**FINAL REPORT**: Organic Farming Systems Options for Controlling Coffee Leaf Rust (CLR) in Kona Coffee

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## Project Summary

A participatory on-farm research project was conducted on five certified organic coffee farms in the Kona district on the Island of Hawaii to evaluate alternative organic-based practices for the management of Coffee Leaf Rust (CLR). Coffee Leaf Rust is a devastating disease of coffee worldwide but has only recently become established in Hawaii over the past few years. Most efforts to date for the management of this disease in Hawaii have focused on chemical controls. However, these have had limited success due to a combination of ideal weather conditions for the disease, highly susceptible coffee varieties, poor soil and plant health, and high costs of labor and imported fungicides.

The goal of this project was to reduce the negative impacts of this devastating disease by focusing on improving plant health through increased applications of locally-available fertilizer and microbial amendments. Treatments included: 1) a granular fertilizer composed of fish emulsion and biochar, 2) Indigenous Micro-Organism (IMO) foliar sprays, 3) a combination of both, and 4) an untreated control. These treatments were superimposed on fertilization and management practices already followed by the individual farms. Data was collected monthly on CLR disease incidence (the presence of lesions) and defoliation.

We observed considerable variability among the five farms, with some showing reduced disease incidence and defoliation with increased fertilization, and others showing no effect of treatment. With only a single year of data collection, and known differences in weather and management practices among farms, this variation was not surprising and led us to seek an additional two years of funding through the USDA-ARS program, "Systems Approaches to Improve the Production and Quality of Specialty Crops." Further, we have been asked to submit a full proposal for an additional three-years of funding from the USDA Sustainable Agriculture Research and Extension (SARE) Program.

## Introduction to Topic

Coffee Leaf Rust (CLR, *Hemileia vastatrix*) is a global disease of coffee that can cause reduced photosynthesis, leaf drop, and reductions in yield. This fungal pathogen was first detected on the islands of Maui and Hawaii in late 2020, and rapidly spread across the State. Surveys on Hawaii Island commercial coffee farms were initiated in December 2020. Disease incidence levels on many farms in the Kona district reached >70% in the first year of the epidemic (2021), with Ka'u following suit in 2022 (Aristizabal & Johnson 2022). Yield losses for the 2021-2022 season in Kona were estimated at 25-75%. The massive shortage of coffee from this world-renowned growing region led to fear and uncertainty regarding the future of this small but economically important industry, which generates ~$130 million annually in green (unroasted) coffee sales alone (NASS 2022).

In general, early management efforts for CLR in Hawaii have focused on chemical control strategies. Many preventative fungicides were quickly approved for use on coffee in Hawaii, as well as two trans-laminar fungicides. These products are imported and cost-prohibitive for many smallholder farmers, particularly since they must be sprayed monthly to be effective. While large conventional coffee farms have been able to absorb this cost, most small farms (of which there are ~1,000 in the State of Hawaii) have not, especially given significant losses in yield suffered last season. Alternative sustainable management strategies are desperately needed as the climatic and socioeconomic pressures of small-scale farming become increasingly challenging to navigate.

Soil and plant health are a central component of CLR management. The international literature indicates that good farm management practices that follow a whole systems approach can result in balanced nutrition and healthy coffee trees. The current proposal aims to evaluate alternative management strategies that are focused on optimizing soil microbial activity and plant nutrition. A central feature of the project is the use of locally available nutrient and microbial amendments to minimize farm dependence on expensive out-of-state inputs. Possible mechanisms of action include biostimulant effects, antagonistic microbial activity, and the stimulation of systemic plant disease defense mechanisms (Kao and Ko, 1986; Weller et al., 2002; Pieterse et al., 2014; Tao et al., 2020; Readyhough et al., 2021). This project was conceived, developed, implemented, and extended to organic diversified, small-scale family farmers.

### Objectives Statement

The objectives for the project included:

1. **Determine if application of fish-emulsion/biochar can reduce incidence of CLR and/or defoliation.** A locally-made, certified organic fertilizer composed of dried local fish waste and biochar (carbon and ash made after pyrolysis of biomass) provides plants with essential macronutrients, while promoting nutrient uptake.
2. **Determine if application of IMOs decreases CLR incidence and/or defoliation.** Indigenous microorganisms (beneficial bacteria, yeasts, and fungi that are adapted to the local environmental conditions) sourced and produced on each farm provides plants with micronutrients and protection from CLR, while increasing nutrient uptake.
3. **Determine whether a combination of treatments 1 & 2 reduces the incidence of CLR and/or defoliation.** Evaluate the hypothesis that the application of both macro- and micro-nutrients provides plants with all the elements needed to grow, sustain crop yields, and protect against disease; and that IMOs and biochar, by helping to improve nutrient uptake increase the benefit of fish emulsion applications.
4. **Extend this information to Hawaii coffee farmers.** Using in-person workshop-style presentations that encourage interactions among attendees, this project will promote ongoing information transfer. Longer-term access to information is attained through video capture of events and posting on the internet. Summary video materials to inspire involvement will also be made available in both English and Spanish.

## Materials and Methods

*Study sites:* Five certified organic farms were selected as the study sites. These farms are spread across North and South Kona (the main coffee-growing region on Hawaii Island), and encompass a broad range of elevations (200-600 m) and microclimates. Farm size ranges from 2-5 acres of coffee, which is typical of Kona coffee farms. Each farm was divided into four sections with similar numbers of trees. One of the four treatments was randomly assigned to each section: 1) Fish emulsion/biochar fertilizer, 2) Indigenous microorganism (IMO) spray, 3) Fish emulsion/biochar fertilizer + IMO spray, and 4) an untreated negative control. Each of the four treatment sections were marked using a different colored flagging tape.

*Fertilizer and IMO preparation and application:* The fertilizer used was a fish waste-based product that was locally produced on Hawaii Island and formulated specifically for coffee (Kona RainForest Farms LLC, Captain Cook, HI). The fertilizer was dried and composted to granular form, and consisted of fish powder, sulfate of potash, powdered blue rock, and molasses, with a rating of 8-6-6 NPK. The initial product used in the first applications contained biochar, but later formulations did not include biochar due to unavailability. The fertilizer was distributed to the coffee trees at the rate of 12 oz per tree, with application to the soil spread out for maximum access to feeder roots. Fertilizer was applied twice per year to the two treatment plots on each farm (fertilizer only, and fertilizer + IMO), in addition to other fertilizers which varied in composition and numbers of applications on each farm. The fish-based fertilizers were applied in June and December.

The adoption of Korean Natural Farming (KNF) was popularized in Hawaii during the 2000s, as part of a movement to adopt more biologically-based systems of production, to reduce the dependence on external inputs, and to help to regenerate the fertility of soils that had been degraded from decades of plantation and pesticide-based monocultures. A central feature of KNF is the on-farm application of indigenous microorganisms (IMOs) which are used to improve the soil fertility, nutrient cycling, and perhaps for disease suppression (Kao and Ko, 1986; Weller et al., 2002; Kumar and Gopal., 2015). Many of the practices followed by KNF have been used by indigenous farmers for generations, especially in Asia, but their purported benefits have not been always well documented in the scientific literature.

Locally collected from undisturbed forests or other vegetated areas, IMOs are used and to improve their diversity, samples are often pooled from several sites. Small square-foot containers, containing about 3 inches of steamed rice, and covered with paper towels and mesh wire, are buried in the soil for 4-5 days to collect the IMO samples. Ingredients used to culture the IMOs include, 'wheat mill run,' obtained from local flour mill processors (or mushroom growth medium waste), and which is mixed (1:1 ratio by w) with granulated brown sugar to obtain a fermented rice mixture. The rice mixture is placed as a mound in the soil (or in a five gallon bucket), and the microbes are allowed to propagate for seven days, while being careful to keep the fermentation temperature below 122F (50C). The final product is ready for application via soil applications, or as sprays (Park and DuPonte, 2008). For spray applications four gallons of concentrated solution is diluted in 50-200 gallons of water for application as a drench in the soil, around the tree trunk, or as a foliar spray. In our case, the trees were sprayed on the underside of leaves with a mist blower, on a quarterly basis. Some of the ingredients used in KNF can be obtained locally, commercially, such as from AlohaOrganic.org, or from Hawaiian Flour Mills, both on Oahu, Hawaii. For reference, nutrient levels of IMO samples obtained from several locations in the Hilo area of Hawaii Island included a range of 1.5-2% N, 1-4% P, and 5.8-10.5% K (Rushing, 2015).

*Data collection:* Soil and leaf tissue sampling was done in July 2021 (prior to the start of the study) and again in December 2022 (six months after study initiation). Sampling methods followed those provided to coffee growers through the UH CTAHR extension service. Ten trees were randomly selected throughout each farm. Soil samples were taken halfway between the dripline and trunk, at a depth of 6-12 inches, with ~¼ cup of soil collected per tree. Samples were combined into a single ziploc bag, mixed thoroughly, and labeled with farm name and date. One branch was randomly selected from each tree, and 1-2 leaves collected from a lateral branch located at about midpoint in the tree. Selected leaves were mature but not old (3rd or 4th pair from the tip). Leaf samples were placed into a ziploc bag and labeled with farm name and date. Samples were refrigerated until submitted for processing the following day to the UH Hilo Analytical Laboratory.

Farms were visited monthly to estimate CLR incidence (presence of CLR lesions) and defoliation (leaves per branch). The survey method follows that described in Aristizabal & Johnson (2022). Throughout each section, ten trees were randomly selected to be sampled for incidence and defoliation. At each tree, a branch was randomly selected and the total number of leaves was counted. The number of leaves with CLR lesions (yellow circular spots with spores on the underside of the leaves) was also counted. While we also planned to follow impacts of the treatments on coffee yield, we later realized that these effects, if any, wouldn't be seen until year two of the study. Thus, results from this portion of the project are not presented here.

*Data Analysis:* The percent incidence was calculated for each of the for treatment sections by adding the total number of leaves with CLR lesions, dividing by the total number of leaves counted on the 10 sampled branches, and multiplying by 100. Leaf retention was estimated by calculating the average leaf count per branch over time for each of the four treatments. Data was analyzed separately for each farm. CLR incidence and leaf retention data were checked for normality using histograms and a Shapiro Wilks test, and equal variances were tested for with a Fisher's Exact test. Individual one-way ANOVA tests were then used to determine if there was a significant difference among the four treatments.

## Project Results

The soil pH at most farms (with the exception of one farm in 2022) was in the optimal range for coffee or slightly above. Soil analyses revealed toxic levels of Ca, Mg, Mn, and P in the soils for all five farms in both years sampled. In contrast, the macronutrients Ca and the micronutrients Fe, Cu, Mn, and Zn were typically deficient in leaf tissue. Other deficiencies in the leaf tissue at some farms included K, Mg, and N.

The results of the one-way ANOVAs showed no significant difference between treatment plots in terms of CLR incidence for any of the five farms examined (Table 1). In general, CLR incidence continued to increase from the start of the study (June 2022) through to the post-harvest (January), after which time incidence began to fall (Figure 1). Incidence again began to increase in July 2023. This is the same pattern that has been widely observed across Hawaii Island since monitoring was initiated in early 2021 (M. Johnson, pers. comm.), with peak incidence occurring during the harvest and post-harvest, followed by a decrease through the spring months when new leaves begin to appear and fruits are developing.

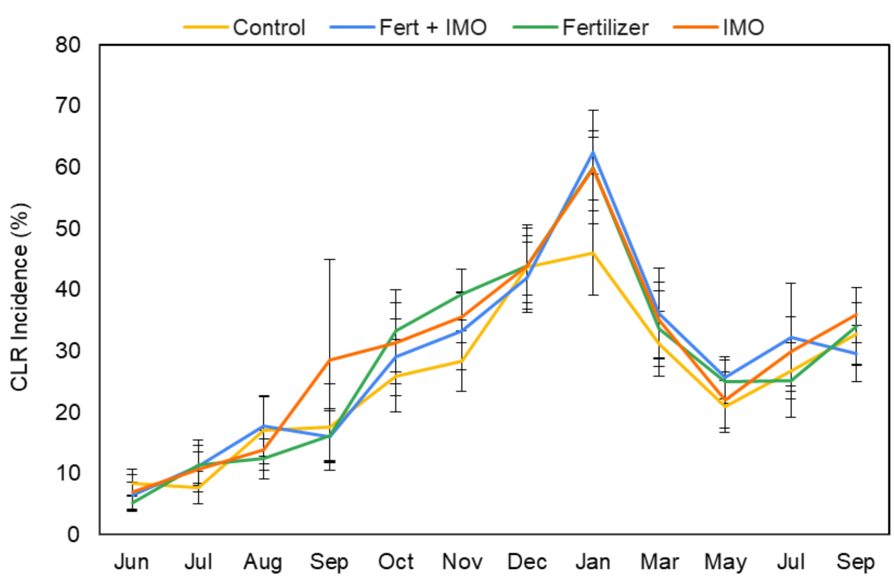


**Figure 1.** Average CLR incidence across the five study farms in Kona, Hawaii Island during the sampling period from June 2022 - September 2023. No significant difference was found among the four treatments on any of the farms examined.

The results of the one-way ANOVAs for leaf retention also showed no significant difference among treatments for the five farms (Table 2). Leaf number per branch was generally highest at the start of the study, and declined into the harvest months as disease severity increased and caused defoliation (Figure 2). The new leaf flush at the start of the rainy season in February resulted in a slight increase in leaves per branch (Figure 2). Prior to the introduction of CLR, the average number of leaves per branch for a given coffee farm in Kona was ~20, while post-CLR numbers average ~10-15 per branch (M. Johnson, unpub.

data). This 25-50% reduction in leaves is reflected in yield loss, with some farms reporting 50-75% yield reduction (M. Johnson, pers. comm.)

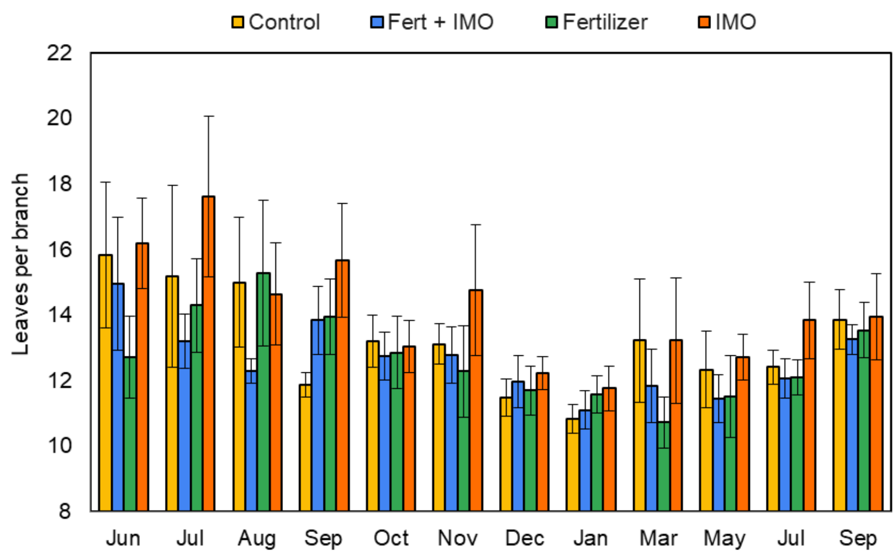


**Figure 2.** Average leaves per branch across the five study farms in Kona, Hawaii Island during the sampling period from June 2022 - September 2023. No significant difference was found among the four treatments on any of the farms examined.

**Table 1.** Effect of several organic treatments on Percent incidence of Coffee Leaf Rust on Five organic farms of the Kona District, Hawaii Island. Results of an ANOVA and follow-on Tukey's test comparing the mean CLR incidence (%) for the 2022-2023 coffee season in four treatment plots across five organic farms in Kona, Hawaii Island.

| Farm | Control | Fert | Fert + IMO | IMO | F-value | df | p-value | Tukey's test |
|---|---|---|---|---|---|---|---|---|
| **Bondera** | 30.27 | 33.09 | 35.10 | 26.85 | 2.15 | 3 | 0.09 | |
| **Olsen** | 25.92 | 24.21 | 22.13 | 28.63 | 1.37 | 3 | 0.25 | |
| **Greenaway** | 28.49 | 36.80 | 35.08 | 30.75 | 1.66 | 3 | 0.18 | |
| **Vass** | 22.85 | 24.09 | 26.92 | 24.49 | 0.50 | 3 | 0.68 | |
| **Stith** | 25.04 | 32.19 | 27.63 | 39.66 | 5.16 | 3 | 0.002 | IMO > Fert + IMO, Control; p = 0.01, p = 0.002 |

Fert= Fish emulsion/biochar fertilizer, IMO= Indigenous microorganism, Control= untreated negative control

**Table 2.** Effect of several organic treatments on mean number of leaves per branch on five organic farms of the Kona District, Hawaii Island. Results of an ANOVA and follow-on Tukey's test, for the 2022-2023 coffee season in four treatment plots Fert= Fish emulsion/biochar fertilizer, IMO= Indigenous microorganism, Control= untreated negative control

| Farm | Control | Fert | Fert + IMO | IMO | F-value | df | p-value | Tukey's test |
|---|---|---|---|---|---|---|---|---|
| **Bondera** | 11.88 | 11.75 | 11.37 | 14.23 | 8.26 | 3 | <0.001 | IMO > Control, Fert, Fert + IMO; p ≤ 0.002 |
| **Olsen** | 14.63 | 13.79 | 13.33 | 14.01 | 0.88 | 3 | 0.45 | |
| **Greenaway** | 12.31 | 12.33 | 13.68 | 12.89 | 2.38 | 3 | 0.07 | |
| **Stith** | 12.23 | 11.08 | 11.43 | 12.29 | 2.43 | 3 | 0.06 | |
| **Vass** | 15.41 | 15.10 | 12.93 | 17.13 | 3.34 | 3 | 0.02 | IMO > Fert + IMO; p = 0.01 |

Fert= Fish emulsion/biochar fertilizer, IMO= Indigenous microorganism, Control= untreated negative control

**Table 3a.** Soil Analysis on five organic coffee farms on the Kona District of Hawaii Island, 2023.

| Location | Elevation | pH | Ca (ppm) | Mg (ppm) | Na (ppm) | K (ppm) | Cu (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|
| **Optimal** | | 5.5-6.5 | 1500-2000 | 300-400 | <50 | 400-600 | 50-2 | 20-50 |
| Captain Cook | High | 6.32 | 3604.07 | 1077.00 | 29.72 | 373.66 | 0.44 | 28.70 |
| Kealakekua | Low | 6.74 | 6335.70 | 951.45 | 9.85 | 2065.81 | 0.37 | 28.65 |
| Captain Cook | Low | 5.81 | 6237.04 | 974.61 | 4.96 | 548.25 | 0.20 | 104.35 |
| Holualoa | Mid | 6.90 | 6257.76 | 658.96 | ND | 584.08 | 0.19 | 7.38 |
| Honaunau | Mid | 6.08 | 2242.80 | 694.19 | 45.49 | 301.60 | 0.57 | 10.54 |

Red values= Below optimal level; Blue values= above optimal level

**Table 3b.** Soil Analysis on five organic coffee farms on the Kona District of Hawaii Island, 2023.

| Location | Elevation | Fe (ppm) | Mn (ppm) | Al (ppm) | P (ppm) | N (ppm) | N (%) | C ( %) |
|---|---|---|---|---|---|---|---|---|
| **Optimal** | | >10 | 15-10 | | 80-100 | | >0.3 | >3 |
| Captain Cook | High | 8.07 | 62.22 | 6.58 | 459.66 | 27.71 | 1.21 | 14.90 |
| Kealakekua | Low | 6.18 | 26.41 | 2.25 | 1321.39 | 14.10 | 0.56 | 6.38 |
| Captain Cook | Low | 21.40 | 39.77 | 4.75 | 1763.65 | 52.91 | 1.25 | 18.88 |
| Holualoa | Mid | 3.24 | 18.13 | 6.58 | 5967.65 | 13.69 | 0.94 | 11.60 |
| Honaunau | Mid | 7.84 | 62.37 | 12.65 | 108.54 | 33.67 | 1.04 | 13.36 |

Red values= Below optimal level; Blue values= above optimal level

**Table 4a.** Tissue Analysis of most recently matured leaves from five organic coffee farms in the Kona District of Hawaii Island, 2023.

| Location | Elevation | P (%) | K (%) | Ca (%) | Mg (%) | Na (%) | C (%) |
|---|---|---|---|---|---|---|---|
| **Optimal** | | 0.12-0.20 | 2.0-3.0 | 1.0-2.5 | 0.25-0.40 | | |
| Captain Cook | High | 0.13 | 1.44 | 0.85 | 0.34 | 0.05 | 46.71 |
| Kealakekua | Low | 0.18 | 2.24 | 0.95 | 0.32 | 0.07 | 45.40 |
| Captain Cook | Low | 0.18 | 1.79 | 0.90 | 0.33 | 0.08 | 45.38 |
| Holualoa | Mid | 0.15 | 1.77 | 0.80 | 0.29 | 0.07 | 45.98 |
| Honaunau | Mid | 0.19 | 2.02 | 1.27 | 0.48 | 0.03 | 45.55 |

Red values= Below optimal level; Blue values= above optimal level

**Table 4b.** Tissue Analysis of most recently matured leaves from five organic coffee farms in the Kona District of Hawaii Island, 2023.

| Location | Elevation | N (%) | Fe (ppm) | Mn (ppm) | Cu (ppm) | Zn (ppm) | B (ppm) |
|---|---|---|---|---|---|---|---|
| Optimal | | 2.5-3.5 | 70-125 | 50-200 | 10.0-30.0 | 15-150 | 40-75 |
| Captain Cook | High | 2.26 | 50.26 | 32.62 | 15.86 | 13.16 | 56.79 |
| Kealakekua | Low | 3.03 | 35.35 | 14.09 | 8.72 | 6.63 | 79.48 |
| Captain Cook | Low | 2.85 | 48.43 | 53.81 | 7.59 | 8.03 | 81.86 |
| Holualoa | Mid | 2.65 | 42.79 | 19.69 | 271.77 | 5.45 | 88.51 |
| Honaunau | Mid | 2.56 | 57.43 | 45.71 | 13.45 | 5.61 | 63.68 |

Red values= Below optimal level; Blue values= above optimal level

## Conclusions and Discussion

The objective of this project was to evaluate alternative nutrient and microbial amendment treatments to determine if these could help to manage or suppress the incidence of Coffee Leaf Rust on several organic coffee farms in the Kona District of Hawaii island. The research hypothesis was that a) trees with an improved nutritional status may be better able to withstand rust infestations, by reducing rates of defoliation, and to recover from infestations, with the production of new foliage; and b) that inoculation with indigenous microbial organisms (IMOs) may help in disease suppression by improving the crop nutritional status (including nutrient uptake), to stimulate systemic immune responses in coffee, and or to suppress disease infestations via biocontrol mechanisms. Nutrient amendments such as fish emulsion, and microbial inoculants, are often applied, not only for their direct contribution of nutrients, but also for the biostimulant effects that they may have, primarily through hormonal action, to stimulate crop growth, and/or to help plants overcome periods of stress or pest infestations, or by inducing a crop's systemic immune response (Readyhough et al., 2021; Weller et al., 2002).

Central goals of this project, in terms of evaluating alternative CLR management strategies were to a) rely on locally available resources and b) to follow a participatory approach as part of the experimental design and selection of treatments. By relying on locally-available resources and by following a participatory approach it was expected that there would be greater "buy-in" and engagement by the participating farmer cooperators, which would increase the likelihood of farmers adopting new or alternative management practices. As part of the participatory approach, the farm cooperators chose to maintain their current fertilizer management practices, and to apply the Experimental treatments as a supplement (and not as a substitute) to their current practices. Thus, the fact that the individual farms chose to maintain their standard baseline fertilizer treatments, may have masked the effects of the treatments evaluated as part of this project, making it more difficult to detect statistical differences between treatments, especially when considering the environmental differences between farms (elevation, rainfall, tree age and physiology, and uneven level of disease infestations in the different locations).

Because, in this project, we were dealing with perennial trees, some of them several decades old, and with well established organic systems, and because of the unique environments between farms, it is likely that any treatment effects (with potential positive effects observed under some environmental/farm conditions, but not others) will most likely be observed after a few years of evaluation. With this in mind, we obtained funding to extend this project for an additional two years, and are now also seeking funding from the USDA-SARE program to further continue the project for an additional three years.

When all the data were pooled together, from the first year of the project, no treatment effects were observed, compared to the control, with respect to disease incidence or leaf retention. However, differential trends/effects were observed between farms, with some levels of improved leaf retention observed in some farms, while no effects were observed in other farms. As we begin to dissect the individual production practices followed on each farm, and as we continue the project, we may be able to begin to identify variables that help to stimulate improved plant health, and disease suppression, as potential management strategies for CLR in Hawaii.

The participatory nature of the project had an inherent weakness, because it made it difficult to control all of the inputs on each individual farm, as you would under an Experiment Station, but on the other hand the participatory approach has brought about greater engagement, buy-in, and credibility by the participants. A greater engagement by the farmer cooperators is likely to bring about better ideas to improve the experimental treatments, and to increase adoption of any new alternative strategies that may be identified by the project, to manage CLR in organic farms of Hawaii.

Some modifications will be necessary with respect to the timing of the experimental treatments to better synchronize the application of fertilizers with rainfall events. In addition, to further improve the use and adoption of IMOs, the farmer cooperators will undergo training for the preparation of IMOs on their farms.

**Outreach**

Because this project consisted of on-farm experiments on 5 different farms, and was led by an organic farmer, considerable information about the project was transferred by simple word of mouth, as well as at regular social, industry or commodity events; announcements were made via Industry newsletters or publications; and updates were provided for dissemination, to the University of Hawaii Sustainable and Organic Farming Systems program.

A description and overview of the project was given by a project PI at the symposium of the Kona Coffee Farmers Association held in February, 2023. Following this event, a one afternoon workshop was held at the farm of one of the project cooperators, to update coffee farmers about the project; to provide a scientific background and rationale on some of the treatments that were being used; to discuss the alternative nutrient management approach that was being followed to manage CLR; as well as to provide a background on the use of indigenous microorganisms (IMOs) (https://www.youtube.com/watch?v=F8It0yJHv0E). About 30 people attended the workshop, including several coffee organic farmers, and the post-workshop evaluations showed positive remarks about the workshop presentations and discussion sessions.

A video was prepared to provide an overview of the project and to present initial results, including interviews with the farmer lead of the project, and with the farmer cooperators (https://youtu.be/SYvOG_mpJjk). The video was also translated into Spanish, to reach an important sector of the organic farming industry in Kona and the state (https://www.youtube.com/watch?v=Au5CGsIbWB0). As the project moves forward, we plan to prepare a written report, to update the farming community about some of the project key results.

**Financial accounting**

*Please see attached spreadsheet.*

**Leveraged resources**

Working with UH-CTAHR, and PBARC Director, Dr. Marisa Wall, the project P.I.'s were able to obtain funding through the USDA-ARS program, "Systems Approaches to Improve the Production and Quality of Specialty Crops" with annual funding of $30,000, for two years.

To further continue the project, the PI's successfully submitted a pre-proposal as part of the 2024 Western SARE Research and Education program, and have now been invited to submit a full proposal by November 2023, for possible project continuation from 2024-2027.

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**Photos and other addenda**

**On farm research by producer participants (2023)**

**Coffee leaf rust on coffee tree leaf (2023)**

**Coffee leaves with coffee leaf rust (2023)**

Coffee trees on coffee farm of study participant (2023)

Research study participant spray demonstration on farm (2023)

*Container of collected Indigenous Microorganisms (IMOs) (Courtesy of Tia Silvasi)*

*View of collected indigenous microorganisms (IMOs), (Courtesy of Tia Silvasi)*


Dr. Johnson at May, 2023 event

Drake Weinart presenting re: IMOs and KNF at May, 2023 event

Dr. Vallenzuela at May, 2023 event


Producer Panel at May, 2023 event