WR Committee

From: cpinick@harc-hspa.com
Sent: Monday, March 19, 2018 3:59 PM
To: WR Committee
Cc: ndudley@harc-hspa.com
Subject: Watershed Management and Protection (WR-5)
Attachments: Attachment information; Koa quarterly rpts.pdf

Importance: High

Follow Up Flag: Follow up
Flag Status: Flagged

Mr. Alika Atay,

In response to your request, the koa project's quarterly reports to Maui Department of Water Supply are attached as follows:
Oct-Dec 2016
Jan-Mar 2017
Apr-June2017
Oct-Dec 2017
Final Rpt 2017

Due to the last minute request, the attached is what we are able to provide before your meeting on March 20.

Further, please note the koa project does not participate in invasive species eradication.

Please contact Nicklos Dudley, koa program manager, if you have additional questions.

Aloha,
Cindy Pinick
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Maui Koa Network
Developing Improved Wilt Resistant *Acacia koa* for Maui Watershed Restoration and Reforestation

Quarterly Report: October – December 31, 2016

1. Tasks Completed during the period:

A)Project planning and coordination for the Maui Koa Network.

i)Development of distribution plan for koa seed.

ii)Future Seed banking efforts with partners

iii)Scheduling the installation of the koa orchard seed site at Haleaimakawi, Leeward Haleakala with our project partners, Haleakala Ranch and Leeward Haleakala Watershed Restoration Partnership

B) On-going site maintenance at Kula Forest Reserve, Mahanalua, Windward Haleakala Ranch site, and Ulupalakua Ranch koa site.

i)The first thinning of the seed orchard and continued site maintenance at the Ulupalakua Ranch koa site

ii)Koa seed was sown for the leeward Haleakala (Haleaimakawi) disease resistant seed orchard site. There are about 30 different koa families representing the leeward Haleakala eco-region

2. Description of work completed

A)We continue to work with our partners to establish and maintain a network of wilt-resistant koa demonstration sites for seed production.

i)A draft distribution plan for Maui koa seed orchards was developed and distributed for input to the Department of Water Supply and our partners. Going forward with input from our partners, the plan will be refined. It is hoped, a final draft can be completed during the first half of 2017.

ii)Future koa seed banking efforts were discussed with partners. Leeward Haleakala Watershed Restoration Partnership and Pu'u Kukui Watershed Partnership are very interested in assisting and will provide inputs as planning proceeds.

iii)Koa wilt resistance seed orchard at the Haleaimakawi Koa Exclosure Site, Leeward Haleakala Ranch is now scheduled to be planted in February. Based on seedlings survival data from the leeward Haleakala eco-region screening trial, approximately 30 koa families were selected for high levels of tolerance to koa wilt.

B) At Kula Forest Reserve, Mahanaula, Haleakala Ranch, and Ulupalakua Ranch koa sites, the exclosure fence lines were inspected and clearing was done. Rat control discontinued at Ulupakakua and Mahanaula sites as this problem now appears to be under control.

Tree growth performance data was collected at both Mahanaula, Haleakala Ranch and Ulupalakua sites.

C) The first thinning of about 50% of the stand was completed at the Ulupalakua Ranch koa seed orchard site. The thinning or rouging was based on analysis from annual tree growth and survival data. The trial was rouged by ranking families and selecting best individual trees within families. These management activities are designed to increase tree canopy development and vigor. This is especially important for seed production.

E) In Kind Project Assistance

During this period, 100 hours of volunteer time was recorded. I would like to especially acknowledge the assistance of Lance DeSilva and Keali'i Kimokeo, of the Maui Division of Forestry and Wildlife for their assistance in maintaining koa planting at the Kula Forest Reserve Site. Diana Crowe of Ulupalakua Ranch, Andrea Buckman, Keahi Bustamente and other members of the field crew members of the Leeward Haleakala Watershed Partnership for their help with maintaining the koa sites at both Haleakala and Ulupalakua Ranches.

F) Outreach: The manuscript "Applied Genetic Conservation of Hawaiian Acacia koa: An Eco-Regional Approach" is now in press. See Appendix 2.

Summary:

About 6 acres of site maintenance work was performed which include weed control, fertilization and thinning to promote improved stem form at the koa sites on the windward slopes of Haleakala Crater during this time-period. In addition, about 500 acres of leeward Haleakala forest land was surveyed for overall forest health as well as koa flowering and seed production.

Appendix 1.

(DRAFT)
DISTRIBUTION PLAN for MAUI COOPERATIVE KOA SEED ORCHARDS

THE XXXX ORCHARD

The objective of this management agreement (the "AGREEMENT") is to document the operations, financing, seed distribution, and obligations of COOPERATORS in the Cooperative Seed Orchard (the "XXXX ORCHARD"):

COOPERATORS ORCHARD are:

- Land owners (LO)
- Maui Department of Water Supply (MDWS
- Hawaii Agriculture Research Center (HARC)
- XXX-others

(Collectively, the "COOPERATORS").

The goal of the COOPERATIVE ORCHARD MAUI is to produce, in a cost effective manner, targeted quantities of well-adapted and genetically improved Koa seed for reforestation projects on forestland owned or managed by the COOPERATORS and by Maui's non-industrial private forest landowners.

Location
The Maui Cooperative ORCHARD is located on land owned, or leased by XXX in TMK. (GPS coordinates)

Operation:
The field operation of the Cooperative Orchard will be the responsibility of HARC. The Seed Orchard Manager will be in direct charge of operations at the site and will be responsible for obtaining the necessary personnel, supplies, and equipment, and for supervising work at the ORCHARD.

*In addition, the Seed Orchard Manager will function as a liaison between COOPERATORS, and for cost accounting and billing COOPERATORS.[May not be necessary??]

Management Committee of the Maui Cooperative ORCHARD:
A Management Committee consisting of one representative from each of the COOPERATORS (the "Management Committee") will be formed and will include but not be limited to the following responsibilities

1. Select a "Cooperative Lead" from amongst the members of the Management Committee, to organize and manage cooperative meetings, keep notes, facilitate cooperative decision making, and determine orchard strategies and future development.

2. Assist in the formulation of management policies for the ORCHARD.
3. Review and approve yearly operating budgets for the ORCHARD.
4. Define seed production goals for the ORCHARD both for the short- and long-term.
5. Develop a yearly work plan for the ORCHARD to include defined objectives, scheduled work activities, anticipated costs, and priorities for completion of tasks.
6. Formulation of long-range ORCHARD development plans.
7. The COOPERATORS understand and agree that no amendment to this AGREEMENT will be required if the Management Committee decides to add new members, change cost shares, or both.

The Management Committee may, from time to time, solicit technical guidance and assistance from USFS, DOFAW, HARC, and others.

All decisions by the Management Committee will be by unanimous agreement of Management Committee members.

The Management Committee will meet at least once each year. The Management Committee will complete work plans for each fiscal year before the start of each fiscal year (July1?).

Size:

The ORCHARD will comprise wilt resistance Koa selections, based upon current selections and the phased integration of new selections over time, and will occupy XX acres of the Orchard Complex.

*The Management Committee may increase or decrease orchard acreage depending upon seed needs of COOPERATORS and long-range plans developed by the Management Committee. The COOPERATORS understand and agree that no amendment to this AGREEMENT will be required if the Management Committee decides to increase or decrease the land area occupied by the COOPERATIVE ORCHARD. [May not be necessary??]

Financing (Need to be refined)

The expense of managing and operating the COOPERATIVE ORCHARD (the "Operating Expenses") will be $XX. The individual share or rate of Operating Expenses that must be paid by each Cooperator (the "Payment Rate") will be a prorated percentage based on need for ORCHARD seed as follows:

Cooperator	*Seed needs (lbs/year)*	*Payment Rate*
LO	XX	XX%
Others	XX	XX%
HARC	XX	XX%
Total		100.00%

The two categories of Operating Expenses include, but are not limited to, the following:

1. Direct Expenses. These expenses will include, but not be limited to, all costs associated with the establishment, maintenance, and management of the MAUI COOPERATIVE ORCHARD, such as cost of seedlings, planting, tags and tagging, weed control, cultivation, thinning, roguing, pollinations, seed collections, seed processing, and miscellaneous orchard maintenance project costs.

2. General Orchard Complex Expenses. These expenses will include, but not be limited to, costs associated with overhead supervision costs, such as insurance, equipment rental and purchase, road maintenance, and other miscellaneous expenses.

Any changes in a Cooperator's percentage of financial participation and percentage of seed share in the MAUI COOPERATIVE ORCHARD will require written agreement of the Management Committee.

Seed Distribution (refine)

The COOPERATORS understand and agree that the DOWAF/HARC Forest Tree Seed Bank reserves the right to purchase up to XX percent (XX%) of all annual seed production in the MAUI COOPERATIVE Orchard for use by non-industrial private forest landowners. Seed will be purchased by the Seed Bank at COST (see definitions under COST). [A "non-industrial private forest landowner" is a landowner with fewer than 1,000 acres of forestland and with no wood production facility. Is this the definition wanted? And /or Forest Stewardship Participant / Maui watershed restoration partnership?]

Customers of the Forest Tree Seed Bank are required to sign a purchase agreement, which certifies that he, she or it (1) is a non-industrial private forest landowner, a non-industrial private forest association or organization, or a public or private nursery serving non-industrial private forest landowners, (2) will plant or grow seedlings with all seed purchased and will not resell seed, (3) will grow seedlings for reforestation or afforestation purposes only and will not grow seedlings for ornamental use, (4) if the customer is a nursery, it will sell on a priority basis all seedlings to Hawaii non-industrial private forest landowners, and will give non-industrial private forest landowners ample opportunity to purchase all seedlings, with surpluses released to other landowners only at the end of the sales season, and (5) will provide annual reports to the Forest Tree Seed Bank.

The remaining seed produced annually will be distributed to the COOPERATORS in the same percentages (Payment Rates) as stated for Financing. All seed is owned by COOPERATORS, who pay for it through their share of the Operating Expenses.

Surplus seed

The COOPERATORS understand and agree that if any Cooperator desires to sell seed originating from the MAUI COOPERATIVE ORCHARD, other than the sale by the Seed Bank for use by non-industrial private forest landowners, each of the other COOPERATORS will have the right of first refusal to purchase the seed, which will be offered at COST. If other

COOPERATORS choose not to purchase the seed, it may be sold on the open market. The amount of surplus seed offered to and available for purchase by other COOPERATORS under this provision shall be in proportion to each Cooperator's Payment Rate specified in the Financing section of this AGREEMENT. Seed purchased by a Cooperator under this provision shall be used only for that Cooperator's reforestation needs and may not be resold or traded by the purchasing Cooperator.

The sale price of control-pollinated seed among COOPERATORS will be determined through direct negotiations of the COOPERATORS involved.

COST

Cost of seed produced by the MAUI COOPERATIVE ORCHARD in any year will include these components:

a. Establishment Expenses - Future value of monies expended by COOPERATORS, including yearly operating expenses, calculated at an interest rate that is equivalent to the published monthly rate for December of each year by the Department of Treasury, Short Term Fund, compounded annually from the end of the year of each expenditure up to the beginning of the year when seed production meets or exceeds targeted goals.

b. Yearly Operating Expenses - Total operating expenses for each year for the MAUI COOPERATVIE ORCHARD.

c. Seed Production - Annual seed production for the MAUI COOPERATIVE ORCHARD.

Computation of Cost Per Pound – Average of Yearly Operating Expenses after orchard seed production meets or exceeds targeted goal plus annual establishment expenses; divided by average annual seed production.

For the first five years of seed production, average Yearly Operating Expenses and average annual seed production will be based on the sum total of years to date since production began. Starting in year 6, Yearly Operating Expense and annual seed production averages will be based on the last five (5) years as a moving average.

The Seed Orchard Manager will calculate COST of seed produced and will communicate information to COOPERATORS as part of the normal cost accounting procedure. Cost of seed produced, calculated for the year prior to the year in which surplus orchard seed is sold, shall establish cost of seed produced on any such sales irrespective of the year seed was produced. This will prevent unnecessary confusion when surplus seed is sold among COOPERATORS, which may include seedlots from several different crop years.

Changes to Cooperator's percentage participation

No changes in a Cooperator's percentage of financial participation and percentage of seed share in the MAUI COOPERATIVE ORCHARD will be permitted, except by written agreement

of the Management Committee. However, an amendment to this AGREEMENT is not required to make such changes.

Ownership and Title

The title and ownership of all real property, improvements, buildings and equipment associated with the MAUI COOPERATIVE ORCHARD will remain with the Land owners, (legal name). The COOPERATOR's interests will be solely in the products of the MAUI COOPERATIVE ORCHARD such as seed, pollen, cuttings, trees, or other miscellaneous genetic materials.

Amendment

This AGREEMENT may be amended at any time by written agreement of the COOPERATORS.

Indemnity clause

COOPERATOR shall indemnify, hold harmless, and defend MDWS, HARC, and its officers, employees, students, and agents, whether current or former, against all claims and expenses, including legal expenses and attorneys' fees, that arise out of the death of or injury to any person or persons or out of damage to property and against any other claim, proceeding, demand, expense, and liability of any kind whatsoever arising out of this Agreement or COOPERATOR's use of the Research Materials.

Termination

Any Cooperator may terminate its participation in the AGREEMENT by providing ninety (90) days written notice to the Seed Orchard Manager. Effective upon the date of termination from this AGREEMENT for the MAUI COOPERATIVE ORCHARD, all rights, privileges, and responsibilities for the terminating Cooperator shall cease; except for the responsibility to provide its prorated share of expenses up to the date of the termination. The COOPERATORS understand and agree that a terminating Cooperator will be financially responsible for Operating Expenses based on a prorated amount to the date of termination. The terminating Cooperator's share will be offered to existing COOPERATORS in proportion to their existing shares in the orchard. In the event that a cooperator assumes additional shares in the orchard in this fashion, their dues and seed received will be adjusted accordingly.

In the event that all COOPERATORS agree to terminate the AGREEMENT, any proceeds from the sale of Koa seed, pollen or other miscellaneous plant materials from the ORCHARD at the time of termination will be distributed among the COOPERATORS in proportion to each Cooperator's Payment Rate then in effect.

Effective Date; Duration

The effective date of this agreement shall be December 1, 201X. Unless terminated by written agreement of all COOPERATORS, this AGREEMENT will remain in effect indefinitely.

THE LANDOWNER(or legal name)

BY: _____ Date_____

Title:_____

MAUI DEPARTMENT OF WATER SUPPLY

BY: _____ Date_____

Title:_____

HAWAII AGRICULTURE RESEARCH CENTER

BY: _____ Date_____

Title:_____

Appendix 2.

Applied Genetic Conservation of Hawaiian *Acacia koa*: An Eco-Regional Approach

Nick Dudley[1*], Tyler Jones[1], Robert James[2], Richard Sniezko[3], Jessica Wright[4], Christina Liang[5], Paul F. Gugger[6] & Phil Cannon[7]

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[2]Plant Disease Consulting Northwest, Vancouver, WA, USA
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Abstract

Koa (*Acacia koa* A.Gray) is a valuable tree species economically, ecologically, and culturally in Hawaii. A vascular wilt disease of *Acacia koa* (koa) caused by the fungal pathogen *Fusarium oxysporum* f. sp. *koae* (*FOXY*) causes high rates of mortality in field plantings and threatens native koa forests in Hawaii. Producing seeds with genetic resistance to *FOXY* is vital to successful koa reforestation and restoration. The Hawaii Agriculture Research Center (HARC), with both public and private partners, operates a tree improvement program to develop koa wilt resistant populations in Hawaii. The population genetics of koa are poorly understood across the broad range of habits that koa occupies and seed zones have not been sufficiently established. Thus, HARC estimates seed zones based on biogeographic variables and has selected wilt resistant koa populations for six ecological regions (eco-regions) in Hawaii. This conservative approach, based on planting locally sourced germplasm, is often a requirement of many restoration programs in the state. We further consider population genomic (single-nucleotide polymorphism) data in relation to the proposed eco-regions. Preliminary analyses suggest genetic differences among and within islands that are broadly consistent with eco-regions, but also suggest additional population differences that should be considered in genetic conservation of koa.

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Maui Koa Network
Developing Improved Wilt Resistant *Acacia koa* for Maui Watershed Restoration and Reforestation

Quarterly Report: January – March 31, 2017

1. Tasks Completed during the period:

A) Project planning and coordination for the Maui Koa Network.

i) Work continues of the development of a distribution plan for koa seed.

ii) Planning continues Seed banking efforts with partners

iii) The koa orchard seed site was installed at Haleaimakani, Leeward Haleakala (photo 2) with our project partners, Haleakala Ranch and Leeward Haleakala Watershed Restoration Partnership in March. There are about 30 different koa families representing koa populations from the leeward Haleakala eco-region (photo1)

B) On-going site maintenance continued at Kula Forest Reserve, Mahanalua, Windward Haleakala Ranch site, and Ulupalakua Ranch koa site.

2. Description of work completed

A) We continue to work with our partners to establish and maintain a network of wilt-resistant koa demonstration sites for seed production.

i) Work continues a draft agreement and distribution plan for Maui Koa Seed orchards.

An agreement is being developed to collect, process, and distribute seed from the Maui koa seed orchard network. Future koa seed banking efforts were discussed with projects partners, Leeward Haleakala Watershed Restoration Partnership, Pu'u Kukui Watershed Partnership and the Maui Division of Forestry, as well as Haleakala and Ulupalakua Ranches. All parties are very interested in assisting and are providing inputs as the planning proceeds. With input from our

partners, the plan is being refined. It is hoped, a final draft can be completed during the first half of 2017.

ii) At the Haleimakani Koa Exclosure, (photo 3) the koa wilt resistance seed orchard (Leeward Haleakala Ranch) was installed in mid-April. Approximately 30 koa families collected from the leeward slopes of Haleakala Crater and were selected for high levels of tolerance to koa wilt were included in this planting. These koa families represent a significant amount of genetic diversity specific to the leeward Haleakala eco-region.

Photo 1. Koa seedlings for the Leeward Haleakala Plantings.

Photo 2. Overview of the Haleimakani Site

Photo 3. Planting Koa at the Haleimakani Site, March 2017

B) At Kula Forest Reserve, Mahanaula, Haleakala Ranch (HR), and Ulupalakua Ranch koa sites, the exclosure fence lines were inspected and clearing was done. Weed control was preformed as required.

E) In Kind Project Assistance

During this period, 80 hours of volunteer time was recorded. I would like to especially acknowledge the assistance of Lance DeSilva and Keali'i Kimokeo, of the Maui Division of Forestry and Wildlife for their assistance in maintaining koa planting at the Kula Forest Reserve Site. Diana Crowe of Ulupalakua Ranch, Andrea Buckman, Daniel Sato and other members of the field crew members of the Leeward Haleakala Watershed Partnership for their help with maintaining the koa sites at both Haleakala and Ulupalakua Ranches.

F) Outreach: On March 8th , a presentation which summarized the Maui Koa Network progress to date was given to the Maui County Council, Water Resource committee presentation. In addition, a one page program summary was presented (see attachment 1.)

Summary

About 6 acres of site maintenance work was performed at existing seed orchard sites which include weed control, fertilization on the windward slopes of Haleakala Crater during this time-period. An additional 1 acre of koa was planted for seed production at the Haleimakani site. Over 1,400 koa seedlings were distributed for planting on the leeward slopes of Haleakala Crater to project partners during this time-period. In addition, about 200 acres of leeward Haleakala forest land was surveyed for overall forest health as well as koa flowering and seed production.

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Maui Koa Network
Developing Improved Wilt Resistant *Acacia koa* for Maui Watershed Restoration and Reforestation

Quarterly Report: April – June 30, 2017

1. Tasks Completed during the period:

A) Project planning and coordination for the Maui Koa Network partners.

i) Planning continues Seed banking efforts with partners

ii) At Haleaimakani, Leeward Haleakala site, an additional 150 koa seedling were planted to complement the earlier planting.

B) On-going site maintenance continued at Kula Forest Reserve, Mahanalua, Windward Haleakala Ranch site, and Ulupalakua Ranch koa site.

2. Description of work completed

A) We continue to work with our partners to establish and maintain a network of wilt-resistant koa demonstration sites for seed production.

i) At the oldest site, Mahanalua, Windward Haleakala Ranch, early indications of the koa trees flowering are there will be a small seed crop this season.

ii) At the Haleimakani Leeward Haleakala site, an additional 150 seedlings from 28 different koa families from the leeward Haleakalaregion were planted at the site. Further, during a follow-up site visit, the seedlings were watered in and are reported to be doing well. The exclosure fence was reinforced and more robust gate chain was installed.

B) On-going site maintenance continued at Kula Forest Reserve, Mahanalua, Windward Haleakala Ranch site, and Ulupalakua Ranch koa site.

i) The Kula Forest Reserve site was inspected with Kanoa Severson from Maui Division of Forestry. Planning was initiated for prepping the site for planting additional koa seedlings later this year. The site was inspected and observations were made on koa trees, weed complex and unique topographic features of the site (photo 1). In addition, adjacent forest area sandalwood populations are being monitored for flowering and seed set (photo2).

Photo 1. 3year old koa at the Kula Forest Reserve site

ii) Mahanaula site, Haleakala Ranch, we continue to monitor this year's seed crop and are planning to be able to harvest the first crop later this year. The site assessment revealed minor wind damage, rat damage and small outbreak of koa rust. The broken branches from the wind damage was pruned and removed from the site. In the area of the grove, where there were trees with rat damage, rat traps and baits were deployed and monitoring will continue. Further, small number of koa trees in the stand were symptomatic for Acacia rust (*Atelocauda digitata*). (Attachment 1). Although rust disease is not fatal to koa, seedpods in the stand can be severely affected. The rust was pruned and removed from the most severely infected trees.

iii) Ulupalakua Ranch koa sites, the exclosure fence lines were inspected and clearing was done. Weed control was performed for an upcoming fall planting and the existing koa stand was fertilized. Monitoring for Acacia rust and rat trapping are on-going.

Photo 2. Haleakala 'Iliahi (*Santalum haleakalae*)

3.Outreach

The Maui Koa Network Project was discussed with this year's Maui Division of Forestry interns. The problem of koa wilt was high-lighted. The solution to this problem is developing populations of wilt resistance koa as a tool for land mangers was reviewed with the objective of ensuring healthy native forests and how this related to the project site in Kula Forest Reserve.

4. In Kind Project Assistance

During this period, 48 hours of volunteer time was recorded. I would like to especially acknowledge the assistance of Lance DeSilva and Kanoa Severson, of the Maui Division of Forestry and Wildlife for their assistance in maintaining koa planting at the Kula Forest Reserve Site. Diana Crowe of Ulupalakua Ranch, Andrea Buckman, Daniel Sato and other members of the field crew members of the Leeward Haleakala Watershed Partnership for their help with maintaining the koa sites at both Haleakala and Ulupalakua Ranches.

Summary

About 6 acres of site maintenance work was performed at existing seed orchard sites which include weed control, fertilization on the windward and leeward slopes of Haleakala Crater during this time-period.

An additional 150 koa seedling were planted for seed production at the Haleimakani site. Over 300 koa seedlings were distributed for planting on the leeward slopes of Haleakala Crater with project partners during this time-period. In addition, about 200 acres of leeward Haleakala forest land was surveyed for overall forest health as well as koa and sandalwood flowering and seed production.

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Maui Koa Network
Developing Improved Wilt Resistant *Acacia koa* for Maui Watershed Restoration and Reforestation

Quarterly Report: October – December 31, 2017

1. Tasks Completed during the period:

A) Project planning and coordination for the Maui Koa Network partners.

i) Planning continues to develop seed banking and distribution plans with our project partners.

ii) At the Mahanalua, Windward Haleakala Ranch site, the first disease resistant seed crop was harvested this season.

B) On-going site maintenance continued at Kula Forest Reserve, Mahanalua, Windward Haleakala Ranch site, and Ulupalakua Ranch koa site.

i) At the Ulupalakua Ranch site, an additional 150 koa seedling were planted to complement the earlier planting.

2. Description of work completed

A) We continue to work with our partners to establish and maintain a network of wilt-resistant koa demonstration sites for seed production.

i) At the Mahanalua, Windward Haleakala Ranch site, the first seed crop was harvested and process this season (photo1). From this seed orchard site, over 5 lbs. of high quality seed was harvested from over 25 different trees (photo 2).

Photo 1. Mother tree with seed

Photo 2. High quality koa seed

ii) At the Ulupalakua site, an additional 150 seedlings from 25 different koa families were planted (Photo 3). Further, during a follow-up site visit, the seedlings were watered in and are reported to be doing well.

Photo 3. Planting at Ulupalakua site

B) On-going site maintenance continued at Kula Forest Reserve, Haleaimakani, Leeward Haleakala Ranch site, and Ulupalakua Ranch koa site. At all sites, the exclosure fence lines were inspected. Clearing and weed control was done as needed. Monitoring for Acacia rust and rat trapping are on-going.

i) Vegetation management continued at the Kula Forest Reserve site. Kanoa Severson and crew from Maui Division of Forestry assisted.

ii) Koa tree survival and growth at the Haleaimakani site has been encouraging (photos 3&4).

Photo 3 &4. Koa sapling at the Haleaimakani site at 8 months after planting

3.Outreach

A presentation was given at Kula Elementary School's Agricultre Program about the importance of healthy watersheds and native plants. This may lead to implementing a koa project with students from the school.

4. In Kind Project Assistance

During this period, 72 hours of volunteer time was recorded. I would like to especially acknowledge the assistance of Lance DeSilva and Kanoa Severson, of the Maui Division of Forestry and Wildlife for their assistance in maintaining koa planting at the Kula Forest Reserve Site. Diana Crowe of Ulupalakua Ranch, Keahi Bustamente and Andrea Buckman, and other members of the field crew members of the Leeward Haleakala Watershed Partnership for their help with maintaining the koa sites at both Haleakala and Ulupalakua Ranches.

Summary

About 6 acres of site maintenance work was performed at existing seed orchard sites which include weed control, fertilization on the windward and leeward slopes of Haleakala Crater during this time-period.

An additional 150 koa seedling were planted for seed production at the Ulupakaua site. Over 5 lbs. of koa seed (30,000 germinates) was harvested and processed. In addition, about 200 acres of leeward Haleakala forest land was surveyed for overall forest health.

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Maui Koa Network
Developing Improved Wilt Resistant *Acacia koa* for Maui Watershed Restoration and Reforestation

Final Report– FY_2017

A. Project Background

In Hawaii, koa (*Acacia koa*) is a valuable tree species economically, ecologically, and culturally. Koa's natural distribution ranged from lowland to montane areas and dry to wet forests. As Hawaii's largest native tree, koa provides habitat for many native birds, insects and plants, some of which are endangered. Koa is also the primary nitrogen fixing species in native forest ecosystems. Koa is Hawaii's premier timber and is used to produce furniture, musical instruments, bowls, surfboards, and craft wood items. Koa has much cultural significance to native Hawaiian and was the focal point of many traditional ceremonies. The resurgence of interest in Hawaiian voyaging and racing canoes using traditional methods has led to a greater public awareness of the scarcity of trees suitable for "canoe koa" and the importance of renewing this depleted resource. With major land use change and declines in sugarcane, pineapple, and cattle production, there is an opportunity and keen interest in utilizing native koa in reforestation and restoration efforts, especially in watershed rehabilitation. However, moderate to high mortality rates in many plantings have impeded past efforts. Currently, many landowners/managers are reluctant to reforest with koa in many eco-regions due to high mortality rates. The primary cause for this mortality is koa wilt, caused by *Fusarium oxysporum* f.sp. *koae*.

Research has shown that natural genetic resistance to koa wilt exists in wild populations and that the frequency of resistance can be increased through selection and breeding. Hawaii Agriculture Research Center (HARC), in collaboration with the USDA-Forest Service, has developed a screening protocol that can quickly assess koa seedlings for resistance to koa wilt. Specifically, this project will use HARC's methods to identify resistant koa seed sources for use in watershed restoration and reforestation on Maui.

HARC has worked with the Department of Water Supply since 2012 to develop a network of sites on Maui to establish wilt resistant koa seed orchards in multiple eco-regions.

Koa seed orchards have been established in three locations on Maui under previous grants. These sites are located at Haleakala Ranch, Kula Forest Reserve, and Ulupalakua Ranch. These locations are primarily on the windward flank of Haleakala Crater. An additional site on the leeward flank of Haleakala Crater was installed during this current grant period.

At maturity (3-5 years after establishment), the seed orchards will provide considerable quantities of locally adapted, wilt resistant koa seed for distribution to various restoration and reforestation projects on Maui. Seed orchard also, have the advantage of producing frequent, abundant, and easily harvested crops of seed. The reintroduction of koa at a landscape level will directly benefit the long-term sustainability Maui County's water supply in high priority watersheds. Koa forests provide opportunity and incentive to remove and control invasive and exotic plant species that are less effective in recharging aquifers. In addition, koa forests will also help to improve water infiltration rates. Further, native koa forests are better suited for watershed restoration than exotic species, as they are locally adapted, non-invasive and utilize water more efficiently. In addition, the benefits of developing wilt resistant koa, are these forests will have added durability, robustness, and resilience, with enhanced adaptability to changing climate and contribute to improved forest health. Without wilt resistant koa seed, many Maui landowners will remain unable to efficiently utilize koa in many of their watershed restoration and reforestation efforts.

The FY2017 objectives are the logical progression of this multi-year project, and are critical to meeting the overall goals of reintroducing koa across the landscape.

HARC is a nonprofit organization with a long history of providing technical assistance to Hawaii's agricultural and natural resource sectors. HARC works extensively with koa due to its importance as a key stone native forest tree species and watershed health.

B. FY 2017 Project Goals and Objectives:

The long-term goal of this project is to provide landowners/managers with an effective tool for managing koa wilt disease in their efforts to restore/reforest Maui watersheds. The development of seed sources that are genetically resistant to koa wilt would remove a major obstacle in utilizing this native keystone species. The short-term benefits include the areas reforested with koa during the project. Additional short-term benefits include the training of Maui based contractors / field crews in koa forestry practices (site preparation, weed management, fertilization etc.). Building local capacity in forestry management practices will increase efficiency/effectiveness of watershed restoration on Maui. The koa plantings will also serve to demonstrate the value of utilizing disease resistant koa seed sources and the value of proper silviculture. The FY2017 project builds on the work performed during FY2012-2016. The FY2017 project funds were used to cover four primary objectives:

1: Post-planting care (silviculture) of koa plantings at the Kula Forest Reserve, Haleakala Ranch and Ulupalakua wilt resistant koa plantings installed in FY2013-14

2: Recollect seed from wilt resistant mother trees identified from previous screening work to enhance koa seed bank for future restoration efforts.

This year's efforts focused on re-collection from of resistant koa mother trees from the Haleakala eco-region.

3: Collect seed from new koa populations on Maui that are unrepresented and previously not collected, (*e.g.* Leeward Haleakala). Partners will provide access to the koa populations.

4: Plant wilt resistant koa seedlings in the Leeward Haleakala eco-region with project partners. The plantings can be utilized as wilt resistant koa seed orchard to efficiently produce seed for specific ecoregions within Maui County.

Project locations and size
(Figure 1)

Existing Resistant Koa site locations:

1. **Haleakala Ranch (Windward)** **2 acres**
2. **Kula Forest Reserve (DOFAW)** **2 acres**
3. **Ulupalakua Ranch** **2 acres**

New Disease Resistant koa planting locations

4: **Haleakala Ranch (Leeward, Waiopai)** **2 acres**
(Attachment 1: establishment report)

BENEFITS to MAUI COUTY

- availability of disease resistant koa seed for landscape-level restoration
- provide landowners/managers a sustainable, incoming generating forestry system to diversify their operations
- stabilization of soil along riparian buffers
- improved watershed health through increased native tree plantings via enhanced fog water inception and infiltration of rates.
- increased supply of cultural important forest products

PARTNERS

- Haleakala Ranch
- Maui Land and Pineapple
- Ulupalakua Ranch
- Leeward Haleakala Restoration Partnership
- State of Hawaii DLNR-DOFAW-Maui
- US Forest Service

- USDA Natural Resources Conservation Service
- University of Hawaii

Figure 1. Locations of Maui Koa Network Sites

C. TASKS COMPLETED FOR FY17

We continue to work with our partners on establishing and maintaining a network of wilt-resistant koa demonstration sites. Our partners include: Haleakala Ranch, State of Hawaii, Division of Forestry and Wildlife-Maui, Ulupalakua Ranch, US Forest Service, and Maui Department of Water Supply.

1: Post-planting care and maintenance of the Maui koa network wilt-resistant koa demonstration sites

i) At the oldest site, Mahanalua, Windward Haleakala Ranch, site assessments revealed minor wind damage, rat damage and small outbreak of koa rust. The broken branches from the wind damage was pruned and removed from the site. In the area of the grove, where there were trees with rat damage, rat traps and baits were deployed and monitoring will continue. Although, there is no recent evidence of continued damage. Further, small number of koa trees in the stand were symptomatic for Acacia rust (*Atelocauda digitata*). Although rust disease is not fatal to koa, seedpods in the stand can be severely affected. The rust was pruned and removed from the most severely infected trees. Finally, the first disease resistant seed crop was harvested from the site this year.

ii) The Kula Forest Reserve site was inspected with Kanoa Severson from Maui Division of Forestry. Planning was initiated for prepping the site for planting additional koa seedlings later this year. The site was inspected and observations were made on koa trees, weed complex and unique topographic features of the site (photo 1). In addition, adjacent forest area sandalwood populations are being monitored for flowering and seed set.

iii) Ulupalakua Ranch koa sites, the exclosure fence lines were inspected and clearing was done. Weed control was performed for an upcoming fall planting and the existing koa stand was fertilized. Monitoring for Acacia rust and rat trapping are on-going.

iv) At the Waiopai, Leeward Haleakala site was installed in March of this year. Seedlings from 28 different koa families from the leeward Haleakala eco-region were planted at the site. During subsequent visits, the seedlings were watered in to aid establishment and weeded. Further, the perimeter fence was reinforced and more robust gate was installed.

2: Recollect seed from wilt resistant mother trees identified from previous screening work to enhance koa seed bank for future restoration efforts.

Based on the results from the last year's koa wilt screening trial which identified mother trees as disease resistance or tolerance to koa wilt, seed from over 40 families located both in west Maui and leeward Haleakala were re-collected. This seed was processed, cleaned and stored at HARC's Maunawili Facility.

Work continues a draft agreement for a seed banking and distribution plan for seed from the Maui Koa Network Seed orchards. Future koa seed banking efforts were discussed with projects partners, Leeward Haleakala Watershed Restoration Partnership, Pu'u Kukui Watershed Partnership and the Maui Division of Forestry, as well as Haleakala and Ulupalakua Ranches. All parties are very interested in assisting and are providing inputs as the planning proceeds. With input from our partners, the plan is being refined. It is hoped, a final draft can be completed during in 2018.

3: Collect seed from new koa populations on Maui

The first significant koa seed crop was harvested during the summer and fall of 2017 at the windward Haleakala, Mahanalua site (Photo 1 & 2). This seed represents a new improved disease resistant population of koa for windward Haleakala sites. This season's efforts resulted in the collection of seed from over 50 individual koa trees in Mahanalua grove

Going forward, additional koa seed orchard sites will produce seed in substantial amounts that will be available for further watershed restoration projects. As the Maui koa network project matures and enters the next phase, there will be a focus on seed orchard site monitoring and management, collection, and processing (Photo 5.) of disease resistant koa seed.

Photo 1: Windward Haleakala, Mahanalua site – age 4 yrs.

Photo 2: Select Mother tree-Mahanalua, Haleakala Ranch

Photo 3&4: Koa seed pods harvested from the Mahanalua site

Photo 5: Processed koa seed from the Leeward Haleakala 2015 collection

4: Plant wilt resistant koa seedlings in the Leeward Haleakala eco-region with project partners. Seedlings from the high surviving families will be out-planted into wilt resistant koa seed orchard at a leeward Haleakala site. This is an efficiently method to produce seed for specific ecoregions within Maui County.

At the Waiopai Koa Exclosure, (Figure 2.) the koa wilt resistance seed orchard was installed in mid-March of this year (Photo 6). Approximately 30 koa families collected from the leeward slopes of Haleakala Crater and were selected for high levels of tolerance to koa wilt were included in this planting. These koa families represent a significant amount of genetic diversity specific to the leeward Haleakala eco-region. After about six months, survival is high and the koa sapling are growing well (photo 7).

Figure 2: Waiopai Site

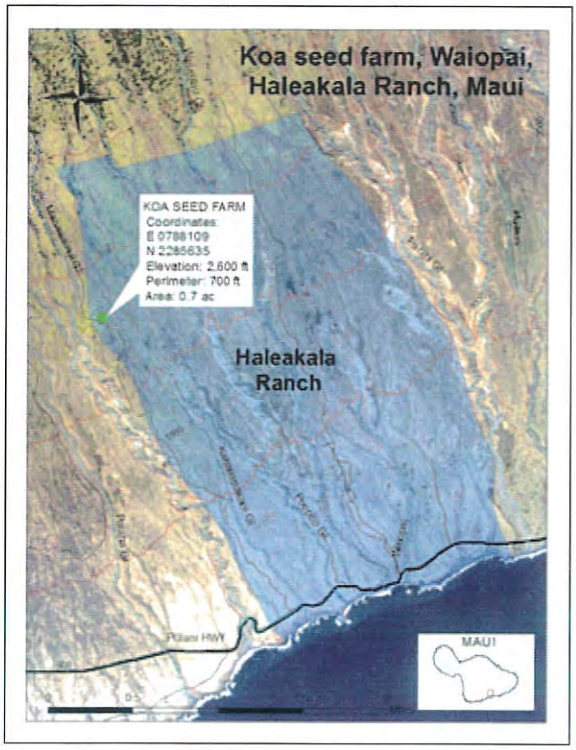

Photo 6: Planting Koa at the Waiopai Site, March 2017

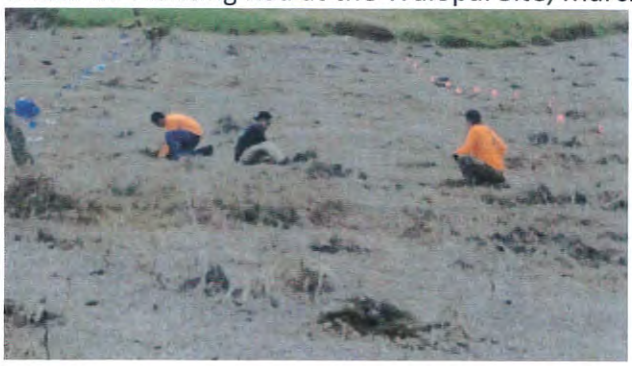

Photo 7: Young Koa at the Waiopai Site, October 2017

6: In Kind Project Assistance

The number of volunteer hours during this reporting period was 300 hours. I would like to especially acknowledge the assistance of Lance DeSilva, Keali'i Kimokeo, of the Maui Division of Forestry and Wildlife for their assistance with ongoing maintenance of the Kula Forest Reserve Site. Diana Crowe for her contributions at the Ulupalakua Ranch koa site, and Keahi Bustamente and the field crew of the Leeward Haleakala Watershed Partnership for their assistance with installing and maintaining the Waiopai site. Finally, Scott Meidel and Jordan Joiekle of Haleakala Ranch for his continued support of the Maui Koa Network project.

Four wheel and all-terrain vehicle use time contributed to the HARC koa network efforts by project partners:12 days at $150 per/day = $1,800 of support

About 8 acres of site maintenance work was performed which includes weed control, fertilization, fence inspection and monitoring at the four koa sites on the slopes of Haleakala Crater during this reporting period.

In addition, about 500 acres of pasture and forest land was surveyed for koa seeds and flowers.

7: Outreach:

On March 8th , a presentation which summarized the Maui Koa Network progress to date was given to the Maui County Council, Water Resource committee. A one-page program summary is attached (Attachment 2)

July 11-13, Attended Forest Regeneration Conference Corvalis, OR July 11-13, 2017 and gave oral presentation on "Expanding the Koa network: An eco-regional approach to deploying disease resistant *Acacia koa* in Hawaii".
Applied Genetic Conservation of Hawaiian *Acacia koa*: An Eco-Regional Approach was published in the proceeding of "Gene Conservation of Tree Species – Banking on the Future" workshop (https://www.fs.usda.gov/treesearch/pubs/55062) (Attachment 3)

Over 1,400 koa seedlings were distributed for restoration planting on the leeward slopes of Haleakala Crater to project partners during this time-period.

STAFF EMPLOYED
HARC's forestry program employs two full time foresters, two .5FTE technicians Approximately .75 FTE is paid using DWS funds.

INVENTORY OF EQUIPMENT
None
AMOUNT OF FUNDING LEVEREGED
Please include an Excel table that identified the amount of funding you received from DWS, amount received from other sources. Please identify all sources by name, and state/federal/county government and or private, nonprofit entity.

DWS provides approximately 10% of HARC's forestry budget. The funding is leveraged at a rate of approximately 2 to 1 using money from USDA, Natural Resource Conservation Service, the US Forest Service, State of Hawaii DLNR-DOFAW and private partners.

FUNDING NEEDED AND WHAT YOU COULD DO IF THERE WAS MORE FUNDING

Increased funding would allow additional screening of Maui koa populations for resistance to wilt. It would also allow for more seed orchards to be established and for the orchards to include more families. Additional families would improve the likelihood of finding families with a combination of multiple traits of commercial importance. Further, additional native forest species, such as sandalwood could be included in the seed for production areas

CONSEQUENCES OF A DECREASE IN FUNDING

A decrease in funding would slow the development of disease resistant koa seed orchards on Maui, thus delaying the ability of land owners/managers to utilize this valuable resource.

Appendix 1: Establishment Report
-Maui Koa Network: Waiopai-Leeward Haleakala Ranch, Maui
Acacia koa Progeny Trial

Establishment report:

Date planted: 16 March 2017 (Rep 1-3)
16 May 2017 (Rep-4)

Location: Waiopai, Kahaleimakani -Leeward Haleakala Ranch Koa Exclosure

Background: One of the major constraints to successful koa reforestation is the koa wilt disease caused by the fungus, *Fusarium oxysporum*. We have developed a koa seedling inoculation technique that is effective for inoculating young koa seedlings with *Fusarium oxysporum*. This allows for rapidly screening of koa seedling families to determine if they are susceptible or resistance to the koa wilt disease. This koa seed source field test will assist in monitoring the durability of resistance to koa wilt among the various seed sources being tested and help validate the long-term effectiveness of the inoculation screening methodology.

Objective: Evaluate the growth performance of 28 different koa (*Acacia koa*) seed sources to identify seed source's that produce seedlings that are vigorous, well adapted, with good stem form, pest resistant, and have commercially acceptable wood properties (color and figure). **

These koa seed sources were collected from natural stands across the leeward slopes of Haleakala, Maui, or selected from previous trials from mother trees of know origin. Superior seed sources can then be selected based on growth performance and survival for utilization in future operational planting or restoration work.

An overall goal of this project is to establish koa as a sustainable crop on former agricultural and pasture lands based on the planting of selected Maui seed sources. Once assembled, these unique genetic

resources can be evaluated in locations that are representative of high priority sites for watershed restoration and reforestation.

Justification: Natural variation has produced populations of koa trees that are well adapted to specific environmental conditions. This results in a range of genetic variation within this species. A seed source test is an efficient way to screen for variation by comparing the growth performance of the progeny of many different parents. Going forward, this site can be managed as a seed orchard, or as an breeding arboreta, by leaving only the best individuals from the best performing koa seed sources and removing less desirable ones.

Treatments: 28 Families of *Acacia koa* (See seed source list)

Design and Procedure: This planting consists of first generation half-sib seeds collected from outstanding individual trees from locations across leeward Haleakala on Maui. A randomized row-plot design was utilized. Each treatment is deployed in row plots which contains five trees each. There are four replications. The spacing is 3 meters between rows and 2 meters within each row.

Planting Methods: The site was prepared for planting by spraying the existing vegetation with herbicide. The koa seedlings were planted by hand into the line prepared by a hand-held power auger.

Koa Seed Source list: Waiopai- Kahaleimakani -Leeward Haleakala
16 Mar 17

Treatment	Seed Source
1	KR-15-17
2	KF-42-A
3	KR-34-C
4	KR-52
5	KF-50-B
6	KR-15-16
7	HH-15-K2
8	KR-31
9	KF-1
10	KR-53
11	KF-42-B
12	KF-44
13	KF-38-B
14	KR-15-19
15	KF-46-B
16	HH-15-1
17	KF-38-A
18	KR-15-14
19	KF-35-B
20	KR-55-A
21	KF-37

22 Susceptible Bulk
23 KF-35-A
24 HH-15-6
25 HH-15-7
26 KF-42-C
27 HH-15-8
28 KF-36

Map Key:

KR = Kipahulu Forest Reserve
KR = Kaupo Ranch
HH = Hawaiiam Homes (Kahikinui)

Maui Koa Network

Kahaleimakani Manawainui Site map

Row	Rep 1	Rep 2	Rep 3	Rep 4
1	15	12	13	21
2	6	11	3	7
3	16	5	19	4
4	21	25	14	20
5	13	6	21	6
6	22	15	10	13
7	17	8	2	1
8	23	24	22	28
9	8	20	26	12
10	27	14	15	10
11	18	27	7	5
12	3	21	17	11
13	9	22	9	2
14	19	2	8	3
15	12	18	24	22
16	25	7	16	27
17	11	3	4	18
18	20	10	28	16
19	28	13	25	19
20	1	26	20	8
21	24	4	5	23
22	2	17	12	14
23	14	23	1	17

24	10	19	11	25
25	4	9	23	9
26	7	1	27	26
27	26	16	6	15
28	5	28	18	24

Makai Gate