D agricultural lands.
PERFORMANCE MEASURE: This will be measured through this distribution of information through the development of print and electronic informational materials.
BENCHMARK: Currently there are not any informational materials concerning cashews grown in Hawaii.
TARGET: It is expected that this information will be disseminated to between 750 and 1,000 interested individuals (producers, value-added manufacturers, and academics).

This outcome was nearly met. Since no seedlings from the first shipment survived, the data that was collected was limited. The temperature, growing conditions and comments collected will be available online and attached to this report. The project was reported in the Pacific Business News March 2013 issue:
http://www.bizjournals.com/pacific/print-edition/2013/03/15/state-explores-cashew-nuts-as.html
The informational workshops were covered by Hawaii News Now and one of the participating farmers on Kauai was interviewed about his cashew production.

Moving forward, Project Staff will include this measurable in the second field trial.

Another outcome to have "at least two members of the HDOA staff will conduct at least 5 site visits to monitor the progress made on the expected outcome of the project and will require at least one progress report and final report from the contractor" was also nearly met. HDOA staff inspected each of the eight farms, located over four islands that participated in the first field trial. Because none of the seedlings survived, only one site visit to monitor the progress of the trial was conducted.

The proposal included the following:
Healthy, viable seedlings: *Completion of preliminary site visit and inspection of plants at their nursery in Anakkayam, Kerala, India will be conducted to ensure that the plants are in good health and can adequately be prepared for transport.*
AMES was successful in identifying a viable nursery with the ideal varieties of seedlings necessary for the field trial. The Kerala Agricultural University is an institution known for its studies of Cashews and has numerous varieties available. An initial site visit was made by AMES to the facility before the decision to move forward and select CRSKAU was made.

Preliminary seedling supplier evaluations: *Discussions, selection, and determination of an ideal vendor to provide the best possible seedlings from their respective nursery.*
AMES was successful in evaluating a supplier. It was imperative to find seedlings of high yielding varieties as seed could not be identified in the same manner. Initial site visits were followed by numerous trips made by AMES and members of the AMES India team to ensure that they were growing the seedlings to specifications. CRSKAU was eager to work with AMES and AMES India and accommodated specific requests where possible.

Procurement of (approximately but no less than) 3,000 Cashew seedlings for the field trial in Hawaii: *Some indication has been given that there is an interest in organically grown seedlings.*
AMES was successful in securing 3,000 seedlings and were able to select and procure the following high yielding varieties suited for varying climates: Madakkthara, Anagha (H-8-1), Akshaya (H-7-6), Dharasree (H-3-17), Dhana (H-1608), Sulabha (K-10-2), Shree, and Anakkayam-1. Each variety selected excels in slightly different Indian microclimates. As a result AMES could then compare and contrast each varietal in terms of its specific Hawaiian site location and variables allowing AMES to hone in on which varieties work best in each Hawaiian locale.

Coordination of paperwork, permitting, supervision of packing, physical transportation from the nursery to the airport, an oversight of seedling transport to the plane: Although slower than anticipated, AMES was successful in securing the necessary export permits and licenses from the

Government of India. During this portion of the project, we ran into numerous setbacks. AMES concluded that a project of this scale was unprecedented in India. Although it took much longer than anticipated, perseverance and understanding enabled AMES and AMES India to obtain the proper export documents.

Air shipment of cashew seedling from Cochin International Airport to Honolulu International Airport: *Once the shipment arrives at Honolulu International Airport, the Hawaii State Department of Agriculture takes custody of the shipment for quarantine purposes and transport of the seedlings to their final locations. All inland costs are the responsibility of HDOA. Temporary nursery staging, inter-island transportation, distribution to the farmers, and damages after landing in Hawaii are also the responsibility of the HDOA.*
The air shipment itself was successfully coordinated between Cochin, Kerala, Dubai U.A.E, Seattle, and the respective Hawaiian Islands. AMES decided due to the delays upon US entry and the impact of Hurricane Iselle, to ship the seedlings directly to their respective islands to allow the participants to pick them up as soon as possible, avoiding the delay that would have been caused by shipping to Honolulu and then shipping interisland. Only the shipment to Hawaii Island was delayed due to the hurricane.

Once the seedlings arrive, AMES will work together with the HDOA to conduct a one day seminar in Honolulu to educate the participants on planting, watering requirements, and care at the time that the plants are ready to deliver: Instead of conducting a one day seminar, AMES and HDOA chose to do an initial site visit at each location before the seedlings arrived to meet with the farmers and hand deliver any beneficial information as well as answer any questions to the best of our ability. USDA APHIS-PPQ and HDOA-PQB were not involved in these meeting but aware of the project and had minimal contact with the farmers during the first shipment of seedlings.
When the decision to import an additional group of seedlings was made, USDA-APHIS-PPQ and HDOA-PQB came forward and have been an integral part and extremely helpful in the preparations of the second shipment of seedlings thus far. We look forward to working closely with them on the continuation of the project and value their information and feedback.

Between three to six visits to the sites to monitor the progress of and to provide guidance over an 18-month period by an appointed representative of AMES International: AMES has made a total of four visits to Hawaii.

1. June 2014 -- Preliminary meeting to help the farmers understand what was needed to be done once the seedling arrives.
2. August 2014 -- A visit to inspect the seedlings, but given their state, additional visits were postponed.
3. September 2015 -- A visit to conduct exit interviews, final site inspections, and close out the project as well as the pickup of the LogTags™.
4. December 2015 -- A visit to educate the farmers on the rules and regulations associated with this project and the post entry quarantine period for the second shipment of seedlings.

Subsequent site visits were suspended upon news that none of the seedlings survived. Discussions began to bring in additional seedlings. Unfortunately the project was not able to import another shipment of seedlings before the end of the grant period. Approvals for a second shipment was

secured prior to the end of the grant period, with permits received in December 2015 showing the second shipment is scheduled to arrive before January 2016.

A final site visit was conducted to close out the project. At this time, four participants chose not to continue for various reasons, but the farmers stated their decision to leave the project was not due to the events that occurred and more due to financial reasons and the revised post entry guidelines.

Data LogTags™ were also picked up and a survey on the project was distributed.
For input from the participants and findings, please refer to the document entitled "Survey Results."
For input and findings from our study of the temperature and humidity readings taken at each of the participating locations, please refer to the individual site reports as well as the document entitled "Temperature and Humidity Findings."

Project staff shifted focus to the second field trial, which while not a part of this project, will have outcomes that were anticipated to be part of this first field trial introduction.

Another visit was made to conduct an informational session for the farmers continuing with the project and for the new participants to educate them about the project and to advise what to expect with the new shipment of seedlings. At this time AMES is working closely with the USDA-APHIS and HDOA Post Entry Liaisons. The new guidelines require the use of a semi-temporary greenhouse setting to hold the seedlings so that they can be carefully monitored over a two-year quarantine period. Both agencies agree that there is a chance for a one-year post entry quarantine period, however, that decision will be based on how the trial is proceeding.

A reference guide at the end of the field trial including information on planting as well as multimedia presentation on the progress of the plants over the entire period of time will be made available to the public. The attached information, "Cashews as a New Crop in Hawaii", is an overview of what cashews are, where they come from, their history, how to effectively cultivate them, current market trends, products, information how this project can benefit Hawaii.

Beneficiaries

The eight farmers that participated in the first trial benefited by the information presented which gave them background information and experience with cashews as a potential new crop for Hawaii. However, considering the outcome of the first shipment of seedlings, the benefit for those involved in the completion of the project is still to be determined.

With the incoming second shipment of seedlings we hope that in approximately 4-5 years the participants of this field trial will directly be able to take advantage of the yields of their trees. Not only will these trees bear fruit, which can be juiced or prepared as jellies, jams, or even alcohol, the nuts are a prized commodity throughout the world and will command a high price due to the niche market Hawaii can potentially create for cashews as they did with Macadamias, Sugar Cane, Coffee, and Pineapple. These non-native species to Hawaii are tightly connected to the persona of the Hawaiian Islands and these Hawaiian Products are prized by the many tourists who visit each year. The vast majority of Americans are very familiar with the consumption of cashew nuts and other cashew products like chocolates and vegan products but are largely unfamiliar with what a cashew looks like in its shell or where it comes from and the number of products that can come from the

Cashew tree. In addition new studies are constantly coming out about the vast potentials for plant derived pharmaceutical based products. Cashews are no exception as there are both pharmaceutical and industrial applications for this plant such as ointments, break liners, and boat paints which are all derived uses of the Cashew Nut Shell Liquid present in the honeycombed structure of the outer shell of the cashew.

It is not expected that Hawaii will be able to compete with India or Vietnam, two of the world's leading producers of cashews, but rather has great potential to create a niche market for high quality and high price, perhaps even organic, cashews in which people would be compelled to purchase due to their local growth and overall rarity in the nut market. In addition to the direct benefit to the participants and in time anyone else who chooses to take on cashes as a new crop, there is also potential to help revitalize Class C and D lands or aid in erosion management as well as create a platform for agro-tourism just as Dole did with pineapple. All of these things are possible with the foundation of this field trial in place.

Lessons Learned

Throughout the course of this project AMES has learned the following and know that these lessons learned will add to the success of a continuation of the project in the second field trial:

Licensing and Import Permit

While AMES is familiar with doing business in India, the delays associated with getting the permits and licenses necessary to import the seedlings in a legal manner proved to be far more challenging than imagined. Project staff could have explored the steps to obtain the necessary permission prior to submitting a proposals, however, this would likely not have reduced the time to receive approval since Cashews was placed on the "restricted" exports list in India, existing concerns from Indian officials that the project would modify and resell the varieties back to Indian farmers, lengthy delays in processing, and an election that resulted in a regime change that led to a major personnel change, could not have been anticipated. The lesson learned is that perseverance and resolve of the Project Managers is key to obtaining licenses and permits. AMES appreciates the generosity and cooperation of the Indian Government in granting permissions for the project.

Sensitive Grafts

When the initial batch of seedlings were growing in the nursery, project staff were advised that the height requirements for seedlings imported into Hawaii must be 18 inches or less from soil level. As a result AMES removed the seedlings for export before allowing them ample time for the grafts to strengthen. Since the first shipment, the HDOA and USDA APHIS Post Entry Liaisons have advised AMES that there is no height limit for the seedlings to be imported into Hawaii.
Grafted Cashew seedlings have not been exported and so not subjected to rigorous international travel and long holding periods. As a result, the little time given for the grafts to strengthen may have left the seedlings more sensitive to travel and fumigation. Learning from the first attempt we intend to let the plants grow out for an additional period of time in the nursery in Anakkayam so that they will be as strong as possible for the long journey ahead.

Packing Seedlings

After AMES received the seedlings from the Kerala Agricultural University's nursery, the seedlings were processed and packed at the AMES India facility. Based on research done by AMES India, it was established that a week would be a reasonable worst case scenario for the seedlings to travel from India to Hawaii. The seedlings were packed to have sufficient water for a week in transit. As each of the seedlings was washed, potting media was removed, and treated in chlorinated water to disinfect, they were also wrapped in a very wet newspaper. While this would have been acceptable for a short duration, it was not intended for a 12-day transit, and contributed to the rot and mold that was found. While it is difficult to establish the fine line between over and under-watering, these trees do well and prefer soil with good drainage and the project should have considered this and packed with less water in the newspaper. For the second shipment, AMES is considering options whether to use wet newspaper or use a different sterile media.

APHIS/HDOA PQ Inspection and Steps to Ensure Smooth Transfer

Arrival in Seattle occurred over a weekend and did not move to customs until Monday. There was a wait of a few days before AMES was advised that the shipment was being inspected. The inspection resulted in several actionable findings which led to the decision to fumigate the plants. During this process, Seattle, WA APHIS staff performed professionally and were pleasant to work with. They did their best to try and get through our shipment as soon as possible and AMES appreciates the process to prevent unwanted pests and fungi that might have unknowingly come in with the shipment. As a result of this information, AMES realized that while initial steps taken were thorough, there is a need to implement even more strict measures to ensure that no unwanted pests enter with the new shipment of cashew seedlings. AMES is implementing additional stringent measures at the nursery as well as in the AMES India facility and will fumigate the shipment in India as an added precaution. AMES is committed to the success of this project and following procedures to protect the biodiversity of the Hawaiian Islands.

Data Collection

By the time the seedlings arrived in Hawaii, they were in poor condition. During the packing process AMES had numbered each seedling with a unique serial number to identify each tree. While this was an effective way to monitor the seedlings and the tags seemed secure, by the time they were inspected in Seattle, many fell off during the inspection process. Plant Quarantine in Seattle was asked to keep any tags found, however, from the number of tags recovered, AMES is convinced that some tags were inadvertently discarded, while others likely fell off the seedling. In the future AMES will use a tag affixed more securely.

It was through trial and error that AMES determined the importance of a reliable and durable tag marking system. During the first field trial, the AMES Project Manager observed that some of the serial numbers were significantly faded by just the first site visit several weeks later. In the future AMES will use a preprinted system or a pen that allows for various weather and longer periods of exposure.

With regard to the physical collection of data, there were a few things that hampered data collection. Wear and tear, water, and the condition of the seedlings proved to be a challenge. Given the events that occurred and the condition of the trees by the first site visit, subsequent field

visits to collect data were indefinitely postponed. AMES was able to collect temperature and humidity readings at each location which will be helpful in determining where ideal growing locations might be as well as where the temperature and humidity tolerances of the seedlings might be at their most extreme. During the initial field visit, each participant was given a data LogTag™ which would collect temperature and humidity readings four times a day for approximately one year. We were able to record general daytime and night time temperatures and humidity at each specific site. Given the number of microclimates found in Hawaii, this is extremely useful data in the determination of whether a location may or may not be feasible for the growth of cashews in the future. While incredibly cost effective, there are limitations to the LogTag™ in regards to water. Since there was concern about damage to the data tag, each participant was asked to keep it in a dry place which may have affected the readings. The project now has a baseline for humidity over the past year and moving forward, can mitigate damage to the tag by using a waterproof enclosure for the tag to collect more accurate temperature data. From the research, it seems that the temperature will be the more important of the two readings for water and temperature.

APHIS/HDOA Going Forward

Since the project began, AMES has followed the rules set forth by the USDA APHIS and HDOA Post Entry Liaisons. Due to staffing changes, both agencies were not available to participate in the project on a regular basis. In the last months, there has been a shift in personnel handling projects in the HDOA as well as USDA APHIS groups and both agencies have dedicated staff assigned to the project. Moving forward, the personnel in these groups have chosen to take an active role in partnering with AMES to ensure safeguards are in place and that the participants are educated about what needs to be done in the event that they notice something out of the ordinary or a tree in distress. AMES is committed to the success of this project as well as to protecting Hawaii and look forward to working closely with the HDOA and USDA and knows that as it is only through such partnerships that projects can be successful.

Conclusion

AMES and AMES India, the HDOA, and the participants have agreed to a second field trial in Hawaii, correcting the lessons learned from the first failure. The field trial introduction to determine whether cashews can be grown in the Hawaiian Islands remains a project with great potential to add a revenue benefit to the farmers. Although the primary trial was not a success due to various issues and natural calamities which delayed the actual transportation to the farmers, all involved agree that a second try is justifiable if the issues related to international transportation and prolonged quarantine procedures can be resolved and the outcomes from the this first project can be realized with the second field trial project.

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Additional Information

Cashew Presentation: "Cashews as a New Crop for Hawaii"
https://amesinternational-my.sharepoint.com/personal/epaulose_amesinternational_com/_layouts/15/guestaccess.aspx?guestaccesstoken=9RsO2yJhCfRWDusfejjAa9jYuVqQlWC2riymz3Q7UOI%3d&docid=05f4a78d908024255bee8f01ca71238a6

Initial Care & Information (attached)

Data LogTags™: "Temperature and Humidity Findings" (attached)

Cashew Field Trial: Initial Care & Info

The Cashew seedlings for the Cashew Field Trial in Hawaii will be arriving shortly. They were grown at a nursery in the northern part of Kerala, India and were created from specially selected plant stocks. Once the seedlings were mature enough for transfer, they were trucked to AMES International's India facility, also located in Kerala, India where the potting media was removed and the roots were rinsed three times. The trees each underwent multiple visual inspection and were rinsed once more in slightly Chlorinated water as an additional precaution. Once rinsed and ready to pack, they were bundled in groups of 5 or less, wrapped in wet newspaper, bagged, and packed in boxes. The seedlings were then shipped from Cochin, Kerala, India to Dubai, then from Dubai to Seattle, from Seattle they will soon head to their respective islands where they are to be received. While in Seattle, they will be inspected by Plant Quarantine and cleared through customs.

The seedlings will arrive shortly and need some very urgent upfront care. Here are a few things to consider during the first couple months:

- The seedlings will be in shock since they were not dormant when uprooted from their pots. Since they are bare rooted and wrapped in damp newspaper they will be extremely fragile upon arrival and some may not survive. When shipped most of the plants fit in a 20in long box.
- Because of the length of their journey, they need to be tended to immediately. Check to see if the plants have enough water then move to a temporary pot/grow bag as soon as possible suggested within 0-24 hours of receiving.
- When you receive the trees they will be tagged with a serial number which describes which island they were delivered to, the variety, the owner, and an individual number for identification.
- See example:

Island	Plant Variety	Participant ID	Indv. Plant No.	Combined Code
OA	01	KA	111	OA01KA111

- In a few days you will be given a detailed list of the varieties and quantity of each for the amount of plants requested. When you plant your trees permanently you may want to pay attention to the Plant Variety part of the number, if you want to plant them in groups.
- Please try to keep the tag on the tree for the duration of the field trial. Information will be collected and recorded for each tree over the course of the one year (or more if desired).

Temperature (F*) & Relative Humidity Data (RH%)

Cashews as a New Crop in Hawaii

The information compiled in this document includes on site observations about the area as well as general strategies for overseeing the cashews over time. The information gathered from the temperature and relative humidity recording LogTag™ is also compiled for reference.

When considering the recorded temperature and relative humidity (RH) data, it is important to considering the following information. Names and addresses have been omitted in order to maintain the privacy of all participants.

Notes about the Collected Data Points and Site Observations (08.28.14 – 09.20.15)

- Data points for both Percentage of Relative Humidity and Temperature in Fahrenheit were collected every 2 hours starting at 12:00 AM
- The information found in this report is based off of the 6AM and 4PM data samples, as these samples occur during the hottest and coldest times of the day and will determine the daily temperature fluxuations necessary to determine if cashews could be a viable crop in Hawaii.
- For consistency data collected before 08.28.2014, the date of activation of the last Log Tag, has been discarded.
- For consistency data collected after 09.20.2015, the last date of Log Tag pickup, has been discarded.
- Data will not be at its most accurate due to the fact that the Log Tag could not be placed directly in the elements due the possibility for electrical failure. Data is intended to give a basic idea of the daily conditions experienced at each participating site location.
- Participant Site Descriptions are a Generalization of their Locations.
- Cashew seedlings thrive in sandy loam, laterite, and soils with good drainage.

Ideal Conditions for Cashews:

Ideal Temperature (*F)*:	60*F – 95*F
Ideal Sustained Avg. RH%*:	83%

* Ideal Temperature Range established from best practices in Kerala India.
*Relative Humidity Average is described as a temporary comparison between the RH% recorded and the average RH% seen in Kollam, Kerala, an area well established in growing for cashews in Kerala, India.