Department of Agriculture
State of Hawaii

SPECIALTY CROP BLOCK GRANT PROGRAM – FARM BILL FY 2015

CFDA: 10.170

FY 2015 HAWAII STATE PLAN

Final Report

Project Coordinator

Sharon Hurd, Economic Development Specialist, Market Development Branch
Agricultural Development Division
Phone (808) 973-9465 / Email: sharon.k.hurd@hawaii.gov

Submitted: December 18, 2018

TABLE OF CONTENTS

Develop Organic Pulse (dry bean) Recommendations to Increase Local Production	2
Developing a Novel Unique Variety of "Royal Kunia" Papaya with High Yield, Superior Taste and Long Peduncle	12
Propagation of Select Hawaii 'Awa Cultivars to Support the Specialty 'Awa Industry	16
Second Field Trial Introduction of Cashews as a New Crop for Hawaii	25
Statewide Hawaii-Grown Cacao Month Initiative to Provide Outreach, Public Awareness and Education Resources	33
Propagation and Distribution of Superior Papaya "Rainbow" Seedlings Using Tissue Culture Propagation Method	38
Jump Starting Hawaii's Fruit Production Industry	41
Hawaii-Grown Specialty Crops Marketing Campaign	48
Hawaii Specialty Farmer Business Training and Promotion	50
Hawaii-Grown Seed: Grower Network and Industry Development through Farm-to-Farm Trials and Electronic Seed Sales & Exchange	54
Further Development and Commercialization of Single Pod Cacao Micro-Fermentation Methods and Small Batch Quality Assessment for Hawaii's Specialty Crop Cacao	65
The Moringa Crop Natural Farming Project	82

Develop Organic Pulse (dry bean) Recommendations to Increase Local Production

Final Report

Counter Culture LLC
http://www.counterculturehawaii.com/

Project Summary

Counter Culture LLC, in partnership with UH Leeward Community College and GoFarm Hawaii, improved variety recommendations and post-harvest procedures for pulse (dry bean) production in organic farming systems in Hawaii. Project collaborators conducted two variety trials on across five sites evaluating 33 promising pulse varieties for organic agriculture in Hawaii's subtropical conditions. Variety trial sites include GoFarm Hawaii, UH Leeward CC and Maui College, Kawailoa Farm, and Counter Culture Farm. As a result of an observational trial of 33 varieties, and a subsequent randomized replicated trial of 10 top performers, five varieties were selected for a final recommended to Hawaii growers: Beniquez, Grey Speckled Palapye Cowpea, Six Nations, SBDT-1, and Mayo Coba. Pulse varieties were evaluated on yield, flavor, growth habit, weed suppression, disease and pest resistance, even maturation, suitability to mechanic threshing, and marketability. A mechanical thresher was designed and fabricated and is now available for use by farmers on Oahu.
Throughout the project period, three separate outreach events were held, including a bean tasting and trial workshop, a field day and bean potluck at the GoFarm Hawaii Waimanalo Campus trial site, and a threshing demonstration and post-harvest workshop at Counter Culture Farm in Waialua. Approximately 120 stakeholders attended these events and were presented with information about growing, trialing, harvesting, threshing, evaluating, and enjoying beans! Additionally, findings were posted on the Counter Culture website and compiled into a PDF that was shared to four networks.
http://www.counterculturehawaii.com/2016/09/01/bean-fest-1/
http://www.counterculturehawaii.com/2016/10/31/bean-fest-2/
http://www.counterculturehawaii.com/2017/05/29/bean-fest-3/

To acquire a starter pack of these non-commercially available pulse varieties or to learn more about use of the mechanical thresher contact Counter Culture through their website (www.counterculturehawaii.com) or call Rob Barreca at (808) 224-1905.

Project Approach

Accomplishment/Impact	Relevance to Objective, Outcome, and/or Indicator
Attended Organic Seed Alliance Organic Seed Growers Conference in Oregon: Project Manager, Rob Barreca along with Trial Designers Jay Bost and Dr. Elliott attended the OSA's conference in Corvallis, Oregon. Although titled "Organic Seed Growers Conference" the conference had a wide range of excellent workshops and information that pertained to pulse production and harvesting, including on-farm trial/selections, small- to medium-scale seed cleaning equipment. The	Accomplishment helped project team evaluate selection, production, and post-harvest techniques to execute variety trial (objective 2), develop thresher (objective 2), and view examples of outreach publications from OSU variety trials (objective 3).

conference also gave us an opportunity to meet with a strong Hawaii agricultural/seed contingent, including Dr. Teves of CTAHR and Lyn Howe, Director of Hawaii Public Seed Initiative.	
Identified and acquired 33 pulse cultivars to plant for first observational trial: Jay Bost, Dr. Elliott, and Rob Barreca acquired a wide range of beans to evaluate for Hawaii's tropical growing environment. Jay and Dr. Elliott used their university connections to acquire promising varieties from Dr. Jim Myers of Oregon State University and John Hart of the USDA's Tropical Agriculture Research Station in Puerto Rico. Additionally, the project included seed from Southern Exposure Seed Exchange, Adaptive Seed, and some local farmer saved varieties.	Related to objective 1.
Planned observation trial, coordinated and distributed seeds and supplies: Met with field trial participants Jay Bost, Dr. Daniela Elliott, Rob Barreca, and Thanh Bidwell to go over trial procedures and distribute seeds and planting supplies.	Related to objective 2.
Planting of first observational trial: Planted 33 pulse cultivars across four Oahu farms: Kawailoa Farm (Punaluu), GoFarm Hawaii (Waimanalo), Leeward Community College (Pearl City), Counter Culture (Waialua).	Related to objective 2.
Harvest of first observational trials: Harvest events held with students at Leeward Community College and with GoFarm students in Waimanalo during which they helped with harvest and learned about the project.	Related to objective 2.
Threshing and winnowing using low-input, low-resource techniques: Project staff verified that tarp threshing and fan winnowing are not ideal for commercial scale-up of pulse production. Especially in more humid/wet regions, such as Waimanalo and Punaluu where plant residue and bean pods can stay wet and result in rotting or germination of dry beans.	Related to objective 2.
Cleaning, sorting, and weighing of dry pulses: Using box fans for winnowing and screens for cleaning, trial participants cleaned, sorted and weighed results from the first planting.	Related to objective 2.
Develop Thresher 1.0: Project staff contracted a local fabricator, Agrefab LLC, to convert a donated wood chipper-shredder into a thresher. Project staff took some leftover, dried bean material down to the Agrefab shop and it was a promising test run. The initial design of the thresher (Thresher 1.0) sped up the shelling job immensely. Project staff provided Agrefab, some design feedback and requested that the thresher be installed on a trailer so it would be mobile/sharable and to install a blower so it can automatically	Related to objective 2.

winnow the plant chaff off. The thresher was/is integral to making harvesting/processing pulses economically viable for local farmers.	
Organize and execute Bean Fest #1 — The More You Eat...: Project staff hosted the first workshop/bean tasting in the Oahu Fresh food hub. The goal for this first event was to have diners taste all 33 bean varieties from observational trial and see if there were any clear winners and losers in regard to taste. There was a really large turnout (approx. 50-75 people) and most everyone was really interested and excited about the bean tasting. Project staff collected data and it helped the staff decide on the 10 varieties to select for the replicated variety trial later in the year based on taste and texture.	Related to objective 3.
Disseminate initial findings: Posted on the Counter Culture website where stakeholders can read more and see additional photos: http://www.counterculturehawaii.com/2016/09/01/bean-fest-1/	Related to objective 3.
Identify 10 varieties and execute randomized replicated trial: From Bean Fest #1 data and the agronomic data from the four observation trial results, project staff selected 10 varieties as the most promising local varieties to plant in the replicated trial: Beniquez, Grey Speckled Palapye Cowpea, Kebarika, Mayo Coba, Red Speckled, SB DT1, Six Nations, Sulphur, TARS-MST1, and Tiger Eye. Project staff planted these varieties in all four trial sites in early September 2016.	Related to objectives 1 and 2.
Organize and execute Bean Fest 2 — Open Season: For the second workshop, project staff demonstrated the in-progress replicated trial at the GoFarm Waimanalo site. There were about 15-20 attendees who joined the workshop. Project staff showed participants what a planted replicated trial looked like and how to analyze any pertinent data while scouting the field. Project staff also had a potluck and cooked three dishes with some of the 10 bean varieties. Project leader made a Sweet n' Tangy Baked Beans with the Grey Speckled Palapye Cowpea and it was a clear favorite! Read more on the Counter Culture website: http://www.counterculturehawaii.com/2016/10/31/bean-fest-2/	Related to objective 3.
Harvest and dry beans from replicated trials: In December 2016 project staff hand-harvested three replications of 10 varieties from the four trial sites. Project staff unfortunately had a heavy amount of rain almost every	Related to objective 2.

day for six weeks around the harvest window resulting in a lot of pods rotting/shattering and some germination in pod for all varieties except the cowpea. Punaluu and LCC both hand-shelled their harvests again while GoFarm Waimanalo and Counter Culture left those harvests to tarp dry and planned on threshing them with Thresher 1.1 in early January 2017.	
Thresher 1.1 — The Next Generation: Agrefab made another set of improvements to the thresher, including installing it on a trailer so local farmers could transport it and added a blower to do some initial winnowing.	Related to objective 2.
Thresh, clean, and weigh harvest results of replicated trial to determine recommendations for local farmers. Tested the Thresher 1.1 and determined what modifications or additions were needed to increase the economic viability of post-harvest. Developed Thresher 1.2 and investigated more small-scale combine implement or seed cleaner.	Related to objective 2.
Organize and execute Bean Fest 3 — The Threshening: On February 19, 2017, project staff hosted 15 participants at Counter Culture Farm for the third workshop. The focus of this event was to demonstrate the mechanical thresher in operation; to educate attendees on post-harvest issues and concerns regarding threshing; to demonstrate hand methods for final winnowing and sifting; and, to have a bean potluck.	Related to objective 3.
Compose results and recommendations document on final project recommendations: The final five recommended pulse varieties are Beniquez, Grey Speckled Palapye Cowpea, Six Nations, SBDT-1, and Mayo Coba, based on yield and other data. Along with these variety selections, project staff composed the final recommendations and information to continue disseminating further through networks via the Leeward CC, GoFarm, and Counter Culture, Hānaiʻ Ai (CTAHR sustainable ag newsletter) websites and email lists.	Related to objective 3.
Each item in the Scope of Service	**Met, nearly met or not met**
Identify and select 10 promising pulse cultivars that would most likely excel in Hawaii organic cropping systems.	Met
Identify key recommendations on well-adapted pulse varieties and processing techniques to achieve pulse performance, yield data, and case studies for cultivars of the 10 pulse types.	Met
Disseminate results of the project, highlighting growing, harvesting, and processing of pulse crops, to farmers statewide through four workshops to be held in Hawaii, Oahu, Maui and Kauai Counties.	Nearly met: due to weather-related delays in field planting for observational trial, project staff were only able to complete three of the four planned events/workshops.

	However, for the first event, Bean Fest #1, project staff combined two workshop activities into the one event (crowdsourced variety evaluation and tasting to inspire bean love) and had a very large attendance (approximately 75 people), so project staff felt that the impact and community engagement was even greater than proposed.

Goals and Outcomes Achieved

#	Objective	Completed?	
		Yes	No*
1	Identify specific cultivars of pulse crops to incorporate in trial (through consultation with relevant pulse researchers and sub-tropical/tropically oriented bean research programs nationally and internationally	X	
2	Trial and document well-adapted pulse varieties, management issues, threshing construction and operation, and yield data in different organic cropping systems across the state of Hawaii	X	
3	Disseminate recommendations designed to increase the production of Hawaii-grown pulse to farmers statewide through an industry publication and workshops conducted by Leeward CC staff at Extension Offices and GoFarm new farmer training sites	X	

Pulses can be seeded and grown relatively efficiently by small organic farmers in Hawaii. While the bean fly and bean borer are two pests of concern, they seem manageable in organic production. The inefficiency and economic blocker is the lack of suitable post-harvest equipment to efficiently harvest, dry (if needed), thresh, freeze (if needed to eliminate bean borer larva), winnow, and clean the dried seed. The project allowed for development of a rudimentary mechanical thresher, which the project staff was able to quantify improved threshing time by 500% (our hand threshing took approximately 20 labor hours while mechanical threshing took 4 labor hours). While moving to mechanical stationary thresher was a great time savings, the staff will continue to look to acquiring equipment that small farmers could share to improve efficiency for harvesting, drying, and cleaning seed to improve economic viability of growing pulses for the local market.

Data Collection was done by logging labor hours for hand threshing versus mechanical threshing for the replicated trial results.

Beneficiaries

Number of project beneficiaries: Approximately 400 beneficiaries

Beneficiaries include approximately 20 Hawaii farmers that attended events or communicated interest directly regarding producing pulse crops, with indirect economic benefit to their families and communities. Leeward Community College, Maui College and GoFarm Hawaii benefited from the proposed project by being able to better serve their 300 students annually in the viability of growing pulses as part of diversified vegetable production regimes. It is anticipated that pulse education will result in increased pulse production and thereby improve the economic success of those producers. With an "increasing popularity for ethnic foods" (USDA ARS), chefs, diners, and shoppers will benefit from increased access to more locally-produced items, specifically a locally produced staple, which in contrast to locally produced vegetables are not widely available currently. Some premier local chefs (including Ed Kenney of Town Restaurant, Alex Le of Pig & The Lady, and Mark Noguchi of Pili Group) expressed interest in trialing local beans in their recipes. An estimated 20 value-added producers who want to use local ingredients will be able to source dry beans for gluten-free flours, bean pastes, tempehs, baked goods, tortillas, and other value-added products.

Lessons Learned

Provide recommendations or advice that others may use to improve their performance in implementing similar projects:

- Would have more regular face-to-face or on farm meetings to observe additional plant traits that would be of interest to document anecdotally for future project consideration.
- Would recommend using Agribon along with neem oil pre-germination to prevent early bird strikes or bean fly damage in order to get a more accurate yield result for best case growing conditions. There was some bean fly damage where plants survived and yielded but project staff were unable to isolate the impact of pest damage compared to environmental suitability of the variety.

Describe your plans for continuing the project (sustainability; capacity building) and/or disseminating the project results.

Project staff plan to conduct another round of observational trials to evaluate more varieties, work on testing market demand for retail and wholesale, further develop retail packaging, and continue to disseminate the project findings in subsequent observational trials. Staff will encourage more farms to grow out these promising varieties and assist in planning, production, post-harvest (i.e. drying), threshing, and marketing through other projects, Farm Link Hawaii, and direct sales.

Challenge	Corrective Actions
June 30, 2016: Project staff intended to execute all four observational plantings on the same date to control for weather, but were slightly out of sync due to busy schedules, infrastructure problems, and staggered purchasing of amendments.	Rushed to plant as quickly as possible so all four farms still managed to plant within 3-4 weeks of each other.

June 30, 2016: Bean fly (*Ophiomyia phaseoli*) caused damage to plants. Neem found to be effective in prevention and treatment.	Implemented neem (OMRI-approved) as a preventative measure for replicated trial (DeBug Turbo neem weekly at 1 ounce to 4 gallons of water starting pre germination).
June 30, 2016: Some beans (notably the bush lima types) maintained greener stalks and leaves so were more difficult to dry out and tarp thresh. They were also ready to harvest at asynchronously. Staff left the harvested beans in sand/onion harvest bags for longer than they should have and it likely resulted in more molding on the beans. When staff noticed this, the beans were removed from bags and laid on tarps to air dry, rotating the piles daily until all beans were threshed.	Removed uneven maturity beans from replicated trial as they were too problematic to harvest for a small organic farmer.
June 30, 2016: The thresher was not yet available at harvesting time. Winnowing by hand was time consuming. Good equipment was integral to ensuring local pulse production and is economically feasible for small producers. Project staff are finalizing requirements for threshing/cleaning and plan to soon acquire a thresher that can be shared by Oahu producers.	Defined thresher requirements to ensure it was ready for replicated trial harvest.
December 23, 2016: The harvest during a rainy winter led to a considerable amount of shattering and lost beans. Data will be somewhat inaccurate, but staff will include recommendations of a winter/spring planting for best chance of a dry harvest. To tarp or table dry a bean harvest one needs a considerable amount of time and space. Success of drying in high humidity conditions would be increased with large wire tables and fans.	Include in recommendations to not plant during spring/winter to avoid a heavy rain period during harvest window.

Contact Information

Contact Person for the Project_____Robert Barreca
Telephone Number_____(808) 224-1905
Email Address_____rob@counterculturehawaii.com

Additional Information

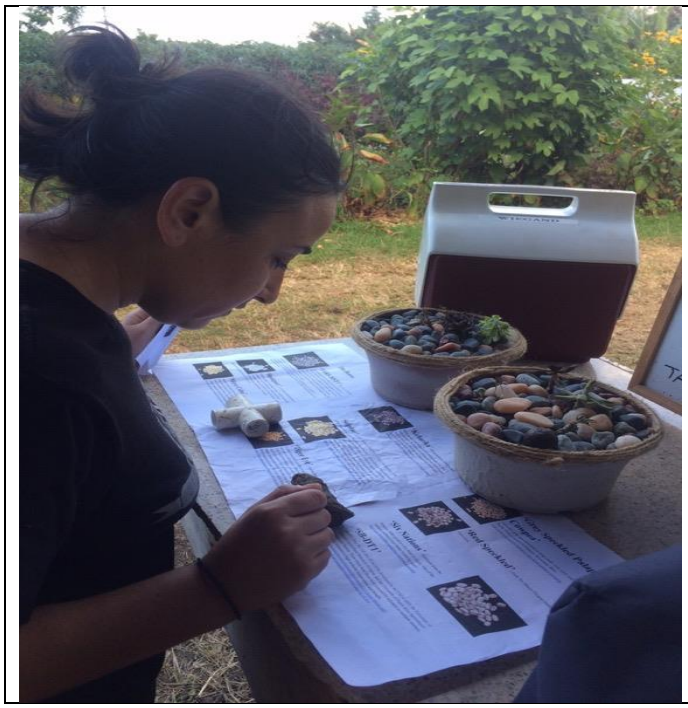
GoFarm Hawaii students helping with pulse harvest Waimanalo (Left)

Air drying harvests that had higher green matter content (Right)

Bean display at Bean Fest #1

Bean Fest #2, showcasing replicated planting

Bean fly larvae and damage



Cultivars planted in observational trial

Project staff planted the following varieties in the observational trial: TARS-HT1, TARS-MST1, Morales, Verano, TARS-Tep 32, Beniquez, SB DT1, Badillo, TARS-LFR1, TARS-Tep 22, Mayo Coba, Beka Brown, Six Nations, Nora Baudette, Jackson Wonder Lima, Sulphur, Kebarika, Tiger Eye Bush Dry Bean, Thorogreen Bush Lima, Henderson Bush Lima, Fordhook Bush Lima, Mshindi, Zawadi, Pesa, Riverside Sugar, White Sugar, Sweet Bean, Red Speckled, PI406164, Round Speckled, Sugar Bean, Borlotti Kenya, Grey Speckled Palapye Cowpea.

An O‘ahu farmer checking out the variety sheet

Developing a Novel, Unique Variety of "Royal Kunia" Papaya with High Yield, Superior Taste and Long Peduncle

Final Report

Hawaii Agriculture Research Center (HARC)
http://www.harc-hspa.com/

Project Summary

In previous breeding programs to improve Hawaii papayas' disease resistance to *Phytophthora palmivora*, HARC and the Project Manager discovered a novel papaya tree from the field of F2 progenies derived from the crosses of 'Kamiya' and 'SunUp'. The plant had unique characteristics of long inflorescence axes and long branched peduncles. Each long inflorescence axes composed of multiple flower clusters, was a hermaphrodite tree and had yellow flesh. The project staff proposed to breed a new papaya variety with long peduncles for high yield and superior taste; and cross the long peduncle papaya with 'Laie Gold' or 'SunUp' to breed for the Papaya Ringspot Virus (PRSV) resistance. Crosses between the best selected 'Royal Kunia' and 'Laie Gold' or 'SunUp' with PRSV transgene were made and progeny were evaluated in field trials to determine their yield and quality. Finally, micro propagation the selected hybrids were initiated for the distribution to papaya growers.

Project Approach

The project staff decided to replicate the unique characteristics of long inflorescence axes with each composed of multiple flower clusters and long branched peduncles along with the tree being a hermaphrodite with yellow flesh. The hermaphrodite flowers were bagged and seeds were collected and germinated for field tests. The first-generation plants had high yields with each tree able to produce more fruits because of their long inflorescence axes to allow more space for fruit to grow. The taste of the fruits was deemed to be excellent. The exact source of the original plant was unknown, which could be due to the natural mutation that occurred within the F2 population, or due to the outcrossing with other varieties growing in Kunia fields at the time. The project was to breed a new papaya variety with long peduncles for high yield and superior taste; and cross the long peduncle papaya with 'Laie Gold' or 'SunUp' to breed for the PRSV resistance. Crosses between the best selected 'Royal Kunia' and 'Laie Gold' and 'SunUp' with PRSV transgene were made and progeny was evaluated in field trials to determine their yield and quality. Finally, micro propagation of the selected hybrids was initiated for the distribution to papaya growers.

Activities Performed:
1) Evaluated the new long-peduncle 'Royal Kunia' cultivar in two locations, HARC Lower Kunia and Upper Kunia sites. The growth, yield and quality of the fruits were evaluated. The new cultivar is a non-GMO version of "Royal Kunia" which can be used for the non-GMO market.

The best trees from the two Kunia fields were selected, based on visual inspection. Project staff selected the best six trees from each field. The fresh weight of the twelve fruits from each tree was taken and the Brix of the fruits was also determined at Kunia laboratory. The 'SunUp' cultivar was used as a control for comparison.

Sampling method: The fruits were harvested from the Kunia fields. For each tree, a total of 12 papaya fruits at different stages of maturity, were used. Fruits were harvested according to a homogeneous group with the same stage of maturity. Four stages of fruit maturity were determined, labeled Stages I, II, III and IV.

Stage I -- The skin color of fruit was yellow covering less than 15% of the surface of the skin with the rest showing green and the seeds were mostly mature black.
Stages II, III and IV were determined when 25%, 50% and 100% of the surface of the skin was covered yellow.

Each sample was divided into four groups of three fruits each. Each group was analyzed and identified as Stage I, II, III or IV, respectively. The weight and Brix of each fruit was determined in the Kunia Laboratory.

For Brix or Soluble Solids (SS), an average value of 10.02 Brix was found for the fruit in Stage I for the 'SunUp' cultivar, which agrees with values described for Solo cultivars. The Brix value went up according to the maturity of the fruit, with the highest Brix value of 12.02 in 'SunUp'. For 'Royal Kunia' lines, the average value of Brix 11.50 was found in Stage I and 14.62 in 'Royal Kunia lines found in Stage IV. The results in Table 1 show a linear increase ($p<0.05$) of SS contents during ripening process, therefore indicating higher sugar concentrations in the most matured fruits. In addition, the Brix in 'Royal Kunia' lines are significantly higher than 'SunUp' culture ($p<0.05$) indicating the 'Royal Kunia' line has sweeter or higher quality fruits.

Table 1 Quality Parameters (Brix or SS) of Papaya fruit for different maturity stages

* Data are Mean of three replicates (+/- SD) with Student T Multiple range test, $p<0.05$, n=3)
** SS – Soluble solids (SS) or Brix
*** RK- Royal Kunia line, SU- SunUp cultivar

Stage of Maturity	RK SS (Brix^0)	SU SS (Brix^0)
I	11.50+/-0.13 D	10.02+/-0.03 EF
II	12.24+/-0.17 C	10.54+/-0.09 E
III	13.01+/-0.39 B	11.35+/-0.15 D
IV	14.62+/-0.21 A	12.02+/-0.21 C

For fresh weight of papaya fruits, in **Table 2**, an average value of fruits with all stages combined (there is no significant difference in the fresh weight from different stages), 710+/-68 grams, was found in 'SunUp' cultivars, meanwhile, 889+/- 75 grams, was found in 'Royal Kunia' lines. The results in Table 2 demonstrate that the fresh weight in 'Royal Kunia' showed approximately 25% increase in fruit weight indicating the "Royal Kunia' line produced relatively larger fruits compared to the 'SunUp' cultivar, which translated to a higher yield in the 'Royal Kunia' line.

Table 2 Quality Parameters (Average Fresh Weights) of Papaya fruit at color break (<15% yellow)

* Data are Mean of three replicates (+/- SD) with Student T Multiple range test, $p<0.05$, n=12)
** FW – Fresh Weight of papaya fruits
*** RK- Royal Kunia line, SU- SunUp cultivar

RK Fresh Weight (g)	SU Fresh Weight (g)	% Increase
889+/-75 A	710+/-68 B	25.2%

2) Cross the long-peduncle 'Royal Kunia' cultivar with 'Laie Gold' or 'SunUp' to breed the hybrids for resistance to papaya ringspot virus. The GMO version of the 'Royal Kunia' was planted in a PRSV infected area.

The best trees were selected based on the visual inspection. The flowers from hermaphrodite trees were bagged and mature fruits were collected, dried in the lab and stored in a 4C walk-in cold room for future use. Selected flowers from female trees were pollinated with the hermaphrodite flowers from 'SunUp' trees to breed the PRSV resistance gene into 'Royal Kunia' lines, and pollinated flowers were bagged and fruits were collected and seeds were dried in the lab and stored in 4C walk-in cold room for future use.

The seeds from both selfed and pollinated fruits were checked for the absence or presence of the PRSV transgene using Gus Staining method. As expected, the self 'Royal Kunia' lines had no Gus gene indicating there was no linked PRSV transgene, therefore, these seeds were a non-GMO line of 'Royal Kunia'. In comparison, 100% of the seeds from the fruits pollinated by 'SunUp' flowers had blue staining for GUS gene indicating the presence of PRSV transgene, therefore, these seeds were a GMO version of 'Royal Kunia' line.

3) Select and evaluate superior hybrid cultivars for growth, yield and quality. Field data such as yield, plant height, and trunk diameter, height of the first fruit, fruit size, Brix and other fruit quality were evaluated. The best 5~10 lines were selected and shoots were collected for tissue culture. The selected lines will be selfed as well for future in-bred breeding.

The seeds from selfed and 'SunUp'-pollinated lines were germinated in the greenhouse and transplanted into the Kunia field in the PRSV infected area, along with 'SunUp' as control. A total 400 plants were planted for the evaluation for growth observation, yield and quality including fruit taste and Brix. Project staff are in the process of data collection and analyzing the fresh weight and Brix.

Disease responds to *Phytophtora* root rot were also recorded and early elimination of disease symptoms including wilting, root rot, fruit rot and powdery mildew was considered in the selection process to make sure the project did not select cultivars which were susceptible to other diseases such as *Phytophthora* and powdery mildew even although the resistance to these diseases were not the objective in this project.

Twelve lines with best growth data were selected for developing tissue cultures for propagation and seeds from the six lines were selfed to obtain seeds for further evaluation and selection.

4) Develop a micro propagation method to produce the plants of new hybrids and distribute them to papaya growers. The micro propagation of selected lines was initiated using tissue culture for further evaluation and for distribution to the growers. The limited tissue culture plants are expected to become available at the end of the two-year project. Continuing grant funds will be sought to continue the tissue culture to achieve a viable operation. A total of six 'Royal Kunia' lines have been established in the tissue culture and limited numbers of tissue cultures have been produced. Project staff will try to increase the numbers of plantlets in the tissue culture in the next few months.

Goals and Outcomes Achieved

The expected outcome of this project was met. The results of this project, including new varieties and information related to the varieties have been presented at the Annual Meeting of Hawaii Papaya Industry Association (HPIA) in 2017 and initial planting materials of the six selected Royal Kunia lines were made available to the papaya growers. The final report will be published on the HARC website for public review and information will be available to interested parties who seek to learn more about this project.

Beneficiaries

The 120 members of the Hawaii Papaya Industry Association (http://www.hawaiipapaya.com) are the beneficiaries. This project provided a superior new variety of papaya with high yield and superior taste to compete in the world market. The new variety will be distributed to Hawaii Papaya Growers through micro propagation. The availability of tissue culture derived from the new variety will give Hawaii growers access to early bearing, early harvest, and hermaphrodite sex type selection to avoid the waste from multiple seedings.

Lessons Learned

Because papaya breeding is a time-consuming process, this project benefited from previous breeding activities where the project staff had selfed progenies which was ready for field grow out. The selection had started ahead of the project and data of the yield, plant height, and trunk size and other characteristics were analyzed with no problems and delays occurring.

Contact Information

Yun Judy Zhu, Ph.D.
Hawaii Agriculture Research Center
(808) 621-1266
JZhu@harc-hspa.com

Propagation of Select Hawaii ‘Awa Cultivars to Support the Specialty ‘Awa Industry

Final Report

Hawaii Agriculture Research Center
http://www.harc-hspa.com/

Project Summary

The project goal was to establish an archive of Hawaiian ‘awa cultivars in propagation gardens at Maunawili, Oahu and Hilo, Hawaii. Through these gardens, local farmers would be able to obtain rooted cuttings or nodes of known Hawaiian ‘awa varieties. Currently, much of the ‘awa sold in Hawaii are of unknown or mislabeled ‘awa cultivars from across Polynesia. This is due to a shortage of known selected Hawaiian cultivars creating a bottleneck of available material. Local farmers and Kava enthusiasts expressed interest in establishing propagation gardens of Hawaiian cultivars, but limited availability of known varieties had made this difficult. The local nurseries do not have enough material to supply the growing demand and an alternative source of known cultivars, provided by this project, was beneficial.

Project Approach

Kava (Piper methysticum), commonly known as ‘awa in Hawaii, is a small shrub native to Melanesia and introduced to Hawaii by early Polynesians. Kava roots and stumps were traditionally harvested to produce a ceremonial beverage, and this beverage remains the primary value-added product made from ‘awa. Kava has become prominent in alternative medicine as a sedative, muscle relaxant, sleep aid and has shown the ability to reduce anxiety. Some of these claims have been substantiated by clinical trials. These effects are due to the concentration of phytochemicals (kavalactones) found in the roots and stumps of the plant. Kava grows well in subtropical and tropical climates and thrives as an understory species in agroforestry and landscape settings. Kava grows particularly well at low-elevation, high rainfall sites such as The Hawaii Agriculture Research Center’s (HARC) Maunawili Experiment Station on the Windward side of Oahu. Traditional production utilized the natural shade of over story trees, improving access to moisture yet providing adequate drainage and maintaining low pest populations. Many of these traditional plantings have been over harvested, due to increased demand and lack of management. The cost for dried Hawaiian ‘awa powder can be as high as $52 a pound. A local source of categorized material for distributors would reduce the cost and the need for harvesting from the wild.

This project was initiated to establish an archive of Hawaiian ‘awa cultivars in propagation gardens at Maunawili, Oahu and Hilo, Hawaii. Through these gardens, local farmers and cultural practitioners are now able to obtain rooted cuttings or nodes of known Hawaiian ‘awa varieties for use as stock plants for propagation. This allowed for the distribution of known rooted cuttings to potential ‘awa growers who can now grow their own stock plants for production, sale, or educational/cultural uses. Producing plants of known lineage and description to additional producers allowed others to propagate and sell plants of named varieties.

Select Hawaiian cultivars were verified by ‘awa experts to propagate based on superior quality or commercially desirable cultivars for production in Hawaii.

Each ‘awa variety was described as containing different concentrations of the kavalactones that produce a range of desired effects. Due to chemotypic variation in Hawaii’s diverse kava germplasm, it was important that these plants were sold as known varieties. This project will help sustain the local consumer market for Hawaiian ‘awa through increased supply.

The project started with the contact and cooperation of Edward Johnston, Jerry Konanui, and Jeri Ooka of the Association of Hawaiian ‘Awa. In July 2015, the Project Manager attended a conference on Oahu and met others involved in the ‘awa/kava community. “Kava 2015-International Conference on Kava” was held at Chaminade College. At this conference, the issues were reconciling the understanding of cultural efficacy and toxicity with Western pharmacology and regulatory understandings, understanding the pharmacology and mechanism of action, visioning the agro-economical future of ‘awa, and closing the loop between cultural practice and scientific data. Attendees learned the difference between the non-Hawaiian kava and the “noble” kava, which comprises most of Hawaiian ‘awa.

HARC had previously worked with Ed Johnston on Hawaii Island in the early 1990’s to propagate ‘awa for a company called C. Brewer and continued that relationship to obtain ‘awa nodes to root for this project. With the resurgence of quality ‘awa, there followed a a great demand for Hawaiian ‘awa, as evidenced by inquiries from Belgium, Germany, and other international areas.

On Hawaii Island, project staff harvested ‘awa canes of the 11 targeted cultivars received from Ed Johnston, and obtained rooted mo’i nodes from Neal Campbell in Kohala. Ed Johnston was generous with his time and his ‘awa germplasm. Jerry Konanui was most helpful in coordinating and contacting others interested in ‘awa. Rooted nodes were sent to HARC on Oahu to be grown out at the Maunawili field station. HARC had plants of the Papa‘ele’ele, Hanakapiai, Opihikao and Panaewa SIG that were already growing at Maunawili. Dr. Skip Bittenbender of the University of Hawaii Manoa also contributed plant material to the project.

Mist house areas were set aside and maintained for propagation of the ‘awa nodes. Nursery greenhouse areas were also dedicated to growing the rooted ‘awa cuttings.

The approach of the project staff for the distribution of the ‘awa plants was to first discern growers’ interest in propagating plants, rather than using the distributed plants for processing into dry powder. Recipients were encouraged to use the plants for planting, propagation and perhaps further distribution. Project staff kept three of each cultivar at Maunawili, and three of each at Hilo for the clonal gardens and stock plants. All extra rooted nodes from the five best cultivars were distributed. The varieties distributed were: Nene, Papa'ele'ele, Mahakea, Opihikao, and Papakea. Ed Johnston had harvested a whole Opihikao plant which resulted in the project staff having a large amount of Opihikao stalks and rooted cuttings. This allowed most of the plants distributed to be Opihikao.

Contact was made with Jerry Konanui and Ed Johnston to start a list of interested persons or groups that might want ‘awa plants. The Big Island Association of Nurserymen were also contacted and the HDOA sent an email to the listserv of agriculturalists that might be interested in planting ‘awa. This outreach received many responses of interest from all islands -- Hawaii Island, Kauai, Oahu, Molokai, and Maui. Project staff received approximately 35 requests for ‘awa plants during the first year,

however, when the plants were ready, some growers were no longer interested. This provided for more plants to be sent to those growers that requested larger amounts of plants or requested different varieties of ‘awa. In 2017, the project distributed ‘awa plants from Hilo and Maunawili to 25+ individuals/groups across the State.

A spreadsheet was created to record the dates of requests, island, individual or company name, and recorded the variety and number of plants distributed. The ‘awa plants were distributed at no charge to the growers except for shipping costs, which was paid by the receiving grower. Plants were shipped via FedEx using their service for time-sensitive items to ensure that plants reached the growers in good condition. Two recipient’s plants were hand carried to Kauai. A set of plants were given to the University of Hawaii at Hilo – College of Agriculture, Forestry and Environmental Resource Management, shared with the Hawaii Community College, to be planted at the UH Farm in Panaewa, with an agreement these locations would be cooperators to maintain the ‘awa plants.

Plants were also given to the Edith Kanaka’ole Foundation for its educational program, the Hui Malama Ola Na Oiwi Hawaiian Health - a Hawaiian health, wellness advocacy group, and to a lomilomihalau for their halau garden.

The project has met the goals and timelines proposed by the Project Manager and staff. The project has ended, however, the ‘awa plants will be maintained and available for future projects.

Goals and Outcomes

All Goals and Outcomes Achieved

Goal 1: Capture germplasm of known Hawaiian ‘awa varieties for propagation and distribution
This goal was met and exceeded
Target: Capture 11 Hawaiian ‘awa cultivars.
Proposal time line: January 2016 to December 2017.
The project propagated 12 ‘awa varieties and a long-term goal is to secure another ‘awa variety, Mapulehu. Obtained planting material for the targeted 11 varieties, as well as securing an additional variety, Papa’ele’elepu’upu’u (Alia 7). The ‘awa varieties obtained, propagated and distributed are listed below:

1. Hookaneiki	5. Papakea	9. Hiwa
2. Panaewa SIG	6. Mahakea	10. Nene
3. Opihikao	7. Papa`ele`ele	11. Mo`i
4. Kumukua	8. Hanakapiai	12. Papa’ele’elepu’upu’u (Alia 7)

The goal has been met by capturing the germplasm of 12 Hawaiian ‘awa varieties.

Long-term outcome: The project has provided germplasm to further propagate and identify the 12 varieties of Hawaiian ‘awa. The project has established repositories for archiving these varieties for future use. A map of the outplants is planned for the HARC Maunawili station.

Goal 2: Establish a clonal garden at HARC’s Maunawili and Hilo Experiment Stations.
This goal has been met.

A clonal garden has been established at Maunawili, Oahu, and Hilo, Hawaii. In addition, UH Hilo and Hawaii Community College are establishing a clonal garden from plants that obtained from this project.

Long-term outcome: HARC and other participating locations can propagate and identify the ‘awa varieties and as repositories, and for archiving these varieties for future use. A map of the outplants is planned for the HARC Maunawili station.

Target: Establish 11 Hawaiian ‘awa cultivars with 3 replicates of each at Maunawili and Hilo.
Proposal time line: Sept 2016 – December 2017
Goal 2 has been met for all cultivars, except for Mo’i, of which there are two plants at each site. Mo’i plants will be propagated as the plants get larger, since this variety was obtained as a young, small plant.
The Maunawili plants were outplanted and doing well. The Hilo plants are in large grow bags, growing on weed mat as understory plants and are also doing well. All clonal garden plants in Hilo are being kept in 10 – 20 gallon grow bags or pots. These have been moved out to the open, as understory plants. The plants have been growing vigorously. Cinder was added to keep the plants upright and to add weight to the bags so that they would not tip over. The cinder also helps to keep the weeds down in the bags.

Whitefly and Phoma shot hole pest problems increased with rainy weather and was treated with sulfur and diatomaceous earth.

Project staff have accomplished the goal which was to grow the plants for the clonal garden. At Maunawili, planting into the ground was completed by the end of the December 2016. At Maunawili, clonal garden plants were of varying sizes, so smaller ones were planted out later as they grew large enough.

Goal 3: Propagate and distribute rooted nodes of the five most desirable cultivars to interested growers who do not have access to propagation material.

Performance Measure: The number of individuals or groups that receive rooted cuttings. Plants were given to 25+ individuals or groups.

Target: Distribute five Hawaiian cultivars to future distributors

Proposed date: June 2017 to December 2017.
Extra nodes were planted into 4- and 6-inch pots and rooted cuttings have been distributed to interested individuals/farmers/nurserymen. Other individuals have been contacted who are interested in growing ‘awa, and sharing cultivars. Extra stalks from Ed Johnston’s Opihikao harvest were used to make many rooted cuttings. Maunawili staff has made rooted cuttings from their own stock plants at Maunawili and from Dr. Skip Bittenbender of the University of Hawaii, of Papa’ele’ele, Hanakapiai, Panaewa SIG, and Nene.

Distribution:
Plants were distributed at no charge to at least 25 individuals or groups. All individual recipients were planning to grow the plants out to propagate more plants to be shared with others, or to propagate for

sale. Many of them are members of the Big Island Association of Nurserymen, and plan to propagate and sell plants.

Other recipients such as institutions or organizations were planning to use the ‘awa plants received for cultural and educational purposes, and to share plant material.

Since the project resulted in extra sets of the collection in Hilo, the staff gave one set of each cultivar to the University of Hawaii at Hilo and the Hawaii Community College to be planted at the UH Agriculture Farm. UH/HCC will maintain the ‘awa plants in the medicinal garden area.

One partial set of small plants was also given to the Edith Kanakaole Foundation for educational and cultural purposes.

A total of 77 plants were distributed to 25 different people or organizations:

2	Hookaneiki	2	Papakea	2	Hiwa
4	Panaewa SIG	4	Mahakea	4	Nene
55	Opihikao	1	Papa`ele`ele	0	Mo`i
1	Kumukua	2	Hanakapiai		

Present the significant contributions and role of project partners in the project.
**Contributors include USDA Fish & Wildlife Service for use of Amauulu greenhouse. This nursery area is good in that it is fenced and has security.
**HDOA helped to contact others who are interested in obtaining named varieties.
**Jerry Konanui and Ed Johnston contacted their constituents and shared the contact information for distribution.

Problems and Delays
Heavy rains and high humidity in March 2016, increased the incidence of rot and disease in the Hilo and Maunawili nurseries, as well as to the plants exposed to heavy rains. Intended use of the HARC Amauulu greenhouse was limited due to excessive heat in that greenhouse. Shade cloth was purchased and installed at the Amauulu greenhouse to try to bring temperatures down, but still, it was too hot during the summer and fall.

One of the main problems in propagating ‘awa in the greenhouse is that when it is dry, red spider mites, mealy bugs and whitefly are a major problem. When it is excessively wet and humid, root rot, stem rots, and Phoma, as well as whitefly become problemmatic without frequent and regular spraying. Even when watering conditions are perfect, insects are still a problem. Regular spraying on at least a weekly basis was needed. There were long periods of time that the plants went without spraying, creating outbreaks of whitefly or mites. There are no pesticides cleared for ‘awa except for sulfur. At Maunawili, there was a problem with root rot and mites in the nursery, which required application of Zerotol and insecticides regularly. The Hilo greenhouses also had problems with whitefly, mites, and mealy bugs requiring a regular application of insecticides.

Additional time was needed to keep the greenhouses and nurseries clean, and to monitor for and treat pests and disease. Keeping the plants free from pests and disease was a challenge.

Loss of plants to rot was common when keeping rooted ‘awa nodes in 4-inch pots in the greenhouse for long periods of time. Cutting the irrigation time to accommodate the small plants caused the large plants to dry out.

It was found that Mo’i and Hiwaawa varieties were the more difficult to root and maintain. The awa varieties recommended for disbursement were Opihikao, Nene, Papakea, Papa’ele’ele, and Hookaneiki. The project did not have many extra plants of any except Opihikao, but some of each were distributed and are maintained at the repositories.

Beneficiaries

Number of beneficiaries: 25+growers on Hawaii Island, Oahu, Kauai, Maui and Molokai and four universities, research centers, and non-profits.

The initial beneficiaries of this project were the many small and large-scale farmers in Hawaii who have expressed interest in growing Hawaiian ‘awa cultivars, as well as cultural practitioners or homeowners who would like to purchase and grow ‘awa for personal use. In addition, project staff shared plant material with the University of Hawaii at Hilo, and the Hawaii Community College to be maintained at their Panaewa Farm site in their medicinal garden, and the Edith Kanakaole Foundation for their educational programs, as well as other entities and groups. Plants were also given to a doctoral student working on Kamehameha School lands in Kahaluu’s agricultural field system, recreating a native Hawaiian agricultural field plot. In exposing her interns and volunteers to ‘awa plants and their cultivation, this project could open students’ eyes to the possibility of growing ‘awa as a commercial crop.

This project has provided more named varieties in collections, and the number of beneficiaries will be increasing even after this project has ended.

Lessons Learned

‘Awa is not difficult to propagate, but ease of propagation varies with the variety and health of the plant material.

‘Awa is prone to many diseases and insects in the greenhouse, and less likely to be attacked if grown outside. Still, there are problems with disease and insects if the plants are not monitored regularly, and more phoma occurred under trees when leaves fell onto the ‘awa plant leaves, under wet conditions.

‘Awa likes good drainage and can be prone to many diseases (Hawaiian ‘Awa – Johnston and Rogers).

Contact Information

Aileen Yeh – Horticulturist/Forester, Hawaii Agriculture Research Center
ayeh@hawaii.rr.com (808) 936-2671

Nicklos Dudley – Forester, Hawaii Agriculture Research Center
ndudley@harc-hspa.com (808) 391-5421

David Kula – Comptroller, Hawaii Agriculture Research Center
dkula@harc-hspa.com (808) 621-1351

Cindy Pinick - Executive Secretary, Hawaii Agriculture Research Center
cpinick@harc-hspa.com (808) 621-1350

Additional Information

Photos

Potted nodes in Perlite

Rooting nodes in sphagnum moss under mist

Potted nodes which have rooted

Maunawili, Oahu - ‘Awa plantings in January 2017.

November 2016 in the greenhouse January 2017 November 2017

Hilo, Hawaii Island nursery ‘awa plants

Jerry Konanui

We would like to take this opportunity to recognize the many contributions of Jerry Konanui, who passed away in December 2017. He worked tirelessly in bringing people together with interests in growing taro and 'awa. He will be greatly missed.

Second Field Trial Introduction of Cashews as a New Crop for Hawaii

Final Report

AMES International
http://www.emilyschocolates.com/

Project Summary

Hawaii has had a long and vibrant agricultural history that is linked to the rise and fall of sugar cane and pineapple, crops that are to this day synonymous with the islands. However, with the decline of these agricultural monocrops, a great deal of land has become vacant, fallow, unusable, or has been carved up for real-estate. Consequently, the ecosystem was at risk for dramatic change and the issues such as residential zoning and water use were competing with preserving important agricultural lands. This project was to conduct a field trial introduction of cashews as a new crop for Hawaii because it is known that cashew trees (Anacardium Oxidentale) are extremely resilient and hardy and require less water than other food or tree crops. With the amount of uncultivated Class C and D lands as well as other available vacant agricultural lands, cashews have great potential as a new crop for Hawaii. The decrease in lands dedicated to sugar cane and pineapple and focus on reclaiming land that is not in use for food production to move Hawaii towards food security, this project was well-timed to introduce cashews as a new crop for Hawaii.

The main goal of this field trial was to build off work completed in the SCBGP FY12 field trial project, that ended in 2015, to import cashew seedlings to Hawaii from Kerala, India. For this FY15 project, the goal was to successfully receive approximately 1600 imported seedlings from India to Hawaii, determine whether cashews would grow in Hawaii, and if they could be a viable agricultural crop for the islands. In this field trial, the cultivation of cashew nuts in Hawaii was tested by a volunteer farmer located on the island of Oahu.

Project Approach

AMES International applied the experience and precedence established during the previous field trial to successfully bring and cultivate cashews seedlings for the Second Field Trial Introduction of Cashews as a New Crop for Hawaii. While the project contract was executed in May of 2016, the scope of work required to execute the second field trial began in January 2016 with the preparation of the seedlings that would be imported into Hawaii. The project goal was to increase the knowledge of the appropriate conditions needed to grow cashews on potential Class C and D agricultural lands as well as to bring in a large number of seeds, Indian government permitting. A summary of the work plan and its outcomes:

<u>Phase 1: Importation of Seedlings from India to Hawaii</u>

- Purchase Seeds/Seedlings and prepare for Shipping
  Approximately 1600 seedlings were fumigated with methyl bromide and packed for export. The preparations included visual inspections, disinfection with chlorinated water, and a root dip

in soil replacement media SoilMoist Fines TM to prevent roots from drying out or becoming waterlogged.

- Hawaii Department of Agriculture (HDOA) staff and the Project Manager and staff created a preliminary framework and list of best practices for post entry treatment once the shipment was cleared for entry into Hawaii.
- Obtain USDA import permits for the Hawaii farmers and Appropriate Export Documentation from India.
- With the assistance of HDOA, project staff were able to procure the appropriate import permits and other associated paperwork needed to import the seedlings.
- Conducted a meeting to garner interest from the farmers to participate in the project and where a farmer/farm was selected for the field trial. Project preference was to divide the seedlings upon arrival to be forwarded to several farms/farmers, however, post entry requirements that were not required for the first field trial, resulted in fewer volunteer farmers/farm participants interested in the project. The post entry requirements involved the construction of a greenhouse where the seedlings would be quarantined for up to two years, to protect the introduction of invasive pests. The additional cost for the greenhouse was unexpected and proved to be unrealistic for all but one of the farmers.
- The farmer/farm that participated was able to complete construction of the requested greenhouse and obtain approval from the Post Entry team (USDA-APHIS-PPQ and HDOA Plant Quarantine Branch) for the structure.
- Import permits were issued, despite office closures due to incoming 100-year blizzard. With the import permit, the Project Manager was able to begin packing for transport of the seedlings housed at the Kerala, India facility.
- Obtained the Phytosanitary Certificate required for the shipment of cashew seedlings to Hawaii. Project staff, as a lesson learned from the previous field trial, supervised and ensured that the Phytosanitary Certificate was in hand prior to the packing of the 1600 cashew seedlings according to requirements from USDA APHIS/HDOA PQB.
- Ship seedlings from India to Hawaii and distribute to participating farmer.
  Seedlings arrived at first port of entry, Seattle, Washington and were promptly sent to the state Plant Quarantine (PQ) station for inspection and customs clearance. In addition to notifying PQ of the incoming shipment, project staff incurred overtime hours, staying with the shipment to minimize the time between inspection, release and forwarding of the seedlings to Hawaii. The result was that the shipment was promptly released and forwarded to Hawaii, a lesson learned from the first field trial project.
- Seedlings arrived in Hawaii and a secondary round of inspection was conducted by the USDA APHIS/HDOA PQB. Some seedlings showed signs of dead scales and fungus, however these observations did not require additional action and the seedlings were released. The field

trial participant farmer, picked up the seedlings upon release and immediately planted all approximately 1600 seedlings within 48 hours.

- Data collection equipment was set up both inside and outside of the greenhouse to monitor temperature and relative humidity.

Phase 2: Monitoring and Data Collection

- Monitor progress of existing seedlings and begin work to import additional seeds.
- Established a control set of seedlings, using the seedlings that were deemed not suitable for export. Project staff collected and stored the plants on the grounds of the Kerala, India facility. By March of 2016, there were approximately 145 seedlings, six of which had leaves growing above the graft which was an indication that the grafts were successful.

Site Visit 1 (February 16): The field trial began with the import of 1,600 Cashew seedlings going to the field trial participant's farm situated in an area of Oahu that receives regular rain and is known for farming. Once the seedlings were released and promptly planted, data trackers for temperature and humidity were set up and the seedlings' initial measurement was recorded at an average just over 12 inches tall.

Site Visit 2 (April 2016): Project manager returned to Hawaii to conduct a second site visit to evaluate the condition of the seedlings as well as recover data from the equipment that was recording temperature and humidity readings throughout the project. At this time, it was recorded that approximately 347 of the seedlings had died and or had been discarded and that 1,253 remained. Of the remaining 1,253, forty-nine of the seedlings started to show signs of life by putting out buds and in some cases, leaves primarily below the grafting point.

Site Visit 3 (February 2017): At this visit, it was noted that there was a massive die-offs of seedlings. Only 16 healthy seedlings remained, however they looked strong and needed to be transferred into the ground. Photographs of each seedling were taken at this time and all peculiarities as well as pictures detailing their progress. In addition, it was noted that the tagging system on the seedlings had deteriorated significantly and the data from the data trackers was retrieved. It appears that temperatures had been peaking at dangerous levels on a regular basis. Of the remaining seedlings the average height was about 14 inches. Shortly after this site visit, the seedlings were planted in the ground.

Site Visit 4 (July 2017): This was the first site visit made after the seedlings had been planted in the ground. The project manager was surprised at the amount of growth in such a short period of time. At this time, the remaining 11 seedlings averaged about 27.4 inches in growth. The grafted portions of the plants had dried out and the root stock accelerated significantly in growth.

Site Visit 5 (August 2017): A follow up visit and walk through with the HDOA Plant Pest Control (PPC) staff was conducted. At this time, PPC staff walked through and inspected the seedlings. They were able to identify one of the most common insects found on the trees, the Sri Lanka Weevil (Myllocerus sp.), and several organic pest control methods were suggested.

Site Visit 6 (November 2017): At this time, the damage to the trees by the pests was more apparent. The trees averaged about 48 inches tall, showing rapid growth due to frequent fertilization, decrease in watering frequency, and ideal climate and environment for growth.

Site Visit 7 (March 2018): By this site visit, the trees were showing a great deal of growth. Trees were inspected by the Project Manager who found significant amounts of damage from a small and at that time, unidentified insect. It is also important to note that the trees had flowered for the first time. The farmer was advised to clip of the flowers so that the tree would put more emphasis into growth.

S**ite Visit 8 (September 2018):** During this last site visit, the Project Manager conducted exit interviews with the farmer and the farm manager. The seedlings were inspected and continued to show damage from an unknown insect (later identified as a Red Banded Thrip [Selenothrips rubrocinctus] by PPC). Despite the significant insect damage, the cashew seedlings were bearing the last of their fruit for the season. It was estimated that the yield from the trees that went to flower was approximately five pounds. From this information, the project was able to determine that the harvesting season for the cashews will occur around September of each year. At this visit, one of the trees, that had been struggling since the time it was planted, had died. This left the final number at 10 healthy and thriving cashew trees topping out at an average height of more than six and a half feet tall.

Informational materials for distribution to interested parties was produced and included in this report.

Goals and Outcomes Achieved

In the proposal for the Second Field Trial Introduction of Cashews as a New Crop for Hawaii, the goal was to establish, and monitor cashew seedlings imported from Kerala, India, in an effort to determine whether cashews could be a new and viable crop for the Hawaiian Islands.

Expected Measurable Outcome:
GOAL: To increase the knowledge of the appropriate conditions to grow cashews on Class C and Class D agricultural lands and to bring in another 5,000 – 10,000 seeds to supplement growing seedlings, Indian Government Permitting.
The goal was nearly met. The proposal was prepared in 2015, prior to the end of the first field trial project. The Project Manager, with relationships established during the first project, planned on importing 5,000 – 10,000 seeds in addition to seedlings. However, the 2016 election in India resulted in governance that disagreed with the export of seeds. That effort is ongoing.

PERFORMANCE MEASURE: This will be measured through this distribution of information through the development of print and electronic informational materials and the arrival and growth of potential additional seedlings.
The publication is included in this report and available for distribution to interested parties.

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).
A digital guide that can be downloaded for free was posted on the Hawaii Tropical Fruit Growers and HDOA websites, estimated reach of at least 1,000 interested individuals.
http://hdoa.hawaii.gov/meetings-reports/reports-listed-by-subject-matter/
https://www.hawaiitropicalfruitgrowers.org/pages/usefulinfo.html

At least two members of the HDOA staff will conduct at least two 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.
Goal was met. There were five HDOA staff that conducted four site visits over the course of the project.

Additional outcomes:

- Project report includes information from experts in Agronomy Crop Production & Field Management;
- Discoveries of insect pests, Sri Lanka Weevil and Red Banded Thrip, both present in Hawaii prior to the project, that were identified by PPC staff of the HDOA and can be anticipated by growers to positively identify threats to the cashew seedlings and make suggestions on how to mitigate those threats. The Sri Lanka Weevil caused exceptional damage to leaves on the tree but seemed to come in waves and was a severe problem for a limited period of time. The Red Banded Trip was consistently found on the plants and seemed to cause leaf discoloration and drop off on the seedlings as well as the likely death of two weakest and smallest seedlings planted.
- The maintaining of numerical data is important to growing cashew seedlings. For this projects, the temperature in the greenhouse ranged from 53.3 degrees F to 115.6 degrees F. The greenhouse and seedlings apparently experienced temperatures well above and below the ideal mean temperature of approximately 77 degrees F that cashews typically thrive in. The discovery of the severe temperature fluctuations was conveyed to the farmer, who added fans to the greenhouse which lowered the greenhouse temperatures during the hottest part of the day.
- At the end of the project, the trees ranged from 3’ 8” and 10’ 3” in height. While the grafted portion of the seedlings unfortunately did not survive on the remaining trees, the root stock of the ten surviving cashew trees planted proved to be incredibly hardy. The remaining cashew trees once planted, thrived in their new environment and demonstrated that cashews can be a new crop for Hawaii.
- The goal to import an additional number of seedlings to help supplement the ones that died during the project was pursued by the project staff. It has been determined that the regulations regarding bringing in seeds was favorable, and efforts to obtain approval to export seeds are ongoing. As the Government of India considers the cashew to be an “endangered

species," seeds can be procured, it is difficult to obtain export approval. Project staff were able to establish contact with government officials in charge of granting permission to export the seeds, however, new government officials resulting from the 2016 election in India, has brought bureaucratic challenges that have not yet approved or proposed new guidelines for the export of cashew seeds.

Beneficiaries

The farmer that participated in the field trial has 10 trees that have survived. The cashew trees have already begun to yield fruit and nuts, and these can be planted or used for grafting. The trees will bear fruit, which can be juiced or prepared as jellies, jams, or even distilled spirits, as well as produce cashew nuts.

Interested parties can learn about growing cashew trees in Hawaii by downloading the digital information guide that is posted on the Hawaii Tropical Fruit Growers and HDOA websites.
http://hdoa.hawaii.gov/meetings-reports/reports-listed-by-subject-matter/
https://www.hawaiitropicalfruitgrowers.org/pages/usefulinfo.html

Lessons Learned

Licensing and Import Permits
Project staff learned that it is most important to first obtain the permits and licenses needed from the Indian Government to export the cashew seedlings from India. These include the Phytosanitary Certificate and Export documentation that can be different for each export request as deemed necessary by the government. The second permits necessary are the import permits issued by the USDA, necessary for the shipment to be released once in the USA. It was advantageous for the Project Staff to make an "in-kind" visit to the government agencies to ensure that cashew seedlings would be exported without unanticipated issues. It was also advantageous to alert the Post Quarantine Inspection station in Seattle, Washington (first point of USA entry), prior to the departure of the seedlings and to coordinate overtime hours to ensure the shipment cleared customs as quickly as possible. As a result, the shipment was successfully cleared in Seattle and as well as Hawaii.

Data Collection
In data collection there were many lessons learned. When initially packed in Kerala, India each seedling was given a unique identification number that would enable us to determine its variety and number in the batch. While the system was an excellent way to determine variety, unfortunately despite being permanent, the identification numbers eventually became illegible. To combat this issue, at the time that the seedlings were finally transplanted, permanent metal tags were supplied to the farmer to make sure that information could still be discerned. Tags were sent but the farm was not able to utilize the tags.
Another lesson learned in data collection was that the data loggers that were used in this project as well as the first field trial project proved to be an exceptionally low cost and effective means to monitor both the temperature and relative humidity of the farm location. Long lasting and resilient

against the elements, one data logger was then kept nearby the planted seedlings in a waterproof housing and the other remained in a covered location to collect relative humidity on premises. By doing so, project staff were able to collect consistent data with minimal interruptions in collection. The only downfall of this equipment was the inability to predict battery failure. However, by again having two trackers, the project was able to maintain consistent records.

Consistency in measurement techniques was another lesson learned in data collection. Throughout the project the ability to take measurements of either the entire grouping of seedlings or a sample size remained easy and consistent with the use of a soft tape measure. However, this became increasingly challenging towards the end of the trial due to the rapid growth of the trees once planted in the ground. By the end of the project the trees exceeded six-feet in some cases making it difficult to obtain accurate measurements. At this time, an app called "Tape Measure"TM was used to obtain an approximation of the cashew tree heights. By the time this method was employed however, the sheer amount of growth of the seedlings was already a powerful testimonial of the success of the field trial and evidence that cashew trees will grow in Hawaii.

Growing Seedlings

Throughout the course of the field trial, the project staff learned a great deal about what did and did not work in terms of caring for the trees. Once the seedlings were planted and established in the HDOA sanctioned greenhouse, significant die off was noticed. While it is difficult to determine exactly why the seedlings died off so rapidly, several factors may have played a role in the significant number of casualties:

Transit fatigue likely played a large role in the health of the seedlings once they arrived. Given that they were packed in boxes for more than 72 hours, the shock of the journey might have been detrimental to their health.

Keeping the seedlings in a greenhouse setting was possibly too much for the delicate newly grafted seedlings to endure, due to the exceedingly high temperatures inside. Suggestions were made to somehow ventilate or lower the temperatures. Unfortunately, the farmer did not have the means to increase ventilation while still maintaining the greenhouse to specifications without making a sizeable financial investment into the temporary structure.

Keeping the seedlings in small pots for an extended period also likely proved detrimental to the wellbeing of the seedlings in the long term. Trees are generally not meant to be grown within the confines of a green house or pot. The lack of space for the root ball may have also had an impact on the health of seedlings.

Soil preparations may have also played a part in the significant die-off of the seedlings in the greenhouse. The initial potting preparations made by the farmer utilized alternating layers of dense and porous materials inside of a conical shaped temporary pot which would allow the taproot to grow and the plants to maintain moisture. However, the media used may have created a drier environment than that which would have been ideal. This was determined as project staff noticed that many of the seedlings that were doing well were the plants that were held in traditional grow bags supplied by project staff, perhaps as a result of the larger size and less porous nature of the grow bag.

The exit interviews conducted with the farmer and the farm manager provided valuable information for the project.

Inability to procure additional seedlings
Part of the project proposal was to procure cashew seeds from Kerala, India to be exported to Hawaii to record the growing of cashew trees from seeds. At the time of this commitment, the project staff believed there was a strong indication that this would be possible and had begun the process of formally requesting an additional permit to export the seeds as well as seedlings. However, despite utilizing project staff based in India, the approvals and permit to export seeds has not yet been granted. The change in governance in India was a challenge and from this experience, the lesson is that working with the Indian Government is a time consuming and often slow process.

APHIS/HDOA Relations
Between working on the first and second field trial, project staff went from having minimal communications/relationship with the USDA/APHIS Post Entry team to having a closer working relationship and better understanding of post entry regulations. The lesson is to maintain a close working relationship with the government entities that regulate imports as new rules and abrupt changes to guidelines can be a challenge for a project to continue and be successful. Some changes result in financial investment that may impact the participants who may not have the ability to invest and continue with a project.

Contact Information

Contact: Emily Paulose
Name and Title: Project Coordinator
Business Entity: AMES International, Inc.
Address: 4401 Industry Drive E.
Fife, WA 98424, USA
Phone: 253.255.2438
E-mail: epaulose@amesinternational.com

Contact: George Paulose
Name and Title: CEO
Business Entity: AMES International, Inc.
Address: 4401 Industry Drive E.
Fife, WA 98424, USA
Phone: 253.946.4779
E-mail: gpaulose@amesinternational.com

Statewide Hawaii-Grown Cacao Month Initiative to Provide Outreach, Public Awareness and Education Resources

Final Report

Hawaii Chocolate Association* (HCA)
https://hawaiichocolate.org/
*The Hawaii Chocolate Association is in the process of renaming the non-profit as the Hawaii Chocolate and Cacao Association as shown on the website.

Project Summary

The Statewide Hawaii-Grown Cacao Month, October 2016, was created to provide an array of activities that provided outreach, farmer resources and educational opportunities to cacao specialty crop beneficiaries and to increase public awareness of this high-value commodity. The project solely enhanced the competitiveness of cacao with the goal of stimulating an increase in acres of cacao planted, providing guidance for growing cacao and generating sales for Hawaii-grown cacao.

The project was timely as it provided outreach and resources for farmers and potential farmers that may not have happened without the information provided by the activities conducted by the project. The project provided opportunities for farmers and processors to network to gain and share information and resources as the cacao community grows. It also provided a platform to focus public awareness on the crop, supported the efforts of the farmers, showcased Hawaii-grown cacao, and encouraged sales by featuring locations where consumers could purchase the value-added products.

The project has economic potential similar to that enjoyed by the Hawaii coffee industry where Hawaii-grown has an identity of having unique characteristics and a higher value. The project was timely as indicators alert the industry that there will be a chocolate shortage in the future and Hawaii, as the only state with the climate to grow cacao, is planning well by planting more acres of cacao to fill the anticipated shortage.

The project intended to build and grow a community of farmers in Hawaii that can grow and process a consistently high-quality cacao crop by providing information and resources needed to be successful. This project built upon previously funded programs by complementing and enhancing the previous work and provided information and collateral materials.

Project Approach

The project was conducted in five islands and targeted growers and potential growers and consumers of Hawaii-grown cacao by providing educational outreach events to stimulate the cacao industry in Hawaii. Specific critical educational materials were created in conjunction with industry stakeholders and provided to the public at large and specific target groups. At each venue, the project provided only Hawaii-grown nib, bean and chocolate sampling, pod and tree displays. There were displays and distribution of literature about the cacao crop and collection of contact information to be provided materials and/or be connected to industry professionals for guidance in planting and growing new and additional acreage as well as educate the public about this high-quality specialty crop.

Project staff concluded that without this type of programing the industry would see much slower growth with a significant loss of public awareness. It is recommended that support of this type of campaign continue as the farmers, without information this project provided, cannot allocate their time or have the resources to create programs. The HCA is the catalyst to oversee and keep industry efforts on track on behalf of the members.

The University of Hawaii`s College of Tropical Agriculture and Human Resources (CTAHR) collaborated with the Project Manager to create and verify the accuracy of the information presented, prior to the printing of collateral materials. In addition, Gunars Valkers, President of the statewide cacao trade association provided direction as to what materials would be the most meaningful to the industry.

Project partners on all islands provided support by providing venues to conduct workshops and disseminate valuable information to interested attendees. Promotion materials produced by this project can be downloaded from the HCA website: https://hawaiichocolate.org/

Goals and Outcomes Achieved

Project goals were to 1) achieve a presence on each island among potential and existing cacao famers; 2) create a catalyst to contact and catalog potential and current farmers; 3) generate media coverage; 4) solidify industry focus on the need for better communication tools to move toward industry sustainability; and 5) create materials to educate, entice, engage and groom potential cacao farmers and to educate the public.

Goal 1: Raise awareness of the industry and stakeholders during the project period.
Industry members were contacted, surveyed and questioned regarding various cacao related questions and concerns in which the results of their answers were formulated into an expanded version of "Frequently Asked Questions" document that is available on the HCA website to increase the awareness of cacao. https://hawaiichocolate.org/content/frequently-asked-questions
This tool for the industry was produced in part by the survey where 18 of the 30 respondents noted increased awareness as a result of the project. These results meet the goal of increasing the awareness of at least one-third of the participants.

The activities on behalf of the Statewide Hawaii-Grown Cacao Month to achieve the performance goals were conducted, coordinated and/or executed at the following locations where a booth that promoted cacao was featured:

County (Island)	Event(s)	Date 2016	Participants
Maui	Maui Mall Farmers Market	Friday, October 28	350
Maui (Lanai)	Dole Park Open Market Fifth Friday Lanai	Saturday, October 1 Friday, September 30	60 150
Maui (Molokai)	Molokai Saturday Market	Saturday, October 29	75
Kauai	Kauai Chocolate and Coffee Festival	Fri/Sat, October 21 & 22	1500
Oahu	Hawaii Chocolate Festival Second Saturday Chinatown	Saturday, October 15 Saturday, October 8	600 125
Hawaii	Maku`u Farmers Market Hilo	Sunday, October 30	150

Tracking results for the activities above were a combination of methods including visuals tracking through observation and guest counts conducted. In the case of farmers markets these were estimated impressions, as there were no official guest counts.

Goal 2: To increase sales during the project period.
This was accomplished in the ticketed venues where the chocolate value-added producers and the chocolate makers were reporting direct sales. A 10 percent increase over last year's sales was reported by at least half of the producers, makers and wholesalers. The actual sales numbers were not disclosed, however, resulting in project staff not able to determine that the goal was met. Comments indicate the demand continues to grow each year, especially in the exports of the value-added products.

Goal 3: Raise Awareness Among Youth 12 – 17 about the cacao industry.
The goal was to have at least 50 percent of the participants would increase their knowledge of the crop by at least 10 percent. This goal was met. Seventy-five percent of the youth responded that they had never seen cacao pods, trees or beans and had no idea that the crop grew in Hawaii! Project staff determined that the goal was met because at each location where cacao information sheets were offered, approximately 2,200 distributed in total, the youth participants picked up the information, were engaged, and were asked a variety of leading questions to determine their knowledge level with a follow up conversation about the correct answers. Project staff also provided educational coloring sheets for younger children to work on and for take home. At several events on Kauai and Oahu, the project offered specific activities to engage children including painting with cacao leaves and a chocolate garden where plants were displayed and educational information was provided.

Goal 4: To increase media attention for the industry during the designated month.
The goal was that the project would result in at least a 15 percent increase in free media coverage. This was accomplished by the many public events and further supported with the results of the media tracking coverage, which will be included in an update to this final report. Cacao related activities provided a platform for the media to explore the topic and even spurred interest in the month prior and post due to advance and post publicity. The resulting coverage was prominently placed above the headline of the front cover of the Honolulu Star-Advertiser (HSA), Crave food section, and the Travel Section of the HAS, as well as recipes included in the MidWeek insert and front cover of the Garden Island on Kauai and received full page coverage and series coverages in several publications. The baseline value of the free print media coverage is $132,733. The value of the free print media for 2016 will be available and included in the next performance report. Preliminary results indicate the value will exceed the project goal increase of 15 percent. (Refer to Additional Information section for Dateline Media baseline report and Print Media samples)

Goal 5: To create materials that can be utilized by the industry to promote the crop.
The goal was met with the creation of information in the form of posters and banners that members can download as a marketing tool (Refer to Additional Information section – banners, flyers). Project

staff collaborated with CTAHR that provided fact-checking as well as input to the collaterals produced. These materials were utilized at the Statewide Hawaii-Grown Cacao Month activities.

Goal 6: To provide growers with information and support for their cacao related business.
The goal was to have at least one-third of the participating stakeholders invited to participate in the project activities. The goal was met by providing information on the HCA website FAQs, promotional materials, contacts with retailers and consumers at the public events and by articles and promotion in print media where at least 29 of the 86 known industry stakeholders participated.
Potential and existing cacao farmers were invited to participate in the October 2016, month-long project via direct mail, email, promotion and advertising. The project manager determined that 100 percent of the known local cacao growers were contacted and were made aware of the opportunities to learn and grow their business as they were invited to participate. This outcome is based on efforts to contact every grower on a list provided by a vast group of resources including: CTAHR, and information found on the internet, phone books, existing membership lists, and via referrals from industry leaders.
The informational materials created by the project are accessible at https://hawaiichocolate.org/. The project provided materials in the form of frequently asked questions, guide to making chocolate, information to support Hawaii-grown cacao and discussion on how to create a best practices guide to further the industry. Educational workshops were also held at the Kauai Chocolate and Coffee Festival featuring cacao expert guest speakers Will Lydate from Steelgrass Farm who addressed the audience to share his industry experience with potential growers as well as doing comparison chocolate tastings of locally grown cacao among the islands to showcase the range of flavors and quality.

Additionally, companies featuring Hawaii-grown cacao participated by providing free samples of Hawaii-grown chocolate including Waialua Estates, Manoa Chocolate, Aloha Chocolate Company, and Moloa`a Chocolate Steelgrass Farm, providing an opportunity for the public to taste Hawaii-grown chocolate. An educational workshop for the general public was conducted by HC Bittenbender of CTAHR at the Hawaii Chocolate Festival on Oahu with standing room only for each session on Cacao history in Hawaii and Making chocolate from Scratch.

Beneficiaries

The project provided support to the small farmers and businesses that may not have the marketing expertise to garner necessary exposure or create meaningful programs. This project allowed them to specialize on what they do best, growing, processing and/or manufacturing cacao and provided them with professional assistance to support the industry allowing them to grow their individual businesses.

Many of the cacao farmers and potential farmers exposed were located in Congressional District 2, which is considered rural, as there is significant acreage there. The project provided information for beginning farmers regarding the cultivation of cacao and information and resources for current farmers regarding processing and promoting.

Growth of the industry can have a huge economic impact on job creation, exports, tax revenue and more. Direct beneficiaries of the project activities were the 86 members of the Hawaii Cacao and Chocolate Association that include 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 from which local chocolate is made.

On each island project staff engaged with at least one potential new farmer that was seriously considering growing cacao as a new crop or expanding their existing cacao production. These efforts provided an opportunity to engage consumers and educate them on the benefits of growing, supporting and buying locally grown cacao versus other foreign chocolates and why it may cost more is because of the quality and benefits of this local specialty crop.

Potential growers will benefit from the increased awareness of Hawaii-grown cacao. According to the survey conducted by HCA in 2014 and 2015, the acres of cacao planted by island are shown below. Total increase in acres planted increased by 48 percent with the highest increase occurring in Maui County. Project staff are awaiting the results of the 2016 industry survey which will be released in January 2017. It is expected that there will be an increase in acres planted.

County	2014 (acres)	2015 (acres)	Percentage increase
Maui	12	22	84%
Kauai	17	27	59%
Oahu	33	38	15%
Hawaii	34	55	62%
TOTAL	96	142	48%

Other beneficiaries were the 3000+ consumers that attended the events during October 2016, who gained knowledge about this emerging industry and had the opportunity to meet the chocolatiers of locally grown cacao, learn how chocolate is made from Hawaii-grown cacao and also taste the superior quality.

Lessons Learned

There is a great demand for information about Hawaii-grown cacao.

Project staff will allow more time to collect and analyze survey results. The project was executed as planned, however, the time of performance for the project was 12 months from December 2015 and the project manager expected to have results from the October 2016 activities by December 2016 and did not request a time of performance extension for the project. An update will be attached to this report to include additional project results.

Contact Person

Amy Hammond
(808) 223-6040
Email: specialeventshawaii@gmail.com

Propagation and Distribution of Superior Papaya "Rainbow" Seedlings Using Tissue Culture Propagation Method

Final Report

Hawaii Agriculture Research Center
http://www.harc-hspa.com/

Project Summary

The objective of this project was to conduct pilot trials to adapt and demonstrate the viability of the operation, practices and techniques learned from other labs in Mainland China and Taiwan to produce and distribute papaya tissue culture plants of the "Rainbow" variety at a lower cost, ranging from $2.50 to $5.00 per plant. Keys to success were the improved success rate of rooting and transitioning of tissue culture plants to potted plants, and reducing the cost of the tissue culture by adapting several cost saving techniques. By having ready access to papaya seedlings with known sex and superior quality at a lower cost, Hawaii papaya growers will benefit from higher yield, lower production cost, earlier bearing of fruit and become more competitive in the national and international markets.

Project Approach

HARC proposed to adapt and demonstrate the viability of the tissue culture and greenhouse practices and techniques to produce papaya seedlings "Rainbow" at a lower cost. The goal was to run pilot trials of tissue culture in the lab and greenhouse to implement these techniques to lower the cost of production of Hawaiian papaya seedlings, and to distribute the seedlings to papaya growers statewide

Task 1: Work with Hawaii papaya farmers to identify the superior papaya "Rainbow" hermaphrodite stock plants from growers' fields on Hawaii Island and the Hawaii Agriculture Research Center's (HARC) field at Kunia for micro propagation.
Project staff worked with Hawaii papaya farmers to identify the superior papaya "Rainbow" hermaphrodite stock plants from growers' fields on Hawaii Island and HARC's field at Kunia on Oahu Island. Twenty-four individual "Rainbow" shoots were collected from the Hawaii Island papaya field and brought back to the Oahu laboratory at HARC. Clean tissue cultures were initiated from those shoots and lines have been conserved, maintained, and regenerated at the HARC lab. The cuttings from the identified stock plants were sterilized and placed in the tissue culture media for micro propagation. The tissue cultures derived from the seeds were confirmed for virus resistance and sex type using the polymerase chain reaction (PCR) method. Clean tissue culture lines of "Rainbow" papaya confirmed for virus resistance and hermaphrodite sex type using PCR has been established at HARC laboratory. Project staff have fulfilled Task 1.

Task 2: Multiply the hermaphrodite plants in the tissue culture media to produce total 1,000 tissue culture hermaphrodites of "Rainbow".
Project staff multiplied the hermaphrodite plants in the tissue culture media. The first trial targeted 200 plants and the second trial increased the number to 800 or more. Total tissue culture plants were achieved to be 200 in the first year and reached to more than 1200 plants during the project term. In addition, project staff have modified the operational procedures to adapt some practices from other commercial establishments to reduce the cost. Disposable autoclavable paper plates were used

instead of expensive tissue culture plates and containers as a cost-savings measure. Project staff have fulfilled Task 2.

Task 3: Implement the improved rooting protocol for adaptation to Hawaiian cultivar "Rainbow" and others.
Project staff have carried out the experiment to optimize the rooting protocol to “Rainbow” and other cultivars. The plant hormones in the rooting media have been optimized for each cultivar to increase the percentages of plants rooted. The plantlets were transitioned from tissue culture rooting media to soil with a 25% higher percentage of plants rooted. Project staff have fulfilled Task 3.

Task 4: Adapt the greenhouse techniques and procedures from the commercial operation to conduct two greenhouse trials that include 200 tissue culture plants for the first trial and 800 tissue culture plants for the second trial.
Project staff set up a plastic covering in the plant growth room to transition the tissue culture plants into soil pots. The plastic cover helped to keep the moisture in the overhead space of the tissue culture plantlets during the acclimatization step. Fungicides were sprayed as needed to keep the fungal disease contamination low. The successfully transitioned plants were grown out in 4” pots and maintained in the greenhouse, which were available for purchase at $2.50 to $5.00 per plant, with income reinvested into the project. Project staff have fulfilled Task 4.

Task 5: Demonstrate the greenhouse operation and techniques at the HARC greenhouse at the end of the project. Present findings and outcomes in the annual meeting of Hawaii Papaya Industry Association (HPIA). Make 1,000 superior tissue culture "Rainbow" papaya seedlings available and be ready to distribute to papaya growers at the price ranging from $2.50 - $5.00.
Project staff worked with the HPIA to coordinate a presentation of the project results at the HPIA annual meeting to the papaya growers. Staff traveled to Hilo at the Annual Papaya Growers Meeting held on September 15, 2017, to give a presentation to papaya growers and people who were interested in setting up their own tissue culture facilities. There were about 60 papaya growers and nurseries’ staff that attended the meeting. Results and finding in papaya tissue culture were presented and shared at the meeting as well as providing details, methodology and procedures of setting up papaya tissue cultures along with information on the estimated costs. A publication was prepared to post at HARC website for individuals interested in more information. Project staff have fulfilled Task 5.

Goals and Outcomes Achieved

The expected measurable outcomes of this project were to produce superior tissue culture “Rainbow” papaya seedlings which were ready to distribute to Hawaii papaya growers. To achieve these goals, the project staff divided the project into two trials, with the first trial to produce 200 tissue culture plants and the second increased to 800 or more. Both goals were met. Other related relatively longer-term outcomes will be 1) to have an efficient tissue culture micro propagation operation with lower cost, 2) to have improved papaya rooting in the tissue culture, and 3) to adapt novel greenhouse techniques to produce papaya seedlings. Technology will be readily transferred to other nurseries or papaya growers to increase the production. Quarterly reports summarizing the data and outcome will be submitted to the funding agency and placed on HARC's website for public review. A field day and presentation will be given to the industry, nurseries, papaya researchers and other interested parties

at the end of the project. These goals were divided into the five tasks detailed in the Project Approach section and fulfilled.

Beneficiaries

The 120 members of the Hawaii Papaya Industry Association (http://www.hawaiipapaya.com/) are the beneficiaries by having superior planting materials available at lower cost and greater quantity as well as nurseries interested in setting up papaya tissue cultures. In general, the papaya industry of Hawaii benefited from this project.

Lessons Learned

Tissue culture plants were initially grown very slowly due to the contamination. The plants collected from the field were difficult to sterilize. It will be very helpful to collect more shoots and cuttings so only clean plantlets will be maintained and propagated as quickly as possible. With tissue culture, there are some high risks for contamination and project staff encountered heavy losses and setbacks due to the contamination issues that occurred in the second year where almost 1000 plantlets were lost. The exact reason for contamination is still unclear and potential causes could be 1) the autoclave which was used to sterilize the culture media might have malfunctioned resulting contaminated tissue culture media; or 2) some slow growing endogenous bacterial inside the tissue culture plantlet. The tissue culture media with antimicrobial agents can be helpful in getting rid of bacterial contamination.

Contact Information

Yun Judy Zhu, Ph.D.
Hawaii Agriculture Research Center
(808) 621-1266
JZhu@harc-hspa.com

Jump Starting Hawaii's Fruit Production Industry

Final Report

Hawaii Tropical Fruit Growers (HTFG)
http://www.hawaiitropicalfruitgrowers.org/

Project Summary

The project addressed the lack of tropical fruit trees available to meet the demand from the members of the Hawaii Tropical Fruit Growers (HTFG) and other growers in Hawaii. HTFG received 30 requests a week asking for sources for specific trees, for example, avocado, citrus, fig, lychee and mango, as well as for more exotic and ultra-exotic trees. The trees, when available, were too costly for most growers to start an orchard for commercial production. The project successfully addressed the availability of tropical fruit trees by propagating over 15,500 and distributing 12,000 trees at a cost of $5 to $20 per tree to HTFG members compared to $45 to $100 per tree from wholesale and conventional sellers. Project income was reinvested into the project to pay for costs associated with the workshops and many trees were donated to schools, Master Gardener programs and recently, to those growers whose farms were damaged by the May 2018 Kilauea volcano eruption.

The project has impacted the sustainability of small farms throughout Hawaii and for the HTFG members. The project itself has become sustainable with funds from tree sales being put back into infrastructure and additional germplasm to be made available to growers. HTFG has also increased their ability to identify the species of fruit trees desired by growers both for commercial crops and as experimental crops with potential economic benefit for future propagation.

In the past three years, HTFG members and volunteers have conducted grafting and air layering workshops and estimate that over 15,500 trees have been propagated through this project, with many still in pots, not ready for distribution. HTFG chapters statewide have used the trees at various events to attract interest in tropical fruit trees. The project has successfully addressed the goal to provide tropical fruit trees to HTFG members and other growers in Hawaii and help meet the demand for the varieties in high demand as well as for the more exotic and ultra-exotic trees. A link to view a poster of the different tropical fruit trees: http://www.fruitlovers.com/poster.html

Project Approach

The tropical fruit trees for this project were sourced from local and domestic nurseries and growers and seedlings and seeds were obtained from international suppliers.

ACTION	TIMELINE
Polled HTFG members to select desired trees;	January 2016

Formed Advisory Committee	
Double checked USDA permits and availability of space and HDOA/USDA guidelines for post-harvest quarantine	Process started in 2015 February 2016 USDA rules changed in 2017 that prohibited the import of the trees without an approved greenhouse. Much of the sourced material was in seedling form, which was held from import pending the approved greenhouse. Project manager decided to bring in seeds, which required inspection, but could be released upon approval, and graft the seedlings grown from seed onto existing trees, which was deemed to be a quicker process with a shorter time frame compared to the construction of a greenhouse.
Checked with overseas fruit tree suppliers in India, Philippines*, Malaysia, Borneo and Japan to confirm seedlings would be prepared for export to Hawaii when Project Manager is ready to receive them; Checked on shipping arrangements.	March 2016 *Philippines trees are pending as the contact passed away
Traveled to Malaysia, India, Philippines and Japan to check condition of trees and purchased trees* and seeds.	April 2016 *Post-entry quarantine rules were revised requiring a greenhouse or facility, however, 250 Mangosteen trees (Philippines) and 4000 other trees were imported prior to the revision; As of December 2018, the 250 Mangosteen trees remain in a shade house quarantine area pending approval to release expected in early 2019; the 4000 other trees were destroyed due to the detection of disease/pests. To mitigate/avoid a repeat of the destruction of the trees, and with knowledge of what to look for in the seedlings, 200 persimmon trees (Japan) are pending shipment to Hawaii awaiting construction of the greenhouse quarantine facility and 750 garcinia trees, such as Mangosteen, kokum and cowa, are being held in India. Several Baccaurea species trees, are being held in Borneo and Australia, however, about 500 seedlings, grown from seeds, being grown out in Kona, Hawaii.
Prepare quarantine area with irrigation systems; travel to Honolulu to pick up	April 2016

Mangosteen and other trees after customs clearance and USDA/APHIS release. Re-pot imported Mangosteen seedlings and plant seeds.	In anticipation of the import of the trees and need for post-harvest quarantine. Mangosteen released; other trees destroyed. Due to post-entry rule changes, project staff decided to bring in over 500 seeds from Asia and took receipt of 650 grafted citrus ordered from certified virus-free nurseries in California, 200 grafted trees, such as jackfruit, from Florida and about 200 grafted trees from a local nursery on Kauai.
Monitor tree health	July 2016 – October 2018
Write growing guides for each species for publication by the Extension Program.	Ongoing Can be found at http://www.hawaiifruit.net/index-pubs.html Guides for durian and finger limes are being reviewed for publication.
Sales and distribution began with member-donated trees and cuttings/grafted plants;	Summer 2016 Average price of trees - $20 each for HTFG members; $40 each for non-members. 500 cuttings of tropical fruit trees that were in high demand, such as dragonfruit and figs, sold for $5.00 each.
Sales and distribution, donations of trees and continued propagation	Ongoing
Final report	August 2018

Goals and Outcomes Achieved

Goal: The primary goal of this project was to get 7,000 - 10,000 tropical fruit trees to the growers in Hawaii at a low cost to "jump start" production for jackfruit, durian, Mangosteen and other varieties of tropical fruit.

Performance Measure:

Purchase 7,000 - 10,000 trees *Due to revision in USDA/HDOA post-entry quarantine guidelines, in addition to purchase, trees were donated or grown from seed (refer to Project Approach section)*	Month 3 March 2016	Goal met – over 15,500 trees propagated through this project.
Trees in HDOA USDA approved quarantine area. *Due to revision in USDA/HDOA post-entry quarantine guidelines, in addition to*	Month 5 to 29 (Some trees can be released after 17 months)	Goal met for trees that were approved for shade house quarantine.

purchase, trees were donated or grown from seed (refer to Project Approach section)	May 2016 – April 2018	
Extension publications written for each fruit.	Month 8 to 15 August 2016 – March 2017	Goal nearly met; ongoing
All trees distributed *The goal of distributing 7,000 – 10,000 trees was met. Estimated 3,000+ trees are growing out or in quarantine.*	Month 24 - 29 December 2017 - May 2018	Goal has been met.
Assessments and final report submitted	Month 30 June 2018	Ongoing; Goal has been met.

Benchmark:
The prices shown are from Frankie's Nursery (http://www.frankiesnursery.com), Lowes, Home Depot, and Plant It Hawaii (http://plantithawaii.com/price-list/) as of July 2, 2015. To provide a sampling of pricing – actual tropical fruit trees to be part of the project may be different.

Tropical fruit tree	$ Price – 1 gallon pot	$ Price – 2 gallon pot	$ Price – 3 gallon pot
Avocado	na	na	45 - 60
Citrus	40	na	30 - 50
Durian	25	na	na
Fig	10	na	30
Jackfruit	na	na	50
Mango	na	40	50
Mangosteen	25	50	60 - 100
Starfruit	na	40	30
White Sapote	na	na	25

TARGET: To provide 7,000 - 10,000 trees at a price at least 50% less than what is available to the growers within 30 months after the project begins.

Benchmark was used to determine that the goal to offer trees to members and growers at lower prices to allow for orchard planting was met. The project successfully addressed the availability of tropical fruit trees by propagating over 15,500 and distributing 12,000 trees at a cost of $5 to $20 per tree to HTFG members compared to $45 to $100 per tree from wholesale and conventional sellers.

Project staff have purchased and accumulated trees from members and non-member contributors:

Tropical fruit tree	Number of tropical fruit trees resulting from the project 2016 - 2018	Tropical Fruit Tree	Number of tropical fruit trees resulting from the project 2016 - 2018
Citrus Tangerines, oranges, finger limes, lemons, limes and pomelo	2300	Mango	2500
Avocado	2200	Marang	400
Peanut Butter Fruit	100	Dragon Fruit	500
Moringa oleifera	100	Lychee	100
Longan	150	Fig	1000
Purple Star Apple	200	Mangosteen	250 (pending release)
Durian	500	Jackfruit	50
Kwai Muk	100	Black Sapote	300
Loquat	150	Rollina	700
Miscellaneous Jaboticaba, Eugenias, Ulu, Tropical Apricot, Lulo, Cacao	1200	Black pepper	350
Achacha	200	White Sapote	100
Cherapu	20	Sea Grape	100
Isabella Grape	250	Keledang	100
Ume Plum	100	Vanilla	250
Baccaurea	500	Shikuwasa	250
Ooray (Davidsonia)	200	Salak	500
TOTAL TROPICAL FRUIT TREES RESULTING FROM THIS PROJECT			**15,720**

The project has brought HTFG members together from around the state for a common purpose. It has served to increase membership by 46 and has convinced past members to pay their dues and become involved. About 500 trees were sold to members early in the project and dozens of members are clearing land and planning on purchasing larger quantities of trees, particularly citrus and avocado, as well as the most popular, mango. HTFG Board members view this as a continuing project post-project. Chapters are planning their own version of the project and already accumulating trees. Maui County has taken a strong interest in the project. They are in the process of procuring land and planning infrastructure to support a location for a repository and area to be able to sell low price trees. Maui County has also contracted the project manager to teaching grafting and propagation classes on Maui and Molokai.

Beneficiaries

The 800 members of the HTFG who contributed their time to the project and were offered the trees at a cost from $5.00 to $20.00 per tree, a cost savings from the conventional price from $45.00 to $100,00 per tree. HTFG benefited from the 46 new members who joined because of this project.

Approximately 1000 participants from agricultural organizations who attended the workshops benefited from learning about grafting, air layering and propagation of tropical fruit trees. These include members of the Hawaii Farm Bureau Federation and Hawaii Farmers Union United.

Nurseries were able to pre-sell the more unusual varieties without having to invest in inventory adding to their profitability.

School groups, Master Gardeners, University Extension and community gardens were able to receive donated trees for planting.

Logistics providers and the new customers from the project benefited by bringing awareness to their rates and services to ship intra-state.

Lessons Learned

In terms of cost structure, project staff have learned to better prepare for price increases over the length of the project. Increases in water and power, interisland air fare and various supplies like irrigation timers were mitigated from tree sales but often caused temporary setbacks. This was exacerbated by a serious wind storm that destroyed shade houses and destroyed a few dozen trees.

Another important lesson is not to underestimate the value of volunteers both in terms of time and donations to a project they perceive as valuable to the community. Much of the success of this project is due to HTFG members and others who saw the value in the program.

Be flexible. Despite four extra days in the Philippines cleaning grafted trees with a fungicide and preparing them with permissible media, the project still lost over 4300 trees from USDA/HDOA inspection. This was a disastrous loss, however, securing seeds to grow-out the trees, sourcing trees from local and domestic sources and donated product made up much of the loss, primarily by HTFG members with additional. The USDA/HDOA is working with the HTFG to make sure it does not happen again.

One lesson was to arrange for more than one contact as a source as the primary contact in the Philippines, Dr. Roberto Coronel, passed away making it difficult to secure trees from that location.

Permits take time, some longer times than others. From India, permits can take more than one year to secure. Growers in India are holding jackfruit, Baccaurea species and black pepper for us.

Keep current on the import regulations as they could be revised and have impact on the release of shipments. In this case, changes in quarantine regulations with the USDA/HDOA, the project was not able to import some of the trees that were available to previous projects. Instead the project has

doubled its efforts within the state to find unusual cultivars and to find certified virus free or tissue cultured trees from the US mainland.

Contact Information

Ken Love
Executive Director
Hawaii Tropical Fruit Growers
PO Box 1242
Captain Cook, Hi. 96704

Ken@mycoffee.net

Hawaii-Grown Specialty Crops Marketing Campaign

Final Report

DTL, Limited Liability Company
https://dtlstudio.com/

Project Summary

Feedback from the Hawaii agriculture commodity groups indicated there was a need for marketing assistance because their focus is serving their membership and reacting to production issues such as pest management, food safety, operational costs with little time or funds to promote their commodity. Through this project, DTL, Limited Liability Company (DTL), was contracted by the Hawaii Department of Agriculture to solely enhance the competitiveness of the specialty crop represented by the commodity association. DTL engaged with 10 different commodity associations to provide the marketing tools that support the associations' activities. The project staff designed and managed the development of marketing and promotional materials such as rack cards, t-shirts and other promotional materials for use at tradeshows and events.

Project Approach

DTL initially worked with the Hawaii Department of Agriculture to identify representatives from the commodity associations selected for the project. Introduction emails were sent to the selected associations to let them know they had been selected to receive marketing materials and support at no cost to them. DTL then took over and met with the groups by phone or video conference to discuss initial ideas for marketing and promotional materials. Most of the point persons for the commodity associations then went back to their boards to discuss their needs. DTL would follow up with the group and either develop materials based on their specific needs or create mock-ups of ideas of potential products. After final selection, DTL would order the materials and have them shipped to the association.

Goals and Outcomes Achieved

Goals

1. Contact at least 10 Hawaii agricultural commodity associations to determine their needs regarding marketing materials
2. Produce marketing materials to be used at least once by the commodity association to promote the organization during the term of the project.

Outcomes

Commodity Association	Promotional Item Provided (number)
Hawaii Floriculture and Nursery Association (HFNA)	9x4 Rack Cards (12,050)
	Brochures - Proofs for HFNA (30)
Hawaii Forest Industry Association (HFIA)	Gloves (700)
Hawaii Tropical Fruit Growers Association (HTFG)	Rain Gauges (150)
	Table Cloths (8)

Hawaii Export Nursery Association (HENA)	Luggage Tags (500)
	Mugs (305)
Hawaii Avocado Association (HAA)	Avocado Brochure (8,000)
Big Island Beekeepers Association (BIBA)	Rack Card (13,000)
Hawaii Organic Farming Association (HOFA)	T-shirts (45)
Hawaii Coffee Association (HCA)	Graphic Design of Booklet
Hawaii Tea Society (HTS)	T-shirts (200)
Hawaii Macadamia Nut Association (HMNA)	Hats (295)

Beneficiaries

The beneficiaries of the project were the commodity associations listed above.

Lessons Learned

The project took more project management and administrative labor than expected.

Communication with commodity groups were done via email, telephone or conference call. No face-to-face meetings conducted. Establishing DTL as a reputable vendor contracted by HDOA was part of the issue. Perhaps if a DTL representative attended and was introduced by HDOA at a conference or other larger function where all commodity groups were represented, this may have prevented some of the communication delays.

Waiting on Board decisions and/or contact responses on what was wanted and/or needed by DTL to proceed. This could take three to six months, with repeated email inquiries from DTL.

Re-define measurable outcomes.

- Conversations with the identified contact did not necessarily involve increasing membership attendance, participation or other engagement. Most conversations and emails dealt with understanding the purpose of the grant, the services DTL offers, questions about their selection and clarity on what the group must provide to move forward.
- The quantifiable/measurable outcome is essentially the completed product or service as determined by the commodity group.

Contact Information

DTL, Limited Liability Company
Angela Petersons
angela@dtlhawaii.com
(808) 593-3048

Hawaii Specialty Farmer Business Training and Promotion

Final Report

Hawaii Forest Industry Association (HFIA)
http://www.hawaiiforest.org

Project Summary

Beginning in September 2016, HFIA presented the Growing Christmas Trees in Hawaii Educational Workshop Series on Hawaii Island, which provided practical farming workshops for potential Christmas tree farmers and others interested in the growing Christmas tree industry in Hawaii. While the Specialty Farmer workshops were part of the ʻĀina Mauna Christmas Tree Demonstration Project, topics were applicable to those interested in growing or selling Christmas trees as well as other agricultural crops. SCBGP funding enhanced this project and promoted specialty crop farming by providing Specialty Farmer Business Training (SFBT) and the creation of a two-part educational film series, covering the 1) HFIA Christmas Tree Planting Workshop and 2) SFBT practices for all specialty crop farming in Hawaii. The goal was to train specialty farmers in the development of a business plan, financial management and marketing and to encourage them to learn how to grow top-quality Christmas trees that can compete with imported Christmas trees in Hawaii's local markets. Publishing this two-part film series and 2,500 Fact Sheets allowed for mass distribution of the knowledge on the specialty crop Christmas tree industry. HFIA conducted evaluation surveys after each workshop and updated content to improve the program. Project updates were posted regularly to the website and social media. Over two years, project success was measured based upon the training of 100 participants in Christmas tree farming methods and other specialty crop farming business practices, and through the distribution of the SFBT and Christmas Tree Planting Workshop film series and Fact Sheets.

Project Approach

To support this new specialty farming Christmas tree industry, HFIA presented the Growing Christmas Trees in Hawaii Educational Workshop Series, providing both classroom-style and planting workshops for potential Christmas tree farmers, nursery workers and others interested in growing Christmas trees. In addition to helping Hawaii's farmers grow more trees and supporting the development of a local Christmas tree industry, this Hawaii Department of Agriculture project funded an innovative Hawaii SFBT and Promotion project that included SFBT, supported by Hawaii Small Business Development Center Network (SBDC) and the creation of a two-part specialty farming educational video series on Growing Christmas Trees in Hawaii.

The SFBT and Promotion benefited farmers wishing to grow and market these and other specialty crops. It helped to initiate a market for locally grown Christmas trees, providing education and employment opportunities. Since there are currently no similar programs available, a unique opportunity exists to assist start-up farms in entering specialty crop businesses.

Goals and Outcomes Achieved

Measurable Outcomes:

Outcome #1

GOAL: Engage current and potential specialty crop farmers in a Specialty Farmer Business Training.

ACTUAL OUTCOME: The 2016 and 2017 SFBT Workshops were held at the Hilo Yacht Club. The Workshops focused on Christmas tree and other specialty crop farming. Hawaii SBDC educators developed and presented curriculum and Big Island TV filmed the presentations. Aileen Yeh gave a presentation on the ʻĀina Mauna Christmas Tree Demonstration Project.

- The March 18, 2016 volunteer planting workshop was attended by 22 people;
- The October 21, 2016 SFBT workshop was attended by 49 people;
- The March 3, 2017 volunteer planting was attended by 23 people; and
- The December 1, 2017 SFBT workshop was attended by 35 people.

TARGET: 50 participants will participate in the SFBT annually. When surveyed, 90% of the workshop participants will state that they have benefited from the business training; 90% will rate the workshop information as either Good or Excellent.

ACTUAL: 49 participants participated in the SFBT the first year. When surveyed, 90% of the workshop participants who took the survey stated they benefited from the business training (are likely to use the information they learned); 100% rated the workshop as either Good or Excellent.

ACTUAL: 35 participants participated in the SFBT the second year. When surveyed, 95% of the workshop participants stated they benefited from the business training (are likely to use the information they learned); 95% rated the workshop as either Good or Excellent.

Outcome #2

GOAL: Share education on Growing Christmas Trees and Hawaii specialty crop business training.

ACTUAL OUTCOME: Big Island TV filmed March 18, 2016 Christmas Tree Planting Workshop and October 21, 2016 SFBT Workshop. Films were ready for publication and posted on the webpage and on YouTube in May and November 2016. The Fact Sheet on Growing Christmas trees in Hawaii was initiated. The Fact Sheet will be distributed at future HFIA events during the grant cycle, 2016-2017. A total of 2,500 ʻĀina Mauna Christmas Tree Demonstration Project information sheets were printed for distribution at community outreach events. The information sheet was posted on the webpage. http://www.hawaiiforestinstitute.org/our-projects/christmas-tree-demonstration-project/

TARGET: Long term outcomes include eventual establishment of hundreds of acres of new Christmas tree farms across several islands, ultimately reducing importation risks of unwanted pests and adding economic opportunities and environmental sustainability to the outcomes of this project. Immediate outcomes include a massive online distribution of free specialty farming business training. Increase in

the production of fledgling specialty crop farms, such as but not limited to Christmas trees. Promotion and marketing of Hawaii-grown Christmas trees unique to Hawaii's region and geography, during the term of the project and the significant decrease of unwanted pests from the import market.

ACTUAL: Online distribution of free specialty farming business training videos.

http://www.hawaiiforestinstitute.org/our-projects/christmas-tree-demonstration-project/
Attendees to the workshops received information to help them increase the production of fledgling specialty crop farms, such as but not limited to Christmas trees. Promotion and marketing of Hawaii-grown Christmas trees unique to Hawaii's region and geography via emails, webpages, press releases, community calendars, YouTube, Facebook, and Twitter.

Beneficiaries

A total of 129 people benefited from two volunteer plantings and two Specialty Farmer workshops.
2016
Volunteer Planting: 22 people
Specialty Farmer workshop: 49 people
2017
Volunteer Planting: 23 people
Specialty Farmer workshop: 35 people

The two-part video series was posted on the web along with the power point presentations, which reached a broader audience. Links to the webpages were distributed to about 500 people in HFIA E-news. The 'Āina Mauna Christmas Tree Demonstration Project information sheet will be distributed at outreach events including Hawaii's Woodshow, Earth Day events, HFIA Annual Meeting, etc.

Lessons Learned

Ethnobiologist Jill Wagner was not able to germinate the seed given to her by Aileen Yeh into healthy seedlings at her nursery in Kaloko. Aileen Yeh thinks Kaloko is too wet and humid. Jill propagated 20 seedlings and Aileen thought 12 appeared that they might turn out to be plantable; however, they are now barely alive.

Aileen gave Kulani Correctional Facility some seed to sow and 20 seedlings to plant at Kulani. So far, they have planted 90 seedlings, which are doing well. They plan to continue planting.

The seedlings planted in Glenwood did okay, however the seedlings in Hilo did poorly. Aileen thinks it is too hot and humid in Hilo. The seedlings at Waimea DOFAW State Nursery are doing very well. Aileen moved the Glenwood seedlings to Waimea since the seedlings are growing best there. She thinks the PH might be too low or acidic because of the acid rain in Glenwood.

Forest Solutions prepared the site for the March 3, 2017 planting and conducted site maintenance in July and November 2017. The 600 seedlings planted in March 2017 are doing well, with a survival rate of 79%.

Cindy Davis-Dykema moved to the mainland so Heather Simmons and Aileen Yeh coordinated the project. Funds budgeted for project coordination were allocated to Hawaii Agriculture Research Center and HFIA, where the funds were needed most.

Contact Information

Heather Simmons, Executive Director
Hawaii Forest Industry Association (HFIA)
P.O. Box 66
ʻOʻōkala, HI 96774
Phone: 808-933-9411
Email: hfia@hawaiiforest.org
HFIA Website: www.hawaiiforest.org

Project photos can be found at the HFIA website:
http://www.hawaiiforestinstitute.org/our-projects/christmas-tree-demonstration-project/

Hawaii-Grown Seed: Grower Network and Industry Development through Farm-to-Farm Trials and Electronic Seed Sales & Exchange

Final Report

The Kohala Center (TKC)
http://kohalacenter.org/

Project Summary

This project addressed the disparity between the availability of locally adapted specialty crop seeds for commercial farmers and home producers, and the increasing statewide demand for locally grown foods and natural/organic products. The production of locally grown and adapted seed is crucial for Hawaii because of the unique growing conditions. Hawaii is the only state located in the tropics and is home to over 140 soil types with most of the climatic zones represented. Many of the main vegetable varieties grown in the U.S. are not adapted to tropics due to the small day/night temperature differential which can cause significant disease and production issues. For increased local food resilience and self-reliance, it was important that the project explore additional avenues to produce seed adapted to Hawaii's diverse tropical conditions, diverse soil conditions, and changing climate. As one of the most isolated island chains in the world Hawaii must continue to grow its own food supply, starting with seeds.

Project Approach

1. Created seed growing protocols and practices including crop data entry spreadsheets for farmer-to-famer variety trials. Using data collected, develop benchmarks for future assessment of seed quality, genetic elasticity, and environmental adaptation. Trial results will be made available on TKC's Hawaii Public Seed Initiative website.

2. Utilized public/private cooperation and resources, with the goal to develop improved crop varieties as a statewide resource, conducted farmer-to-farmer variety trials with the present network of growers. Within HSGN, resources exist for seed saved from varieties that do well in identified locations. However, methods for evaluating seed quality, local adaptation, genetic elasticity, and potential yield per farm are lacking. Farmer-to-farmer variety trials, conducted with standardized protocols and guidance from CTAHR partners, served to identify varieties that met quality and performance criteria and demonstrated a trend towards crop improvement. Furthermore, this project served to build farmer seed knowledge and strengthen farmer relationships. Building from this platform, project staff created a statewide resource of open-pollinated, locally adapted seed varieties.

3. An electronic Hawaii Seed Sales & Exchange was developed as a marketplace for locally adapted, open pollinated seed which has passed performance criteria, is unique from what is presently available in Hawaii, and meets Hawaii State Seed Law requirements. It is hoped that in the future every seed sale will be a value-added product for the farmer and a means to diversify farm production and income profile. New varieties will be added as this project continues beyond March 2018.

4. Created project awareness and statewide market demand through workshops, media campaigns, and social media platforms.

Table 1. Work Plan and Activities Achieved

Activity	Responsible Parties	Changes made to Responsible parties	Timeframe	Activities Achieved 2016	Activities Achieved 2017-2018
1. Design procedures, protocols, and variety trial data entry sheets for growers	Lyn Howe, TKC; Hector Valenzuela, CTAHR		Months 1-2: Jan-Feb, 2016	February, 2016	Ongoing
2. Survey network farmers for open-pollinated seed varieties they have been growing and saving seed from in their locations and access their interest in conducting variety trials	Lyn Howe, TKC		Months 2-4: Feb-Apr, 2016	April, 2016	Ongoing; at 2018 meeting
3. Coordinate seed distribution and begin 1st series of variety trials	Lyn Howe, TKC		Months 3-9: Apr-Sept, 2016	June, 2016	
4. Visit statewide farm trials and conduct island workshops, one workshop per island site	Lyn Howe, TKC; Russell Nagata, Glenn Teves, Hector Valenzuela, CTAHR		Months 6-9: June-Sept, 2016	April – Oct, 2016	
5. Farmers to send seed selected from successful trials to Hawaii Island Native Seed Bank for packaging, redistribution, and storage	Lyn Howe, TKC; Jill Wagner, Hawaii Island Native Seed Bank		Months 8-10: Aug-Oct, 2016	Aug, 2016	Ongoing
6. Send out farmer trial survey evaluations; evaluate, compile all data, evaluate trial protocols to determine changes for 2nd trial series	Lyn Howe, TKC; Russell Nagata, Glenn Teves, Hector Valenzuela, CTAHR		Months 8-12: Aug-Dec, 2016		January 2017; Jan-March 2018
7. Develop workshop materials	Lyn Howe, TKC; Russell Nagata, Glenn Teves, Hector Valenzuela, CTAHR		Months 13-15; Jan-Mar, 2017		Ongoing
8. Design electronic marketplace	Neema Oshidary, TKC	Arthur Dodge Designs	Months 13-19: Jan-July, 2017	Website online Aug 2016	

9. Design seed packets and send for printing	Lyn Howe, TKC; Jessica Young, JY Design Pro	Seed packet Contest winner	Months 14-16	Oct.-Nov. 2016	
10. 2nd variety trials begin; determine farm locations and send selected seed to trial sites; identify farm sites for workshops	Lyn Howe, TKC; Glenn Teves, Hector Valenzuela, CTAHR		Months 14-22; Feb-Oct, 2017		Completed by Dec. 2017
11. Begin media campaign and continue to promote though the year	Liam Kernell and Lyn Howe, TKC		Months 14-24: Feb-Dec, 2017		Completed by Dec. 2017
12. Conduct workshops at farm site on each island location	Russell Nagata, Glenn Teves, Hector Valenzuela, CTAHR; Lyn Howe, TKC		Months 19-21: July-Sept, 2017		Completed by Dec. 2017
13. Collect data from 2nd trial; evaluate and collect seed from farmers	Lyn Howe, TKC; Glenn Teves, Russell Nagata, Hector Valenzuela, CTAHR		Months 20-22: Aug-Oct, 2017		Completed by Dec. 2017
14. Package and send seeds for controlled storage	Hawaii Island Native Seed Bank		Months 20-23: Aug-Nov, 2017	Aug. 2016 – ongoing	Ongoing
15. Draft and finalize industry pamphlet; incorporate trial results, highlighting benefits of microclimate adaptation	Jessica Young, JY Design Pro; Liam Kernell and Lyn Howe, TKC; Hector Valenzuela, CTAHR	Arthur Dodge Designs	Months 20-21: Aug-Sept, 2017		Completed by Dec. 2017
16. Distribute industry pamphlet and promotional materials; promote project via social media	Neema Oshidary, Liam Kernell, and Lyn Howe, TKC	Arthur Dodge Designs	Months 21-24: Sept-Dec, 2017		Completed by Dec. 2017; ongoing
17. Seed marketplace development; continue promotion efforts; analyze markets for sales to begin after January 2018 (after contract period of performance	Neema Oshidary, Liam Kernell, Lyn Howe, Nicole Milne, Jill Wagner, and Lyn Howe, TKC	Arthur Dodge Designs	Months 23-24: Nov-Dec, 2017		Completed by Dec. 2017; ongoing
18. Write final grant report; continue to trial and add seed varieties to electronic marketplace beyond duration of this grant	Lyn Howe and Nicole Milne, TKC		Months 23-24: Nov. 1-Dec. 30, 2017		April 2018; ongoing

Goals and Outcomes Achieved

Goal 1: Development of a standardized format and evaluation procedures for farmer-to-farmer variety trials including protocols, quality standards, evaluation of environmental influences in low input systems.

Outcome1:

1. Recruitment
    - Potential seed growers were sent letters to gauge interest in participating in projects for the HDOA/SCBG project. A poll was sent to and completed by all growers to determine potential seed varieties to be trialed.
    - The project team, with input from contract farmers, developed standardized best practices, seed growing protocols, and crop specific data entry sheets. All documents were disseminated and shared in Google Docs for each farmer to complete. This data will determine performance in different environmental microclimates. The seed production and data collection protocol sheets can be used in the future by all network growers and members of the public interested in growing seed; future seed education workshops will use these protocols as teaching tools.

2. Strategic Planning Year 1: Conducted a three-day statewide strategy and working group meeting January 13-16, 2017, on Hawaii Island to bring growers together. Breakout sessions topics:
    - Breed for new varieties with Network partners Russell Nagata and Glenn Teves
    - Organize schedule, content, and locations for island Seed Fest days and workshops with Arthur Dodge Designs and Lyn Howe
    - Determine descriptions for each variety of seed packets
    - Review seed cost analysis for varieties
    - Discuss the organizational structure of the Hawaii Seed Growers Network
    - Discuss best efforts for public outreach

3. Strategic Planning Year 2: Conducted a three-day statewide strategy and working group meeting held March 6-8, 2018, on Hawaii Island. Participants included 8 statewide farmers from the Hawaii Seed Growers Network, 4 partners from The Kohala Center (Milne, Blazak, Willich, and Kernell), 1 partner from GoFarm Hawaii, and a University of Hawaii at Hilo plant breeder. Discussions included:
    - Selling seeds, seed inventory tracking, and order processing and filling
    - Growing seed crop varieties in 2018
    - Increasing seed inventory
    - Mentoring new seed growers
        a. Track Beginning Farmers and GoFarm graduates for potential HSGN members
        b. Create a single day event to lure new growers on each island; attention must be paid to level of experience
        c. Structure contracts with new growers

- Determining organizational structure due to the generation of income through the marketplace
- Marketing and sales promotion including farmers markets and social media
- Breeding new varieties
- Working with farmer training programs (TKC's Beginning Farmer Rancher Development Program, GoFarm Hawaii programs statewide) to train new seed growers for the marketplace and have student farmers run variety trials on new breeds
- Defining financial and equipment needs and an associated budget
- Analyzing nutritional components of selected seed varieties as a marketing tool; increasing importance of nutrition per acre or "nutrient dense" food
- Writing blogs to increase marketplace awareness
- Developing a plan for business growth: more new varieties, more seed growers; need to breed new varieties by finding good parent lines to build on and possibly access UH parent lines in storage
- Tracking customer comments and sales of each variety to determine which to keep growing and what the public would like to see offered
- Continuing on-farm Seed Fest days with tastings of different varieties being sold on the marketplace
- Tabling at and offering seed for sale at statewide farming and agricultural events

Goal 2: Two years of farmer-to-farmer variety trials conducted statewide to determine farmer seed producing capability, seed quality, microclimate adaptability, farmer yield potential, economic feasibility, and production challenges. After the completion of these trials a minimum of the 10 best performing varieties will be selected and available for sale.

Outcome 2:

1. Variety Trials: **Completed 56 crop *variety* trials**
    - Nine farmers were surveyed to list varieties trialed and production outcomes
    - These 9 farmers have completed 56 crop *variety* trials
    - Of these 9 farmers, **7 agreed to continue to produce seed** for this project

2. Variety Identification: Using information from these 56 varietal trials, the project team and contract farmers identified the best varieties to be grown for seed production and marketplace in 2016-2017
    - Contract agreements and contract required documents checklist were distributed and signed by farmers participating in this project
    - Seed cost analysis; comparing costs of similar seed sold by other businesses to determine seed packet pricing structure were conducted
    - Results of farmer-to-farmer variety trials conducted determined performance in various microclimates; the data was used to compile a list of seed crops to be grown for the online marketplace
    - Each grower determined the crop varieties they would grow for *production* trials

3. Production Capability: Growers on **Molokaʻi, Maui, Oʻahu, Hawaii island were all approved** to continue as participants on this project
   - On-farm site visits were conducted on all islands by Hawaii Public Seed Initiative's Program Director to determine capability of seed growers and seed quality
   - Kauaʻi's potential seed grower, an excellent market gardener, was not approved due to inability to properly select and save seed that was viable; project staff are working to find a capable grower on Kauaʻi

4. Network-Building: Periodic group conference calls were conducted to share ideas, concerns, and production status

5. Protocols: Seed banking and testing protocols were developed
   - Input received from the director of the Hawaii Island Seed Bank, and a network member and agriculture teacher at University of Hawaii Leeward
   - These protocols continue to be reviewed and refined
   - Seed produced was sent to Hawaii Island Seed Lab for drying, data base entry, and storage

6. Testing: To date a total of **31 varieties have passed or exceeded germination standards and are offered for sale at the online marketplace**
   - Hawaii Seed Growers Network submitted varieties of locally grown and adapted seed for germination testing to University of Hawaii at Mānoa's Seed Lab and University of Hawaii Leeward.
   - All germination records will be maintained on file, as required by the Hawaii state seed law

Goal 3: Development of an electronic marketplace, Hawaii Seed Sales & Exchange, to provide a source of sales of locally adapted seed produced and prepared in compliance with Hawaii State Seed Laws.

Outcome 3:

1. Network Formation: **Hawaii Seed Growers Network**
   - Conducted Google polls for group decision making and to aid in determining a name for the network; "Hawaii Seed Growers Network" was chosen
   - Determined the ability of each farmer to grow 2 to 4 of the seed varieties chosen for the online Hawaii Seed Growers Network marketplace.
   - Coordinated efforts, made group decisions, and addressed concerns through regular conference calls

2. Outreach: Held statewide **Seed Packet Design Art Contest**
   - As a means to engage the public and create project awareness, a statewide seed packet design art contest, offering a $300 prize was conducted; all art entrants were asked to

submit an Assignment of Artwork Contract
- Two designs were chosen in October 2016; contest winners were contacted and paid for their respective designs; contestants who did not win were sent a letter of appreciation

3. Seed Packaging: **A total of 10,000 seed packets were printed** using the two winning designs from the seed packet design art contest
   - Quotes for printing seed packets were requested from several companies
   - Cenveo printers in Honolulu were chosen to produce and print the seed envelopes on recycled paper
   - Materials for labels were purchased

4. Online Marketplace: The Hawaii Seed Growers Network (HSGN) website was **launched in December 2017**
   - Photographs and farm and grower descriptions were submitted and added to the grower's page of the HSGN website
   - A Google Doc was used to gather and record all seed descriptions from the growers for the website; shorter descriptions (with a character minimum) were entered for seed packet labels; labels are hand applied to printed packets, these strategies provide a level of flexibility and reduces costs of packets printed for each variety
   - All crop varieties were added to the online marketplace and continue to be added as submitted
   - The Hawaii Seed Growers Network applied for and was given a Hawaii State Seed License, as required by law; due to costs of inspection for shipping out of state agricultural products, shipping is only within the state of Hawaii
   - Advertised online marketplace through social media, several online publications, agricultural and gardening listservs, and via participant contacts gathered at all seed events: https://www.hawaiiseedgrowersnetwork.com

5. Marketplace Results: Total sales from Hawaii Seed Growers Marketplace to date: **559 seed packets for an income of $2,841**
   - As of April 29, 2018, the online marketplace has completed 95 transactions with 478 seed packets sold and generated sales revenue of $2,282
   - A total of 47 seed packets were sold at a Variety Showcase event held on Oahu in March 2018 for an additional $188
   - A total of 34 seed packets were sold at a seed exchange on Hawaii Island for an additional $136
   - Seeds available on the marketplace in 2017 include:
     - Chimbu Purple Wing Bean
     - Cleome
     - Datil Hot Pepper
     - Hawaiian Sunray Pepper (sweet)
     - Kaala Sweet Pepper

    - Kahala Soybean
    - Lualualei Pole Bean
    - Nalo Orange Corn
    - Nanas Fingers Hot Pepper
    - Peking Black Pole Bean
    - Poha Berry
    - Red Zebra Pole Bean
    - Roselle
    - Santa Cruz Okra
    - Tithonia
    - Tsunga Mustard
    - Violets Multi-Colored Bean
    - Zens Long Bean
    - Provider Bush Bean
    - California Black Eye Pea
    - Canasta Lettuce
    - Costa Cucumber
- Seeds to be produced for the marketplace in 2018 are being finalized by network members in spring 2018; HSGN members expressed interest in continuing to grow many of the varieties grown in 2017, including the most popular varieties, and experimenting with new varieties

Goal 4: Conduct statewide awareness of the project via workshops, media campaigns, distributed publications and linking developed varieties to the HAWAIʻI PUBLIC SEED INITIATIVEs online Seed Variety Selection Tool.

Outcome 4:

1. Events and workshops: Conducted (1) seed event and (1) workshop on Oahu, (2) seed events on Molokai, and (4) seed workshops on Hawaii Island. The availability of locally adapted seed at the Hawaii Seed Growers Network online marketplace was introduced at all events. All workshops were free and open to the public.

- **Oahu**: In 2016 Jay Bost, HSGN member, hosted one seed workshop on Oahu. In 2018 Bost worked with Organic Seed Alliance to initiate and organize a 2-day intensive event on Oahu over March 11 and 12, 2018. This workshop for Hawaiian farmers, students, and seed stewards was an opportunity to take farming skills to the next level and learn fundamentals of plant variety improvement and organic plant breeding. Researchers from OSA, University of Wisconsin, and Oregon State University (partners of the Northern Organic Vegetable Improvement Collaborative – NOVIC) along with University of Hawaii (UH) instructed in this workshop. While HPSI director Lyn Howe was not able to make the event, Dr. Melanie Willich, TKC's BFRDP program coordinator, attended in her place.
- **Molokai:** Glenn Teves (UH CTAHR), project partner and HSGN member, held a 2016 seed workshop and in 2018 hosted a "Local Seed for Local Needs" workshop for 30

participants on Molokai.

- **Hawaii Island**: Three public seed workshops were held on the island in 2016, including in east and west Hawaii on HSGN member farms. In early 2017, a one-day workshop was held in conjunction with TKC's Beginning Farmer and Rancher Development Program in Honokaa, Hawaii Island. The workshop focused on advantages of using locally produced and adapted seed, local seed availability through the online marketplace, and techniques for growing and saving quality seed using protocols developed during the scope of this project. Final BFRDP evaluations indicated the seed workshop was one of the top three lectures of the 9 month program. An additional workshop in conjunction with TKC's BFRDP is planned for summer 2018.

2. Social Media: TKC's Hawaii Public Seed Initiative Facebook page **reached 1,335 individuals** and directed users to the HSGN website.

- The Seed Packet Art Contest was advertised by social media, posters, the Hawaii Seed Growers Network website, and agricultural and gardening listservs. By generating contact information of people who attended seed events and have expressed interest in being contacted, project staff were able to notify people when the electronic Hawaii Seed Sales & Exchange marketplace was online and when new events were offered.

3. Grocery Store Distribution Assessment:

- We contacted local food outlets and natural food stores to determine if making seed packets available in these locations were of interest in the future
- To date the natural food stores and Locavore store in Hilo have shown strong interest
- We agreed that the project was not ready for this step and will need to determine if sufficient seed inventory can be generated to satisfy these locations, acquire seed racks, and learn to manage inventory properly

4. Seed Festivals: In September 2017 a series of free **"Local Seeds for Local Needs" Seed Festivals** were conducted by the project network growers on (3) Islands at (4) locations. A total of **120 participants attended** these events statewide.

- To create impact, these free and open to the public statewide events where held on the same day and same time. All focused on creating awareness about the importance of gardening with seed varieties locally adapted for Hawaii's semi-tropical micro-climates and low-input systems.
- Information promoting this event was disseminated by press releases, social media, and posters. Project staff used seed packets to personalize invitations for some individuals to the Seed Fest.
- Reservations were taken on Eventbrite from which further contact lists have been generated.
- Each on-farm event included workshops, demonstrations, variety tastings, and tours of variety trials; event hosts introduced the varieties that will be available online at the Hawaii Seed Growers Network marketplace.
- Exit surveys demonstrated participant enthusiasm for purchasing the networks seeds and for knowledge shared at the events.

- Contact lists generated at these events were utilized to announce the opening of the online marketplace in December 2017, and for marketing use in conjunction with Constant Contact and "Shout Outs".

5. Variety Showcases: Event on Oahu attended by over **50 participating plant breeders, agricultural researchers, and chefs, and over 150 guests**.
    - One of the online marketplace seed varieties, Nalo Orange Flint corn, was showcased in the 2017 Culinary Breeding Network Showcase annual event in Portland, Oregon.
    - Hawai'i Seed Growers Network made seeds available for sale at the Variety Showcase Event on Oahu, March 13, 2018. This was the first Variety Showcase event to venture beyond Portland, Oregon.
    - This event was designed to allow participants to experience the agricultural diversity in tropical crops through varietal tastings. While HPSI director Lyn Howe was not able to make the event, Dr. Nicole Milne, TKC's vice president for programs, attended in her place.

6. Seed Variety Selection Tool (SVST):
    - TKC's Hawaii Public Seed Initiative's (HPSI) SVST is an effort to assist small scale food producers in selecting vegetable varieties best suited to their specific locations. The tool consists of a map that defines climate zones for Hawaii and a database that identifies varieties of vegetable crops that farmers and gardeners contributing to this tool have found to be successful in these zones.
    - The SVST is housed on HPSI's homepage at www.kohalacenter.org/hpsi/svst. Instructions on how to use the tool can be found on the website.
    - Neema Oshidary, TKC's former website and project developer, worked closely with Lyn Howe, Project PI, and Liam Kernell, TKC's communications director, to develop this tool. Mr. Oshidary left TKC in summer 2016 and further development and integration of the SVST is on hold.

Beneficiaries

1. All event participants and customers who purchased seed from the online marketplace benefited from:
    - Availability of locally produced and adapted seed for greater gardening success
    - Understanding the importance of growing with locally adapted seed
2. All seed grower/partners benefited from:
    - Developing greater expertise in seed production
    - Designing and critiquing seed growing protocols and production sheets
    - Learning to work as a statewide network and make group decisions
    - Developing and growing locally adapted varieties for the online marketplace

Lessons Learned

1. HSGN Expansion:
    - The network must expand to become a viable business
    - Expansion must involve new members, increased number of varieties grown and available for purchase, and increased quantities of seeds available for purchase

- New members must be skilled growers, able to follow seed production and data collection protocols
- Seed growers must be compensated for producing seeds, either via sales, workshop fees, grant honoraria/stipends, etc.
- Marketing is key for sales: spikes in sales were seen immediately after HSGN and its members were in the press or were active on social media accounts
- Pursue technical assistance in business development from TKC, including marketing, accounting, product testing, legal considerations, and financial capitalization for the for-profit business
- Working statewide has challenges as there is spatial separation that makes decision making and communication efforts slow. It is important to have annual meetings where all parties involved come together for networking and strategizing.
- Creating a 5 year strategic plan for both HPSI and HSGN would facilitate statewide network continuity.

2. HSGN Business Structure:

- HSGN members must decide in 2018-19 on its business structure
- TKC's Hawaii Public Seed Initiative could continue on with seed education and outreach activities while the Hawaii Seed Growers Network incorporates as a stand-alone, for-profit entity
- If incorporated as a for-profit entity, HSGN should continue to work closely with TKC's Rural and Cooperative Business Development Services program and TKC's Hawaii Public Seed Initiative, specifically on public and grower education, community outreach, and local economic development
- Pursue technical assistance in business development from TKC, including incorporation paperwork

Contact Information

Dr. Lyn Howe, Project Coordinator
Ph: (808) 887-6411
Email: lhowe@kohalacenter.org

Dr. Nicole Milne, Vice President of Agricultural Initiatives
Ph: (808) 887-6411
Email: nmilne@kohalacenter.org

Mailing Address:
P.O. Box 437462
Kamuela, Hawaiʻi 96743

Further Development and Commercialization of Single Pod Cacao Micro-Fermentation Methods and Small Batch Quality Assessment for Hawaii's Specialty Crop Cacao

Final Report

Hawaii Agricultural Research Center (HARC)
http://www.harc-hspa.com/

Project Summary

Cacao production in Hawaii is increasing in response to the growing demand for Hawaii-made chocolate. In much of the cacao producing regions of the world, it is common practice for growers to select highly productive trees on their farms, propagate the selections through grafting, and plant the selections that will increase productivity.

Many cacao growers in Hawaii are interested in following this tradition, but are restricted because they are currently unable to accurately assess the flavor profiles of the selections. Flavor profile is a key trait for growers because the Hawaiian chocolate industry is based on producing high value, specialty chocolate with superior flavor. This project aimed to empower growers with the ability to accurately assess the flavor profile of individual trees, enabling selection of trees with superior flavor characteristics.

Project Approach

The plan of work for the Single Cacao Pod Micro-Fermentation Methods is outlined as follows;

A. Single Cacao Pod Ferment Methodology Utilization

1. Assess provided methodology, adapt to local facilities and environment, and train HARC staff to conduct micro fermentations.
   At the Hawaii Agricultural Research Center Kunia (HARC) Research Station, a small micro fermenter was set-up under the instruction of Ed Seguine of Seguine Cacao & Chocolate Advisors. Training sessions were conducted for HARC staff and others.
2. Send samples of ferments to Ed Seguine for processing and sensory analysis.
   Over 48 individual cacao micro-fermentation samples were sent to Seguine Cacao & Chocolate Advisors for evaluation.
3. Ed Seguine provided samples of chocolate to HARC for sharing with growers and other interested parties as appropriate for sensory calibration in Hawaii.
   48 individual cacao liquor (mélanged fermented cacao beans) samples were provided for evaluation and sensory calibration. These samples had notable flavors including citric acidity, fresh tropical fruit, dried stone fruit, floral flowers, roasted nuts. Cacao beans with fruit, floral, and nutty flavors are considered the most desirable Hawaiian chocolate flavors.
4. Assess sensory data and simplify to obtain rating scores for selected cacao cultivars.
   A simplified sensory data rating system was developed for HARC and other cacao growers. HARC staff conducted tasting sessions for each of the chocolate samples and evaluated them using the simplified rating system shown below:

				LIQUOR EVALUTION DESCRIPTORS - Please indicate a mark of 0-10												
Ref	Name of evaluator	Date of evaluation	Panel Code	Cocoa	Acidity	Bitterness	Astringency	Sweet	Fresh Fruit	Browned Fruit	Nutty	Floral	Woody	Spicy	Off Flavors	LIQUOR comment
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

B. Develop commercial service for Hawaii Cacao grower pod assessment.

1. Take ferment data and methodology and develop business model around the concept.
   A description the cocoa flavor profile and small batch processing can be found in appendix A. This document was posted on the HARC website, included in several postings of the quarterly Hawaii Cacao and Chocolate newsletter and sent to all active members of the Hawaii Chocolate and Cacao Association (HCCA) https://hawaiichocolate.org/current-members with current contact information as of 2016.
2. Host open forums for Cacao growers on all islands to demonstrate the potential of the service and show typical results.
   Several cacao growers were contacted directly on all of the four major islands. Many expressed interest, however only a few growers availed themselves to the service. In addition, two outreach demonstrations on cacao fermentation and chocolate processing were held on Oahu.
3. Provide a lead in (no cost service) for growers to assess one sample in the final six months of the project.
   Flavor profile services were provided for three Hawaii cacao growers: Kahuku Farms, Oahu, Moloa'a Bay Farms of Kauai, and a farmer from Kahaluu, Oahu.

Significant results and accomplishments:

- A micro cacao fermenter was set-up and HARC staff were successfully trained on its operation.
- Over 48 individual cacao micro-fermentation samples were processed and evaluated for fine flavor potential.
- A simplified sensory data rating system was developed for cacao flavor evaluation.
- An outreach program was implemented for the cocoa flavor profile and small batch processing service.
- HARC Maunawili heirloom cacao varietal collection was evaluated and several fine flavor cacao cultivars were identified. Appendix B, lists the Maunawili cacao cultivars. rated highest for fine flavor.

Conclusions and recommendations:

- Micro-fermentation technology is a powerful tool to evaluate individual cacao cultivars for flavor potential. Once identified, individual cacao trees with known fine flavor profiles will directly add-value to the crop. This can be as much 100% premium over commodity grade cacao beans. About 25% of the cacao trees sampled had fine flavor potential, thus not all cacao produced in Hawaiian is of specialty quality.
- Utilizing the micro-fermentation technology fine flavor cacao cultivars in HARC Maunawili and Kunia collections were identified. These fine flavor cultivars may form the basis for an expanding specialty chocolate industry in Hawaii and is a mechanism for Hawaiian producers to add-value to their product. These cultivars can be made available to growers to support a specialty industry in Hawaii.
- A new approach to grower outreach should be developed. Some but not all, of artisanal cacao and chocolate producers in Hawaii are very interested in identifying individual cacao cultivars with fine flavor potential. The micro-ferment technology and flavor profile service can add value to the Hawaii cacao industry and for individual farmers and should be adapted on a wider scale.

Favorable developments:

- A renown specialty chocolate manufacturer, Guittard Chocolate is excited about the potential of an expanding fine flavor cacao industry in Hawaii and has expressed an interested is sourcing fine flavor cacao beans with known flavor attributes. Guittard Chocolate believes components to further develop fine flavor cacao are now in place. Discussions are now underway on how best to develop and scale HARC's fine flavor cultivars. This potential new fine flavor cacao cultivar project presents an opportunity for Guittard Chocolate and HARC to work together collaboratively to make these cultivars available to growers to now be cultivated on a larger enterprise level scale and support a growing specialty industry in Hawaii.

Contributions and role of project partners in the project are listed below:
Ed Seguine of Seguine Cacao and Choloate Advisors has provided flavor evaluation consulting and training
Dr. HC "Skip" Bittenbender of University of Hawaii-CTAHR, cacao extension specialist has provided technical support (micro-ferment/outreach)
Mel Jackson Sweet Green Fields has provided technical support (micro-ferment/outreach)
Susan Schenck has provided technical support (micro-ferment)
Chifumi Nagai has provided technical support (cultivar genetics)
Dan Nelis and Michelle Yamaguchi of Dole Food Company and Waialua Estate Chocolate have provided technical support (sample processing equipment)

Goals and Outcomes Achieved

Objective 1. Develop and optimize single pod fermentation methodology for use in assessing current flavor profiles of existing germplasm. This objective was met.

Outcome 1. Facilitate the use of single pod micro fermentation technology in Hawaii.
Ed Seguine of Seguine Cacao & Chocolate Advisors visited Hawaii and conducted a training session for HARC staff and others. A simplified sensory data rating system was developed for HARC and growers

(Simplified Rating System and Appendix C). HARC staff conducted tasting sessions for each of the chocolate samples and evaluated them using the simplified rating system.

In addition, Mr. Seguine also conducted a training on single cacao pod fermentation methodology, cacao bean drying, processing of the beans into cacao liquor and instructions on making chocolate from these samples.

A total of 48 individual tree single pod fermentations were completed and chocolate samples were made from each (Photos 1,2,3). The samples were sent to Seguine Cocoa & Chocolate Advisors for flavor profiling and evaluation. This resulted in the identification of several fine flavor cacao cultivars (Table 1).

Table 1. Cacao cultivars identified with a fine flavor profile utilizing the micro-fermentation method from HARC Maunawili variety garden. (Cultivar I.D. code)

1. MW-2017-01	5. MW-2017-08	9. MW-2017-13
2. MW-2017-04	6. MW-2017-09	10. MW-2017-14
3. MW-2017-06	7. MW-2017-10	11. MW-2017-15
4. MW-2017-07	8. MW-2017-13	12. MW-2017-17

Photo 1. Ripe cacao pods from selected cacao trees at Maunawili, Oahu

Photo 2. Selected ripe pods from cultivar MW-2017-07

Photo 3. Micro-ferment of beans from MW-2017-07

Objective 2. Initiate an outreach program to allow growers to have their cacao germplasm evaluated. This objective was met.

Outcome 2. An informational flyer was created to introduce and inform local Cacao farmers on the establishment and availability of the HARC Cocoa Flavor Profile and Small Batch Processing Service. This flyer included information on the purpose of the service, methods of processing and analysis, and professional collaborators and was included in the HCCA monthly newsletter, and available on the HARC web page. HCCA member farmers, including those from all four major Hawaiian Islands were e-mailed this flyer individually. Flyers were also distributed at the Parade of Farms event to current and prospective farmers. This is including in Appendix A.

HARC Cocoa Flavor Profile and Small Batch Processing Service
HARC web page
HCCA news letter
Email each HCCA member individually
Growers on each of the four major Hawaiian Islands were personally contracted.

Objective 3. Establishment of a low-cost service for individual cacao cultivar assessment. This objective was met.

Outcome 3. HARC Cacao flavor profile service was created using the protocols developed for single pod micro-fermentation, and processing standards established by Mr. Seguine for flavor profile evaluation sample preparation. An all-inclusive service that required local farmers only deliver ripe Cacao pods. All processing was done by HARC. Analysis was conducted by Mr. Seguine. This allowed for adherence to strict processing protocols, and reduction of experimental variables due to the

control of the fermentation, roasting, and milling of samples. Farmers were incentivized to participate in the service, by HARC providing the first sample evaluation for free. This has provided local farmers with a no cost opportunity to try the service.

Objective 4. Did the Grantee clearly convey completion of achieving outcomes by illustrating baseline data that has been gathered to date and showing the progress toward achieving set targets? Yes, this objective was met.

Outcome 4. In Hawaii, the data collected to date represents the baseline for individual cultivar flavor attribute analysis. To date, no other research has attempted to measure flavor attributes on an individual tree level. By determining fine flavor for individual cultivars, project staff have identified elite genetic material that can have major benefits for the growing Hawaiian Cacao industry. By disseminating this known material to local farmers will potentially increase crop value.

Objective 5. Did the grantee highlight the major successful outcomes of the project in quantifiable terms? Yes, this objective was met.

Outcome 5. Approximately 48 individual samples were processed, including three samples from local farmers. Of this, 12 of the 48 or 25% of the total amount evaluated, were determined to possess fine flavor attributes. The flavors that were determined to be the most desirable among all samples were Citric/ Fruity acidity, Fresh Tropical Fruit, Floral Flowers, and Nutty flavors. The samples that were selected exhibited one or more of these flavor attributes. More investigation is required to evaluate flavor change during life span of tree, as environmental conditions and inputs vary, and a better understanding of how desirable flavor attributes of selected clones may vary when planted at different sites.

Beneficiaries

The initial beneficiaries of this project are the many farmers in Hawaii who are currently planting or considering planting cacao orchards. By 2018, industry respondents predict an additional 100 plus acres will be planted; 80 on Oahu, 12 on Hawaii, 9 on Maui, and 1 on Kauai.

Downstream are the Hawaiian chocolate makers who would benefit from an increased local supply of high quality, Hawaii-grown beans and those growers who would prefer to produce their own specialty chocolate and need flavor information. A recent UH survey showed that 50% of existing cacao growers showed a keen interest in processing beans into their own chocolate, thus realizing all the potential value from the crop. The potential economic impact is to aid in developing a high-value specialty cacao industry in Hawaii by identifying cultivars with fine flavor and quality. Biosecurity is also enhanced by not importing cacao cultivars with potentially harmful diseases, but rather by developing local cultivars that have been evaluated and selected for fine flavored chocolate.

Direct beneficiaries of the project activities are the members of the Hawaii Cacao and Chocolate Association (https://hawaiichocolate.org/) that includes farmers as well as producers and friends of the industry as they will benefit from the identification of cultivars with fine flavor and quality that is a goal of the project.

The project purpose is to transfer a specialized micro-fermentation technology that enables accurate flavor analysis of small quantities of beans (i.e., from a single tree). Once identified, individual cacao trees with known fine flavor profiles will directly add-value to the crop. This can be as much 100% premium to commodity grade cacao beans. The farm gate price of fine flavor beans can be as much as $12.00 per pound, compared to commodity grade beans of $6.00 -$8.00 per pound.

Lessons Learned

- Micro fermentation technology is a powerful tool to evaluate individual cacao cultivars for flavor potential.
- Some but not all, of artisanal cacao and chocolate producers in Hawaii are very interested in identifying individual cacao cultivars with fine flavor potential.
- About 25% of the cacao trees sampled have fine flavor potential, thus not all cacao produced in Hawaiian is of specialty quality.
- These fine flavor cultivars may form the basis for an expanding specialty chocolate industry in Hawaii and is a mechanism for Hawaiian producers to add-value to their product.
- Research takes time, and isn't always predictable. Flexibility must be built into timeline and project expectations.
- Government agency support is essential, especially during developmental stages of an emerging industry such as cacao in Hawaii.
- Finding the right social conditions in which a project can flourish is essential. Owing to emergent nature of the Hawaii cacao industry, the current level of grower sophistication is generally low and there appears to be a reluctant to adapt new technologies.

Contact Information

Nick Dudley
Hawaii Agriculture Research Center
808-391-5421
Ndudley@harc-hspa.com

Additional Information

Appendix-A

HAWAII AGRICULTURE RESEARCH CENTER

Formerly Hawaiian Sugar Planters' Association

PO BOX 100, KUNIA, HAWAII 96759

TELEPHONE: (808) 621-1350 FAX: (808) 621-1359

http://www.harc-hspa.com

HARC Cocoa Flavor Profile and Small Batch Processing Service

Hawaii Agriculture Research Center (HARC) in collaboration with UH Manoa (CTAHR), Guittard Chocolate, and Seguine Cacao is providing small batch processing and flavor evaluation service for local cacao growers looking to evaluate the flavor profile of their trees.

This service allows local cacao growers to receive flavor analyses from trained tasters to evaluate the flavor attributes of their pods against international standards recognized by Cocoa of Excellence and the Fine Chocolate Industry Association.

The characterization of the flavor profile of cacao trees will provide growers valuable data on the flavor attributes of their productive cacao orchard on a scale from the whole orchard down to individual trees. This service provides the processing of fresh cacao pods, covering fermentation, drying, aging, and processing into chocolate liquor by HARC research technicians trained in micro batch cocoa processing. Processing protocols match those used in the Fine Chocolate Industry Association Heirloom program, Cocoa of Excellence competition and CAOBISCO international standards. The HARC flavor panel has been trained by Seguine Cacao and Chocolate Advisors using international flavor standards and attributes. For orchard evaluation growers provide at least 20 pods, fully ripe and freshly harvested to HARC for processing. Flavor analysis will be completed within 12 weeks from the date of pod delivery. This will provide adequate time for processing, including the critical aging of the dried beans to stabilize flavor. HARC will return prepared liquor samples and flavor attribute scores confidentially to the submitter.

Upon completion of the analysis by HARC Cocoa Flavor Profile and Small Batch Processing Service, growers will receive comprehensive flavor data, a valuable tool for future cacao production. By meeting the international standards for processing and flavor analysis, growers will be equipped with reliable data that will quantitatively relate the flavor attributes of their cacao to that of the international marketplace.

Please contact ndudley@harc-hspa.com for further information:

****

Appendix-B: Maunawili Heirloom Varietal Evaluation

These are the evaluation summaries of the best samples submitted to Ed Seguine. They were produced using the HARC fermentation protocol. This provides detailed information on the flavor produced by the individual genetics of a specific cultivar. This data defines that quality and value of HARC cacao cultivars.

A total of 40 cultivars were evaluated for this project. Those below were the highest rated for fine flavor. For a more precise examination of the flavor traits possessed by individual cultivars. HARC micro-fermentation protocol was developed and used to individually ferment each sample. The other measurements such as Pod yield per Season, Beans per Pod, Wet and Dry Bean weights, and Pod Length and Circumference were taken to further differentiate and evaluate individual cultivars, and evaluate if they possessed any other desirable traits.

MW-2017-01 (Sample I.D. 9811)
Color: Medium to lighter brown with yellowish hues
Aroma: Mild, light chocolate with light fruit notes

Flavor: Very smooth profile with low bitterness and astringency. Chocolate is low but in balance with the bitterness and astringency. Mild yellow fruit notes with a nut character--clean and quite good. CoEx 9.0

Pod Yield per Harvest Season: 43
Beans per Pod: 42
Wet/Dry Bean Weight: 2.52g/0.81g
Pod Length/Circumference: 9.25in/7in

MW-2017-04 (9400 Sample I.D.)
Color: Medium Brown
Aroma: Bright, slight acidity, fruity
Flavor: Low in chocolate intensity but moderate acidity primarily fresh fruit driving a range of fresh fruit notes. Clean and bright. Good balance (fresh fruit, slightly longer fermentation 6-6 ½ days) add cocoa intensity. CoEx 8.0

Pod Yield per Harvest Season: 43
Beans per Pod Average: 44
Wet/Dry Bean Weight: 2.04g/0.72g
Pod Length/Circumference: 9.5in/7.25in

MW-2017-06 (Sample I.D. 9814)
Color: Medium to lighter brown
Aroma: Very mild with mild nut notes.
Flavor: Low roast overall with very low bitterness but also low chocolate. This is a study in primarily nut notes with nut skins and mild fresh fruits. Very interesting, would have a high chance to score well in CoEx as well as Heirloom. CoEx 9.0

Pod Yield per Harvest Season: 42
Beans per Pod Average: 44
Wet/Dry Bean Weight: 2.35g/0.87g
Pod Length/Circumference: 9in/10.5in

MW-2017-07 (Sample I.D. 9817)
Color: Medium brown
Aroma: Floral flowers, resins, and fresh fruit
Flavor: BAM! Intense floral notes with fresh tropical fruit notes. Unfortunately, the astringency is aggressive. Some gentle adjustments of the fermentation should be able to re-balance and preserve fruit and floral notes but bring down the astringency. This is similar to the clone TSH 919 in the intensity of the floral character. Interestingly, the astringency cleans up really well in the mouth, as opposed to a badly under fermented astringency.

Pod Yield per Harvest Season: 47
Beans per Pod Average: 41
Wet/Dry Bean Weight: 2.53g/0.91g
Pod Length/Circumference: 10.5in/7.75in

MW-2017-08 (Sample I.D. 9819)
Color: Medium to slightly darker brown
Aroma: Chocolate
Flavor: Notable chocolate notes. Interesting balance in browned roasted, dark wood and the chocolate but the astringency is slightly high. Does have some interesting browned fruit and floral notes--primarily earthy with some herbal.

Pod Yield per Harvest Season: 51
Beans per Pod Average: 42
Wet/Dry Bean Weight: 2.15g/0.89g
Pod Length/Circumference: 8in/11in

MW-2017-09 (Sample I.D.9822)
Color: Medium brown
Aroma: Mild chocolate and nuts/nut skins but slightly on the raw side.
Flavor: Slightly on the raw side. Flavor does express chocolate, with some fresh fruits and wood and nut notes. CoEx 8.0

Pod Yield per Harvest Season: 30
Beans per Pod Average: 42
Wet/Dry Bean Weight: 2.62g/0.94g
Pod Length/Circumference: 10in/9.5in

MW-2017-10 (Sample I.D. 9826)
Color: Medium brown with reddish hues. Very attractive.
Aroma: Very mild, wood, nuts, slight browned
Flavor: Interesting complex of flavors including fruit acidity and fresh citrus and floral tropical fruit notes. Does display some nut and nut skins notes. Good. CoEx 8.

Pod Yield per Harvest Season: 60
Beans per Pod Average: 41
Wet/Dry Bean Weight: 2.4g/0.93g
Pod Length/Circumference: 9in/11in

MW-2017-13 (Sample I.D. 9401)
Color: Medium brown with darker and slightly yellowish hues
Aroma: Smooth, rich chocolate and some dark fruit notes
Flavor: Complex with lots of smooth chocolate, low bitterness and astringency, and complex range of fresh fruit, floral and browned fruit notes (floral notes, layers of complexities) award winning level.
CoEx (N/A)

Pod Yield per Harvest Season: 30
Beans per Pod Average: 45
Wet/Dry Bean Weight: 2.75g/1.1g
Pod Length/Circumference: 9in/14.5in

MW-2017-14 (Sample I.D. 9832)
Color: Medium brown with rich hues, slightly on the dark side.
Aroma: Very mild, very. Some mild roasted nut notes
Flavor: Smooth flavor profile with low bitterness and clear nut and nut skins notes that come off quite smoothly. CoEx 8.0

Pod Yield per Harvest Season: 42
Beans per Pod Average: 44
Wet/Dry Bean Weight: 1.95g/0.96g
Pod Length/Circumference: 9in/8in

MW-2017-15 (Sample I.D. 9397)
Color: Rich medium brown
Aroma: Mild with chocolate and browned notes
Flavor: Smooth chocolate profile though lower with browned fruit (dates) and mild fruit acidity. CoEx (N/A)

Pod Yield per Harvest Season: 50
Beans per Pod: 35
Wet/Dry Bean Weight: 2.5g/0.97g
Pod Length/Circumference: 9in/11.5in

MW-2017-17 ((Sample I.D. 9776)
Color: Medium Brown with slight yellowish hues
Aroma: Slightly acidic, fresh citrus and tropical fruit note, mild browned, low chocolate notes
Flavor: Chocolate base is on the slightly lower side but is supplemented by an immediate sharp citric/ascorbic acidity that is associated with fresh citrus and tropical fruit flavors. Dominated by the fruit notes. CoEx (N/A)

Pod Yield per Harvest Season: 28
Beans per Pod: 39
Wet/Dry Bean Weight: 2.6/0.96g
Pod Length/Circumference: 13in/11.5in

MW Composite #1 (Sample I.D. 9401)
Color: Medium to slightly lighter brown
Aroma: Mild with mild browned fruit character
Flavor: Moderate to pronounced cocoa with mild acidity. Balanced bitterness and slightly increased astringency with browned fruit and over ripe fruit notes. CoEx (N/A)

****

Appendix C: Cacao Flavor Descriptors

Cocoa Flavor Profile (CoEx): Glossary of terms for flavour evaluations with matching descriptors and examples of some origins/reference notes for calibration. Reference: *Ed Seguine and Darin Sukha, CoEx Edition 2015*	
Meaning	
None present	
Just a trace and may not be found if tasted again	
Present in the sample	
Clearly characterizing the sample	
Dominant	
Maximum that you have experienced	

Description	**Examples of Origins/References (for calibration)**
Describes the typical flavour of cocoa beans that are well fermented, roasted and free of defects - Chocolate bars, fermented/roasted cocoa	Low intensity = 1 - 2, (Unfermented cocoa)
	Medium intensity = 4 - 6, (Fully Fermented Indonesia, PNG, and Arriba)
	Strong intensity = 8, (West Africa)
Citric Acid – Fruit	Low intensity = 0 - 2, (West Africa)
Acetic Acid – Vinegar (you can smell it in the sample)	Medium = 3, (Arriba)
Lactic Acid – Vomit like, like in sour milk or molasses	Strong = 4 – 8, (PNG and Malaysia
Mineral Acid – Metallic tasting	
Usually due to a lack of fermentation; perceived on the rear of the tongue/throat – Caffeine (Coffee), Beer, Grapefruit	Low intensity=1-2 (ancient criollo)
	Low/Moderate (normal) intensity =3-4 , (West Africa)
	Strong intensity = 7-8, (Unfermented cocoa
Usually due to a lack of fermentation; mouth drying and/or puckering effect which boosts the production of saliva; perceived between tongue and palate or at the back of the front teeth. – raw nut skins, Banana skins, some wines	Low intensity=2-3 (ancient criollo)
	Moderate (normal) intensity = 3 - 4, (some West Africa)
	Medium intensity = 5-6, (Arriba)
	Strong intensity = 7 - 8, (Unfermented cocoa)
Describes liquors with a characteristic flavour of unrefined caramelised cane juice (Panela). – Caramel, brown sugar, fudge	Low intensity = 0, (West Africa - Ghana)
	Strong intensity = 5 - 8, ancient Criollo (Venezuela)
Broad range of fresh fruits	Low intensity = 1 - 2, (West Africa)

Fruit berry - currants, not fully ripe raspberry.	Medium intensity = 3 - 5 (Fully Fermented Indonesia,

Fruit citrus - essence of citrus.	Strong intensity = 6 - 7, (PNG, some Trinidad (TSH))
Fruit tropical - banana, passion fruit, orange, almost always some citrus note involved.	
Fruit dark tree - plum, dark cherry.	Low intensity = 2, (West Africa)
Fruit dried - dried apricot, banana etc. caramelization of fruit sugar, essence of a fruit that has undergone the drying process, sulphur and nutty notes also.	Medium intensity = 3 - 5 (Fully Fermented Indonesia,
Fruit over ripe - beginning of over fermentation, over ripe fruit as a step to over fermentation.	Strong intensity = 6 - 7, (PNG, Some Caribbean origins)
Fruit brown - prunes or dates.	
Nutty - nut meat	Frequently just as a note = 2–3 but can be pronounced 5-8 (ancient Criollo types),
Nut skins – associated with some astringent sensation like skins of almond and peanuts etc.	Too low roast or under fermentation of most origins
Broad range from green grassy vegetative to flowers and perfumed types notes	Absent - Low intensity = 0 - 2, (West Africa)
Floral - coming from natural environment you can get this by taking a walk in your garden, green earthy, herbal and woodsy.	Medium - Strong intensity =3 - 7, (Arriba, Scavina, some Trinidad (TSH))
Floral grassy - green on fresh cut grass, very fresh grass, young leaf (green floral).	Floral Orange Blossom - Peru, Ecuador
Floral green vegetative (dark green) - green vegetative, old cocoa leaf crushed, dark green note. Green beans, cooked bell peppers (dark green vegetables)	Ecuador origin beans tend to be floral, herbal, floral orange blossom, earthy.
Floral woodsy (generic) - was grown now dried essential oil, structural bases, going for walk in forest before winter, the dried flowers.	Floral mushroom and earthy are positive attributes (not earthy associated with off flavors musty, moldy etc.).
Floral mushroom - mushroom, meaty, savory, MSG.	
Floral earthy - forest after the rain, smell of dampness coming up from the cocoa estate soil.	
Floral Herbal - Aged dried spices. Commonality of all the dried herbs. and linked with astringency at times.	
Floral perfumy - a persistence that lingers like when fixatives (e.g. Vanilla) added to perfume to kick the smell into a persistent mode.	
Floral flowers - breathe it in and it’s gone. Difference between most roses and a Lincoln rose.	

Floral orange blossom - Is essentially floral-flowers but with orange blossom flavor specifically.	

Woody light wood - ash, beach, maple, white pine, cut cocoa tree.	Woody light wood and Woody resin are often (but not always) associated with under fermented and acidic beans
Woody dark wood - oak, walnut, teak.	Woody dark wood is often (but not always) associated with well fermented beans
Woody resin - pitch pine, balsam of dark or light tree resins.	
Spice tobacco - Tobacco spice is the smell outside a tobacco shop, not ashy and dirty but rather like pipe tobacco, sweet.	As a note = 1, or clearly present in the sample = 2 – 3.
Spice peppery - spicy, peppery, savory.	Spice tobacco from West Africa, particularly Ivorian beans.
	Spice peppery - mainly Columbian and Peruvian origins.
Goes beyond simple attributes but is intended to reflect an overall attribute standing. It is NOT a score derived from any formula or calculation from the attributes but stands on its own for each evaluator to indicate.	No off flavour must be present in giving a high scoring (>5) for Global Quality.
It gives an impression of <u>Overall</u> quality.	We expect the beans to be good and not have those defects. If they do, the overall quality would be not very good =1 – 4.
	Zero for global quality means a serious flaw is present. This is <u>not</u> a “veto” but is a very clear opinion of the quality—or in this case lack thereof
Hammy - carved meats, ham, and improper fermentation.	
Smoky - happens when burning vegetative matter (wood, grass, cocoa hulls etc) Other off flavors – cocoa contaminated with diesel fumes	
Leather - not freshly tanned in a leather store, but rather more like leather with sweat and urine, like horse saddles.	
Over fermented manure - farm yard, manure.	
Over fermented putrid - Feces.	
Dirty –unpleasant dirty character, like dirty utensils, often associated with quality of astringency, increased astringency = increased dirty flavor etc. Function of dusty.	
Bark wood - not good, typically unpleasant, dry, dusty, smelly, not a clean smell. Under fermented, astringency, raw, leather, dirty tend to be associated with bark wood as well.	

The Moringa Crop Natural Farming Project

Final Report

Tri-Isle Resource Conservation & Development Council, Inc.
http://tri-isle.org/

Project Summary

The Moringa Crop Natural Farming Project was designed to be both an investigation of growing Moringa for multiple uses as well as an educational project for new farmers interested in growing moringa on their farms. Beginning on December 18, 2015, a two-acre parcel on Maui's dry and windy west side, was prepared by farm apprentices from the Hawaii Farmers Union United (HFUU) Farm Apprentice Mentoring (FAM) Program. By March 2016, over 4321 trees were planted on Simpli-Fresh Farm, the farm of Project Site Manager, James Simpliciano. Over the course of the two-year project, the project staff worked to ensure high yield and quality by selecting well-adapted Moringa varieties for food production including fresh leaf for Asian markets, a powdered superfood, the pressing of seed for oil and as a substrate for mulching. Korean Natural Farming methods were used to strengthen plants in the face of pests, wind and lack of water. Since variety selection and evaluations have been identified as activities of high importance to Extension Service Agents and growers, a primary focus of this project was to use well established performance practices by apprentice growers to evaluate and optimize grower profits through enhanced quality and reduced costs of production. The project resulted in knowing where the markets are, how to reach them, and how to brand the HFUU product. The most important result was the dozens of farmers including five that graduated as FAM apprentices on Maui who are interested in growing Moringa.

Project Approach

The Moringa Tree is already an important nutritional and multipurpose crop in tropical environments throughout world. Hawaii's College of Tropical Agriculture and Human Resources (CTAHR) has researched the viability of Moringa as a highly nutritious and viable commercial crop for Hawaii. Dr. Theodore J.K. Radovich, Associate Specialist for Sustainable and Organic Farming Systems for UH-Manoa, Department of Tropical Plant and Soil Sciences has done extensive research on Moringa (Moringa oleifera) and was a valuable resource. One important result of his research was to determine the economic viability of the crop for Hawaii. Dr. Radovich found that the cost of growing Moringa is estimated at less than $5,000/acre, not including operating overhead. His research reinforced that Moringa is an important vegetable and oil crop for Hawaii and that the genus Moringa includes several multi-purpose species that are receiving increased attention worldwide because of their potential to enhance health, nutrition and revenue generation in the tropics. The leaves of Moringa oleifera are well regarded for their high concentration of nutrients, particularly protein. The pods of Moringa oleifera are also consumed and the seeds yield a high value oil that has potential culinary, cosmetic and biofuel applications. Almost all parts of the tree are used for food, oil, fiber and medicine.

The Moringa Natural Farming Project had two purposes. 1) Provided an on-farm mentoring opportunity for farmer apprentices to learn how to establish the financial viability of the Moringa tree as a commercial food and superfood crop for local markets and as an export for small indigenous

farmers in Hawaii; and 2) combined fertilizer and amendment applications for use in Korean Natural Farming.

Farmer and mentor, James Simpliciano, grew Moringa on a two-acre plot on his Simpli-Fresh Farm on Maui's dry west side. The Moringa was grown for the purposes of 1) commercial marketing of the Moringa fresh greens for Asian food markets; 2) powdered superfood from dehydrated leaf for health-conscious customers; 3) dropped leaves and bark from coppicing for mulch; and 4) research the sale oil from crushed seed pods. Farm apprentices from the (HFUU) FAM Program on Maui participated in all aspects of the planning, growing, marketing and distribution of the Moringa crop. The apprentices learned to keep careful records and under supervision from HFUU and FAM administrators, they were able to create the basis of a feasibility and business plan for the Maui County funded FAM project. The results of the project will be shared with farmers statewide with HFUU's Kauai, Big Island and Oahu chapter members engaged in both commercial and Korean Natural Farming.

Goals and Outcomes Achieved

Outcome #1

Goal: The project will increase the production of Moringa trees for food, medicinal/superfood, substrate and fermented plant juice for sale in local or export markets.

Performance Measure: Number of FAM participants committed to planting more acres of Moringa after second cohort of the FAM Program.

Benchmark: None of the FAM participants are committed to planting Moringa.

Target: To have at least 50% of the FAM participants committed to planting more acres of Moringa by project end.

Outcome Achieved

One goal of the program was that the Moringa Project serve as an educational venue for future farmers on Maui. Six FAM apprentices worked on the early and mid-term stages of the Moringa Project as paid Assistant Site Managers. Part of the job besides planting, laying weed mat, maintaining the fields, and helping with crop fertilization, was to help create the information needed for a feasibility study and business plan. Decisions were made with the Site Manager and HFUU staff on what equipment and supplies were needed and by when. A feasibility study and business plan model were introduced to the apprentices and is still in process with two years of data recorded (see example below) in spreadsheets maintained and updated by the apprentices with oversight by the Site Manager and Program Manager. By the end of the project, three of the apprentices committed to growing Moringa on land that they are farming or plan to farm, having learned best practices of growing moringa.

Three FAM apprentices drew up a crop monitoring plan, expense and income reports, and eventually engaged in the data collection activities to determine the economic viability of the project.

Five different experiments were conducted, one in a certified commercial kitchen to measure drying time and yield, one in a large processing center for Spirulina to determine if higher production methods were feasible as demand increased, and two experiments were conducted in a solar dehydrator, which was a 20-ft. container coupled with a leased commercial kitchen, which was to process the land dried Moringa into powder using a purchased pulverizer.

In addition, the FY17 FAM program did their Harvest-Post Harvest module on-farm demonstration on Simpli-Fresh farm. Five apprentices helped to harvest fresh leaf (41 lbs. of both India (16 lbs.) and UH-Manoa (25 lbs.) from the trees. The raw leaf was hung in the solar dryer container and three days later, eight apprentices took the now dried leaf to Simpli-Fresh farm's leased commercial kitchen where the sticks and yellow leaves were removed and the dehydrated leaf was processed with the project's pulverizer, bagged and labeled. The yield for the Indian was 11 oz dried powder @$10/oz. gross =$110 and UH yielded 57.6 oz @ $10/oz = $576 gross. One of the conclusions of the feasibility study was that the labor and commercial space to harvest and process the Moringa was cost prohibitive. At that point the Site Managers and Assistant Site Managers (FAM apprentices) went back to discussions about options for large scale production, perhaps in another facility.

Two acres of trees started to seed all at once and the project staff used the feasibility study template to determine if selling the seed to interested buyers would be more lucrative than pressing them into oil. The project staff harvested 33 lbs. of seeds and conducted an experiment in collaboration with Pacific Biodiesel, asking Pacific Diesel to press the seeds into oil. The FAM Apprentices' business plan included research on the benefits of using moringa seed oil for cooking, and compared to its sister olive oil, with Moringa having anti-aging, acne, and dozens of other uses including water purification. This part of the feasibility study will be completed in the future and not part of this project.

Nine FAM Apprentices, Site Manager James Simpliciano, and Project Manager, Phyllis Robinson all took a 12-week class in FAM Program Regenerative Farm Business Planning with David Fisher. A business plan template was filled in based on project inputs, e.g. capital expenditures, labor, transportation, supplies, water and the productivity forecasts based on research for each Moringa tree planted. The crop production plan measured all outputs, costs of marketing and distribution, sales, and final income for the project (see lessons learned below).

Beneficiaries

As a chef, the Moringa Project's Site Manager, James Simpliciano introduced Moringa to the renown chefs in the resort communities of Ka'anapali and Lahaina. The chefs benefitted from the project through the introduction and some have incorporated Moringa into their menus.

In the two years of the Moringa Project, project staff shared the project's benefits and challenges through 30-minute presentations to three (of the four) monthly HFUU Maui Chapters' locavore pot luck meetings. During the meetings, Site Manager Simpliciano convinced 10 chefs to use Moringa for their dish at the locavore potluck dinners and then explain to the crowd of between 60-100 people, including many farmers, the cultural history of Kalamunggay (Moringa), how it can be used as a spice in Filipino cooking and its health benefits. And, for the farmers, Site Manager Simpliciano described the growing tenacity and drought resistance of Moringa. Chefs included: Sheldon Simeon, Kyle Kawakami,

Rob Mason, Mark Ellman, Chris Schobel, Angel Green, Jeff Sheer, Gevin Utrillo, Alvin Sevilla, and Charlie Owen. The impact of the meetings and dinners created a demand for Moringa with the chefs and the chefs have started purchasing Moringa!

The Site Manager, through the Simpli-Fresh website, established relationships with chefs from abroad when they would visit his farm. This included private chefs from Korea, Japan, Canada, and France. With their contact information, they became potential beneficiaries for the export of the Moringa as both fresh leaf and powder.

During two of the Maui Ag Fests and two Grown-on-Maui events, two of the chefs used Moringa powder for their dishes and won first place. Chef Gevin Utrillo, of the Hyatt's Japango Restaurant, made a moringa scone. He won using the Moringa powder in the scone, adding ice cream and Kula strawberries. The next winning chef was Alvin Sevilla from Banyan Tree at the Ritz Carlton. He made a Moringa chimichurri with braised beef cheeks and a poached egg. Beneficiaries were the chefs whose efforts to use Moringa were rewarded with first place awards!

By the end of the project, two apprentices had decided to expand their growing of Moringa onto adjacent land. In addition, several HFUU Farmers and one of HFUU Farm Apprentice Mentoring (FAM) Program apprentices expressed an interest in growing Moringa on their farm. Through the project presentations, the apprentices are realizing the benefits of growing Moringa on their own land. Kalo Farmer, Bobby Pahia of Aina Ola Farm and his partners Victorino Manzano and Jeremy Spencer and FAM apprentice, Vicki Shortell have carefully followed this project. Vicki learned about the Moringa Project through the FAM program, has decided to introduce Moringa on her three-acre farm in Haiku, Maui. She also purchased Moringa to try it out in her tea business. It will be interesting to see how the Moringa crop fares in the wetness of Haiku winters.

Lessons Learned

Challenge

Originally, this project was to take place on two farms, each with a Site Manager. One Site Manager was called away and the project continued with only one Site Manager, which resulted in the fields not always maintained properly.

Corrective Action

The Project Manager, with approval from the HDOA, moved the funding from the second Site Manager position to hire four Assistant Site Managers, three of which were FAM apprentices who had been working on the project as volunteers and as an educator/administrator, which was as asset to the project. This action enabled the apprentices to see the value of trying different crop practices to establish the best growth conditions for the crop.

Challenge

Another challenge for the project was the lack of water. The lack of water was magnified because the neighboring farms that share the water use conventional methods of agriculture, which requires a greater amount of water than for the Korean Natural Farming method. There was a period of 10 days of no water after a flash flood, when boulders clogged the system and had to be removed. Young Moringa seedlings suffered and with no water for 10 days, their growth was slower.

The water on the farm is deemed "ag water" and not potable, which prevents the farm, Simpli-Fresh Farm, from achieving organic certification. Site Manager James also learned that "ag water" cannot be used to wash produce for commercial sale. The challenge for the project staff was to bring potable water to the farm.

Corrective action

The solution would have been a catchment system, however, the cost of installing a system on the farm was prohibitive. The project staff found a commercial kitchen where the crops could be washed and dried, however, travel to and from the commercial kitchen was time-consuming and took the staff off the farm. The Simpli-Fresh Farm owner is researching potable water filters and sterilization using infrared lights on the farm.

Challenge

The farm is in a dry and dusty part of Maui Island with a well-traveled shared road which creates a great deal of dust that settles on the crops, creating an opportunity for dust mites. The white diamond back butterfly moth was problematic as well.

Corrective action

Project staff implemented Korean Natural Farming methods to help with biological control and used the JADAM Moringa plant juice as a fertilizer helped to mitigate some of the problems.

Challenge

The feasibility study included research into various approaches to processing Moringa and led to the purchase a pulverizer that could process 40 lbs. of Moringa per hour and the creation of a solar dryer in a 20-foot container that used a solar attic fan and an air conditioner to dry the leaves in 24 to 36 hours, depending on humidity levels. This would be adequate production if the project was to stay as a cottage industry, which would not likely motivate or be of interest to new farmers. Additionally, as the project staff conducted harvest/post-harvest testing and documenting of the results, it became clear that this method was very labor intensive. Operational costs on Maui are high, and with the cost of farm labor and commercial space competing with jobs and rentals for the visitor industry, project staff concluded that a value-added Moringa product produced with this method would need to be priced higher than the market to be profitable.

Corrective Action

Moringa is a prolific crop with high yields. The project staff remain confident of the high demand for the Moringa product and found a company on Hawaii Island that had a GW3 refractor window dryer that could process 1,000 lbs. of Moringa per hour into a product that was water soluble. This corrective action, however, is not feasible at this time as the raw material would need to be in liquid form (which would be costly to produce) and use of the machine is $100/hour. The project staff are buoyed that there is a solution and are considering options in their business plan. The project will continue to process Moringa using the pulverizer and solar dryer to provide product to their customer base and to maintain production at a cottage industry level.

Challenge

Local and global competitors that buy the powdered Moringa from India or Africa, encapsulate or package as powder, will label the retail product as "Maui Moringa" or similar. These products are sold at half the price of the locally grown and processed product and have not nutritional breakdown on

their packaging. Some companies will buy the Maui Moringa seed, grow out the product in Mexico and ship the processed product back to Maui where it is sold as "Maui Moringa".
When apprentices learned of these competitors, two left the program at the end of the project because they determined the competing products would make it difficult to have a profitable business.

Corrective Action:

The Site Manager James enrolled in courses to create value-added products offered at the Maui Food Innovation Center and learned about marketing and branding, and participated in workshops offered by the USDA, the Hawaii Department Agriculture and the County of Maui. Through these activities, he has learned about branding programs such as the "Made in Hawaii with Aloha", the Hawaii Seal of Quality and the Made in Maui labels. With the new label showing the nutritional analysis as corrective actions, the project intends to create a new market of consumers interested in purchasing a certified "Local" product. There is interest in a locally produced product from Hong Kong, SAR China, Australia, Canada, Dubai, and the mainland. Through this project, the staff understands the value of organic certification and will pursue certification. Showing the USDA Organic on the packaging will further distinguish the product.

Summary of Lessons Learned from the Site Manager:
I have learned enough from these two years that I feel confident to provide recommendations or advice that others may use to improve their performance in implementing similar projects:

- *Have adequate, reliable labor, but keep the cost of labor down through utilizing internships and apprenticeships as learning opportunities without promise of profit in the early stages.*
- *Prepare the surrounding area with windbreak and weed barriers before crops are planted to assure a successful crop.*
- *Investigate the competition; project staff found that there were other businesses processing powder and pressing moringa oil. I believe, however, that through proper education of farmers to grow the crop and to consumers about the nutritional value of the crop, there is still room for growth in this industry for local residences and farmers.*
- *Apply for organic certification to compete with the world market.*
- *Learn from the project and correct and improve the business plan.*
- *Rely on your "village" to make the product. In this case , the project was supported by family and friends, farming organizations, the University of Hawaii Staff, Kamehameha Schools, and Apprentices.*

Contact Information

Project Manager, Phyllis Robinson, pfierrorob@aol.com, (808) 647-4066
Project Site Manager, James Simpliciano, jsimpliciano@gmail.com, (808) 269-2626