Course #	Title	Description	School Year
SUS6060	Intro to Hawaiian Ethnobotany	Learn the fundamentals of Hawaiian Ethnobotany in-class and outside at Kauluwehi, a new on-campus ethnobotanical garden serving as a living, learning lab. Gain skills in plant identification of endemic, indigenous and Polynesian introduced flora and hands-on training in ethnobotanical uses of plants in Hawaiian culture for cordage, clothing, housing, health, food, fishing and sailing	2019-2020
SUS6061	Ethnobotany: Field Workshops	Further your knowledge in ethnobotany through hands-on learning in off-site field trips on topics such as limu (sea algae) identification and cordage making.	2019-2020
SUS6056	Cobb Earth Oven Workshop	Learn to build a cobb earth oven using natural materials. Cobb building focuses on the use of locally sourced building materials including straw, sand and clay with a waterproof finishing layer of lime plaster. In this hands on workshop you learn about proper ratios and mixtures and see why building together with community is both fun and interactive!	2019-2020
SUS6900	Perspectives on Native Hawaiian Sustainab	Connect with Native Hawaiian culture and learn from the ahupuaa model of sustainability. Part one of this two-session course will provide a rich discussion of how Hawaiian traditions and history can enhance and inform today's sustainability efforts. Part two will feature an experiential tour on-site at the Waihee Coastal Dunes and Wetlands Refuge to see firsthand how pre-contact Hawaiians sustained their community while protecting the land.	2019-2022
SUS6017	Building Operators Certification 1	Program focuses on energy efficiency, prolonging equipment life, and delivering cost savings through preventive maintenance. The BOC® program was created by the Northwest Energy Efficiency Council (NEEC) and is specifically designed for facility managers and support staff, building operators, maintenance workers, chief/facility engineers and staff, and mechanical and electrical contractors who support chiller plants.	2019-2022
SUS6105	Certified Interpretive Guide Training	The course combines the theoretical foundations of the profession with practical strategies in delivering quality interpretive programming to visitors. The goal of the CIG program is to provide consistent, high quality training for staff and volunteers on the basics of presenting interpretive programs. Certification is a way to document that you possess skills and knowledge that allow you to perform effectively in the interpretive profession.	2019-2020
AGR6005	Sustainable Farming: Fundamentals from S	This training with organic farmer Gerry Ross introduces participants to the fundamental practices of building living, healthy soil to nutritious organic vegetables and fruits in a tropical setting.	2019-2022
AGR6007	Managing Pests & Diseases for Plants	Learn holistic Integrated Pest Management (IPM) strategies to monitor and control pests and diseases. Learn to identify common pests and diseases found on vegetables and ornamentals, how to diagnose your plant's symptoms and problems, and the cultural, mechanical, biological and safe chemical controls to avoid and resolve pest and disease issues.	2019-2022
AGR6040	Planting Fruit Trees I	This 3-hour classroom session will give you the how-tos of designing, planting and caring for a fruit tree orchard.	2019-2022

AGR6041	Planting Fruit Trees II	Continue with an afternoon tour of a developing orchard to explore the step-by-step methods for caring for a variety of fruit trees at Pono Grown Farm.	2019-2022
AGR6255	Permaculture Design Certification	The course integrates regenerative agriculture practices including keyline design, holistic management for home gardeners, landscapers, farmers, ranchers, architects, land owners, teachers, and sustainable businesses.	2019-2020
ENR6709	Hawai'i's Marine Naturalist	Tailored for tour boat crews, naturalists, and ocean enthusiasts this course offers an overview of some of Hawaii's most visible and oft-encountered protected marine life, their basic biological needs, distribution and how to assist in their protection.	2019-2020
AGR6515	Aquaponics Technician	Explore an agriculture and natural resources pathway through 80 hours of online training in commercial and backyard aquaponics and hydroponics. Learn concepts, skills and systems to raise fish and produce.	2019-2022
AGR6550	Aquaponics Apprenticeship	Gain hands-on skills and training as an apprentice in the WaiPono Farm aquaponics greenhouse. Apprentices earn a stipend upon successful completion of the program.	2021-2022
SUS6101	Sustainability Leadership	Explore the seven core concepts of sustainability including sustainable economics, ecosystem services, ecological footprint, waste reduction, carbon neutrality, local first, and adaptive resilience. Gain an understanding of the fundamentals of systems thinking to recognize the interconnectedness of people, environment and processes.	2017-2022
SUS6820	Off Grid Energy Lab	Learn to design and develop solutions for small- medium sized off-grid energy systems in Hawaii. Participants will actively collaborate to research and design off-grid solutions and develop budgets and installation plans for an applied off-grid project.	2021-2022
SUS6051	Energy Efficiency Lab	Learn to analyze energy efficiency data and develop practical, cost saving solutions in a hands-on lab through an applied project. Engage in data collection, energy and process efficiency analysis using Excel and develop a cost / benefit analysis for an applied project.	2021-2022

SUS6026	Entry Level Photovoltaic Design & Installatic	Learn the principles of small business, residential and commercial PV installation and battery-based design. This training prepares participants to take the Entry Level North American Board of Certified Energy Practitioners (NABCEP) PV Associate exam. Participants will complete Intro to Renewable Energy prereq module, Entry Level PV Design & Installation and Battery-based Photovoltaic Design courses to earn a Renewable Energy Certificate and be eligible for the certification exam.	2015-2022
SUS6007	Battery-based Photovoltaic Design	Students will work through step-by-step design process for battery-based applications, including stand-alone (off-grid), grid-tied with battery back-up, and hybrid systems. Apply the National Electrical Code (NEC) to battery-based systems.	2015-2022
AGR6090	Farm Apprentice Certificate	The Farm Apprentice Certificate of Professional Development (CPD) encompasses a six-month, 10-module curricula consisting of 11 courses designed to provide the fundamentals of knowledge and practice through instruction and on-farm mentoring demonstrations to prepare a beginning farmer to operate a farm using regenerative agricultural practices.	2018-2022

Developing Sustainable Aquaponics Systems for Food Security and Community Resiliency in Hawaii

External Evaluation

July 2021

Index

Executive Summary

Based at the University of Hawaii Maui College, the project intends to 1) Develop curriculum and implement apprenticeship-based workforce training program in aquaponics and sustainable food systems; 2) Evaluate the effectiveness of integrating locally sourced inputs; 3) Build community capacity through education, outreach and collaborative networks with local government and workforce-focused nonprofit organizations; 4) Increase the number of students pursuing college and career pathways in agriculture.

A team of independent external evaluators led by *Hawaii Integrated Analytics LLC* conducted the evaluation of Year 1 of the grant by reviewing the new curriculum developed, engaging participants of the program into different surveys, conducted interviews with faculty and staff in charge of developing and teaching the new curriculum and reviewed teaching evaluations of instructors.

Despite the challenges imposed by COVID-19 (including online learning, limited interaction with the community, etc.), notable preliminary findings of the program include:

- The curriculum developed has the right balance of theory and practice that is well received for a very diverse cohort of students.
- Observed the robust operation of the program even under the challenges of COVID-19. Instructors were able to pivot to online instruction as necessary.
- Students were satisfied with the program, as reflected in pre and post evaluations of the program. Students gained significant knowledge on aquaponics and were very satisfied with the hands-on, in-class activities and lectures. Students improved their skills in a greenhouse, aquaculture, and horticulture. Students also felt confident that their experience taught them how to build their own aquaponics system for personal or commercial reasons.
- Evaluators observed improvements in the value of life-long learning, ʻāina-based learning, and a large educational multiplier of 50% or more, which would likely lead to intergenerational increases in educational attainment.
- The students also showed improvements in participants' mental health who continued in the program and documented healthier eating practices for the cohort of participants.

The main recommendations of the program revolve around:

- Continuous caution that should be exercised during COVID-19 to meet the project goals. Despite the higher-than-expected student attrition, it remains within normal levels for an outreach program operating during COVID-19. It is recommended that continuing measures to reduce this attrition are in place for the Year 2 of the grant.
- Despite the instructor’s effort to adapt a European aquaponics textbook to the local Hawaiian context, further improvements can be made to facilitate the theory into practice. The book's final chapter may be omitted in favor of social science examples based in Hawaii, rather than some materials that some students found offensive.
- Continue the engagement with stakeholders, from local nonprofit organizations to healthcare and well-being stakeholders, to make this program sustainable in the long term.

Overall, the program is on track to meet and exceed the aims proposed.

Introduction

Based at the University of Hawaii Maui College, the summary of the project (provided by the grantee) are to develop a workforce training in aquaponics as an effective food production method of raising fish and produce together in a single energy-efficient, recirculating system. Conducted at the WaiPono Farm at the University of Hawaii Maui College, the project aligns with the Agricultural Workforce Training program goals by developing new curriculum that integrates job-based, experiential learning opportunities and new technologies to enable a work-ready labor force for 21st century agricultural jobs. Participants to be recruited include adults in Hawaii, with a focus on Maui County, interested in education and careers in sustainable agriculture, aquaculture, and aquaponics. Project objectives include: 1) Develop curriculum and implement apprenticeship-based workforce training program in aquaponics and sustainable food systems using AI technologies such as remote sensing and machine learning; 2) Evaluate the effectiveness of integrating locally sourced inputs; 3) Build community capacity through education, outreach and collaborative networks with local government and workforce-focused nonprofit organizations; 4) Increase the number of students pursuing college and career pathways in agriculture with a minimum of 75% continuing education and/or employment in agriculture-related fields upon completion. The potential impacts of the project include advancing knowledge in the applied sciences in agriculture, improving natural resource use of water; developing a sustainable, culturally informed food systems model to reduce dependence on imported inputs and fossil fuels; and building a network of partners to support a sustainable agriculture system.

Notably, the project has unique challenges and opportunities that are specific to Hawaii. For instance, local farmers face substantially higher costs of resources in Hawaii relative to mainland locations. Hawaii also follows the national trend of an aging agricultural workforce and a lack of insufficient numbers of trained and diverse professionals entering the agricultural profession. Despite all these challenges, unique local opportunities exist to improve the sustainability of agriculture through optimizing local resources, building a pipeline of new agriculturalists, and building community capacity. Having these challenges and opportunities laid out, the program would develop a new curriculum that aims to impact a diverse group of students from all age ranges (for cohort 1, ages 17-59 years old).

Notably, the grant uses unique infrastructure and personnel at the UHMC. For facilities, WaiPono Farm Greenhouse provides hands-on experiences to the students. In addition, classroom and online technology at UHMC was utilized. The program also included various personnel that makes this possible, including three instructors, curriculum developers, coordinators, instructional designers, and advisors.

In addition, the program utilizes an outreach model of training that attracts a diverse group of students that would not typically attend college, thus expanding the capacity of the program to new settings.

Structure of Program and Main Outcomes (Year 1)

During the first year of the project, the main activities of the project observed by the evaluator included:

1. Development of the new training curriculum that includes new methods for optimizing aquaponics systems in Hawaii (Fall 2020)
2. Students received hundreds of hours of theoretical training and hands-on training. The first cohort of apprentices graduated in Spring 2021 with a Certificate of Professional Development
3. A variety of community workshops were developed.

Anticipated Program Outcomes

The project seeks to achieve the following outcomes:

1. Increase the number of students pursuing college and career pathways in agriculture on Maui, with a focus on underrepresented, first-generation college-going, culturally diverse, and Native Hawaiian participants
2. Increase in new fundamental and applied knowledge of aquaponics among participants aged 16 years and older.
3. Increase in skills in greenhouse operations, aquaculture, and horticulture Standard Operating Procedures among participants.
4. Increase efficient operational methods to source local fish feed.
5. Increase in use of agricultural technologies in aquaponics systems in Hawaii.
6. Increase the number of students pursuing college and career pathways in agriculture on Maui, focusing on underrepresented, first-generation college-going, culturally diverse, and Native Hawaiian participants.
7. Set the ground to more significant outcomes such as:
    a. Cultivate a robust and competitive agricultural workforce
    b. Address food security in Hawaii through the production of more local food
    c. Increase productivity of food production
    d. Improve community health

Evaluation Methodology

Surveys of Student Participants

Two questionnaires were developed to solicit data relevant to student outcomes in the aquaponics apprenticeship program. The surveys focused on the requested categories of Demographics and Socioeconomic Status, Health Status, Community Orientation, and SLIM Experience. The questionnaires were developed in collaboration with the program staff and the team of evaluators. The program staff was able to provide subject matter expertise, and the data analysts used prior evaluation experience to determine the optimal questions and phrasing for the survey.

The questionnaires were deployed to the participants using Qualtrics software at the beginning (intake) and end of the program (follow-up). Primary data was accessible only to the analysts, who provided de-identified data and analysis to program staff. All students were asked to take part in the surveys. Of the 16 students, only 12 students completed the intake survey, and 10 took part in the follow-up survey. This resulted in only six students who took both surveys that will be used in this report for comparison purposes. The lack of data on the students who did not take both or either survey may result in the inability to generalize results to the entire cohort. There may be differences between those who did and did not take the surveys.

Interviews with Instructors

To achieve a fuller picture of the program activities and outcomes, the three instructors were each interviewed. The instructors included the primary lecturer, the greenhouse coordinator, and the assistant to the greenhouse coordinator. The interviews took place over Zoom with the team of evaluators. Each interviewee was asked the same questions, and each interview lasted 20-30 minutes.

The questions were co-developed between the evaluators and the grantee to learn more about the instructors, their experience in the program, and any recommendations they could provide. The instructors were asked about their backgrounds related to aquaponics and how that led to and motivated them to be a part of the program. They were asked what the most and least effective or successful aspects of the program and their recommendations for improvement were. They were also asked if they felt that the program led to increased connection for students to the ʻāina and Hawaiian culture.

Participant Characteristics

The 12 participants who took the intake survey in the program included individuals from varying backgrounds. Half of the participants were male, and the other half female. The majority were Caucasian (67%), along with individuals who identified as Caucasian and Native Hawaiian, Native Hawaiian, Filipino, and other. The largest educational attainment group of the participants was those only with a high school diploma or equivalent (GED), representing 42% of participants. A wide range of college majors (planned, current, or graduated) were in the program, including Agriculture & Natural Resources, Culinary Arts, Computer Science, and Hotel Operations Management. The program targeted a wide range of community members, with the youngest participants being in high school and the oldest being 59 years of age, many of whom would traditionally not be attending college at this time.

Characteristic	N = 12
Age	46 (17, 59)
How do you identify? - Selected Choice	
Female	6 (50%)
Male	6 (50%)
What are the ethnic groups you identify with (Check all that apply) - Selected Choice	
Caucasian	8 (67%)
Caucasian,Native Hawaiian	1 (8.3%)
Filipino	1 (8.3%)
Native Hawaiian	1 (8.3%)
Other	1 (8.3%)
What is the highest degree you earned? - Selected Choice	
High school diploma or equivalency (GED)	5 (42%)
Associate degree (junior college)	2 (17%)
Bachelor's degree	1 (8.3%)
Master's degree	3 (25%)
Other. Please describe:	1 (8.3%)
What is/was your major in college?	
Agriculture & Natural Resources	1 (10%)
Computer Science	1 (10%)
Culinary Arts	2 (20%)
Dietetics	1 (10%)
Education	1 (10%)
Educational Studies	1 (10%)
Hotel Operations Management	2 (20%)
Other or I did not graduate from College	1 (10%)
Unknown	2

Table 1: Participant Demographics

Study Results

In the following section, we analyze the close-ended and open-ended questionnaire responses to explore specific questions and broader inquiries. Direct participant quotes from the open-ended written responses are included to illustrate significant points in the participants' own words. The results section is divided into six subsections, starting with the participants' insights regarding their experience in the program. We then examine participants' perspectives about the experience and their post-program outcomes in the three areas of educational attainment, health and well-being, and social networks. Finally, we discuss the respondents' recommendations for the refinement of the program.

Results from Students

Program Experience

This section will evaluate the participants' written responses to their goals, experiences, and suggestions for the program. They were asked a series of open-ended questions regarding their expectations and outcomes from being in the program.

The first question asked was "At the beginning of your participation in the sustainable aquaponics apprenticeship program, what were your goals, and have they changed after your participation?" The following word-map was created based on the responses. The size of each word represents how frequently it was used.

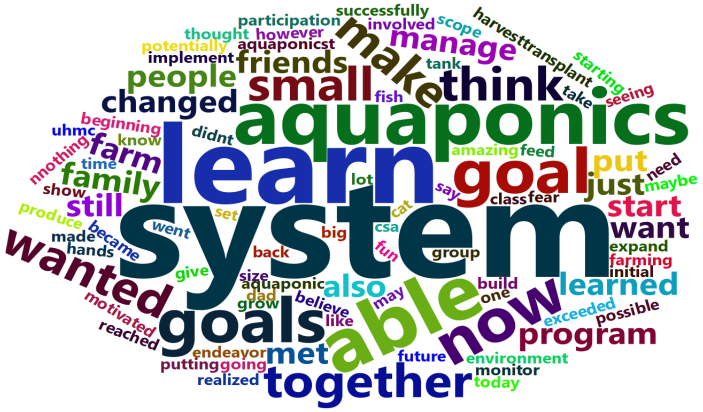

Figure 1: Word Map of "At the beginning of your participation in the sustainable aquaponics apprenticeship program, what were your goals, and have they changed after your participation?"

From the word-map, it can be seen that most participants joined the program to learn about aquaponics systems. The program gave a few students the confidence to increase

their original goals of having a small system to a larger scale. Below are some direct quotes:

"My initial goal was to learn about the future of farming, and after my participation, I am now able to put together a system and know what to monitor, how to harvest/transplant. And I also met some amazing people who I learned a lot from."

“Thought I was going to do just an aquaponic system for my family and friends. Now I believe I could make a go of starting a small CSA set up.”

"My goal was to learn about aquaponics and to maybe make a system of my own. After the program, I am now motivated to make a big Aquaponics system like the one at UHMC and also give the produce I grow to people who need it.”

They were then asked, "What were the most rewarding parts of your participation in the program?" The most common themes included making new friends, learning about the system, and the hands-on experience. Students expressed that they most valued working with the staff to learn-by-doing in combination with the informative classroom sessions.

Figure 2: Word Map of “What were the most rewarding parts of your participation in the program?”

The participants were asked what the most challenging part of the program was. The homework readings and research projects were mentioned in nearly every response. A few students mentioned the time commitment needed to complete assignments exceeding their expectations. A couple of respondents mentioned difficulty with using a

computer with no prior experience and struggling with the necessary mathematics. The following word-map was created from this question and highlighted these responses.

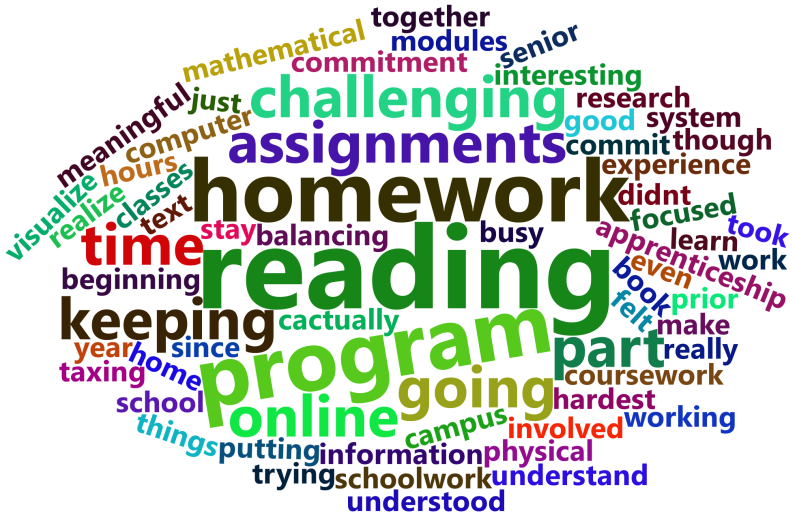

Figure 3: Word Map of “What were the most challenging parts of your participation in the program?”

A direct quote from a participant includes most of the concerns that were described by students. As most students expressed that they enjoyed the hands-on and in-class activities and lectures, the main challenge appears to be the work done at home on top of their outside commitments and responsibilities.

> “The most challenging part of the program was the homework. I understood the time commitment involved at the beginning of the program. I just didn't realize how taxing it would be on me. I could commit to the physical part of the program but when I had to go home and do reading and research for homework, I could not stay focused even though the assignments were interesting and so meaningful.”

The students were asked "What were the most valuable things that you learned?" Participants described the specific lessons that they found most useful, including how to set up the systems, the detailed understanding required, and the balance to keep it running. A word-map of the responses is shown below.

Figure 4: Word Map of “What were the most valuable things that you learned?”

The participants described the specific lessons and tools they found most valuable. They mainly discussed being able to create their own system using what they learned in the program. Below are some direct quotes from students.

"I would have never thought of the amount of time that goes into taking care of a greenhouse and these systems. It made me appreciate it more, and seeing how quickly these plants grow and are able to be harvested was super exciting! I am extremely thankful I had this opportunity because I would like to do this for a living and set up my own system as well.”

“Learning a lot about what PH, ammonia, nitrite, and nitrate levels are supposed to be was pretty valuable. Also, to make sure to look around the system to make sure everything is working and that no plants have any bugs or are dying.”

The final open response question that was asked of participants was to discuss any suggestions for improvement they have for the program. While some participants thought the program was successful as is, others offered some recommendations. These included increasing the duration of the program up to 20 weeks, having more time in the greenhouse, and having a break of a week or two in the middle for catch-up on assignments. A final word-map was created using the responses to this question.

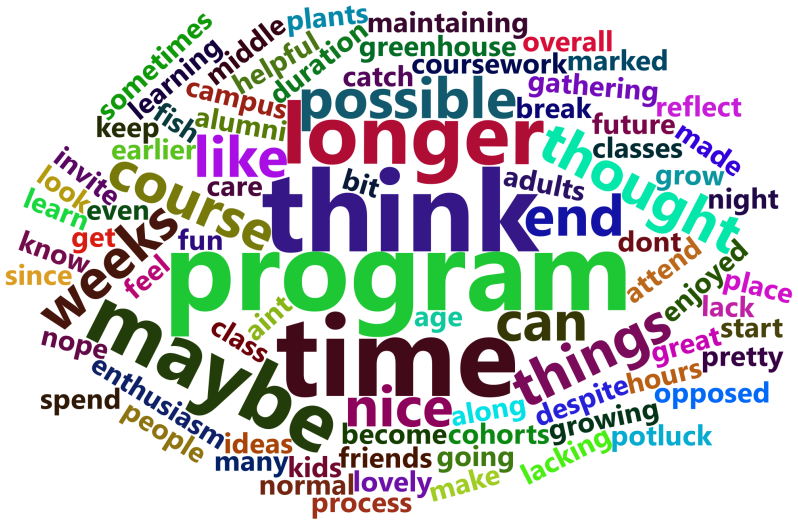

Figure 5: Word Map of “Figure 4: Word Map of “What were the most valuable things that you learned?”

Overall, the open response questions pointed to a positive experience for most participants. Learning how to set up the systems and what is needed to keep one running, having hands-on experience, and meeting people also interested in aquaponics were the most common positive aspects that students named. The main critiques were the amount of at-home reading, researching, and assignments, on top of the classroom and greenhouse time. Students reported increased confidence in their ability to run their own systems for their families or as a small business. A few students suggested that the program be longer and that there be more allotted time to work in the greenhouse.

Educational Attainment

Valuing Education

For this subsection, only students who completed both the beginning and follow-up surveys will be included to have an equal comparison for before and after. This is only six students (out of a total class size of 12); however, their responses still indicate some trends resulting from their participation.

The students were asked a series of questions regarding their value of education and learning. While most students “Agreed” or “Strongly Agreed” with all statements, more shifted to “Strongly Agree” at the end of the program. Participants tend to view education as an asset and value college, ‘āina-based, and lifelong learning for themselves and others, as shown in Table 2.

For the question of “Please state how much you agree with the following statements regarding education: - I believe college has positively impacted my life,” two students

shifted from an ambivalent response of “Don’t Know” to agreeing or strongly agreeing, indicating an increase in the perceived positive impact of college. The other increases in responses were movements from “Agree”.

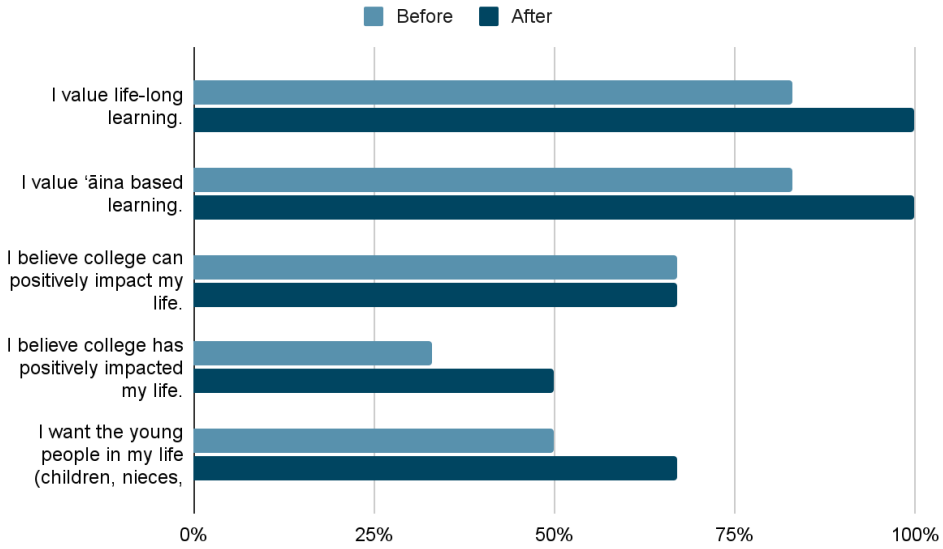

Table 2: Participants who "Strongly Agree" with the value of education questions N=6

Education Aspirations

Participants in the program were asked what degrees they aspired to attain. While only five responded to the question, they showed a large variance in the degrees which they aspire to attain. The largest category was those hoping to get a Bachelor’s Degree. Associate, Doctorate, and other degrees had equal numbers of student responses.

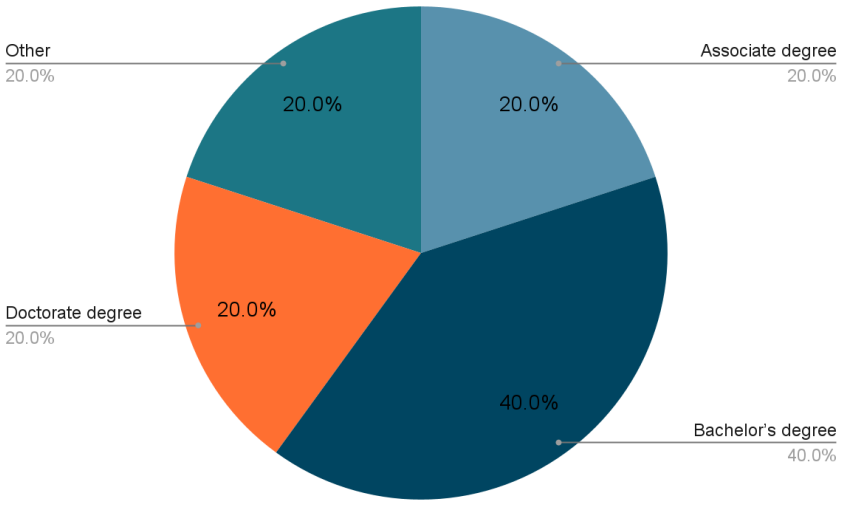

Figure 6: Degrees participants aspire to attain N=5

First-generation students are the first people in their families who graduate or intend to graduate from college. The students were asked if they were or expected to be first-generation students. Half of the students were not, and 42% said they were or expected to be.

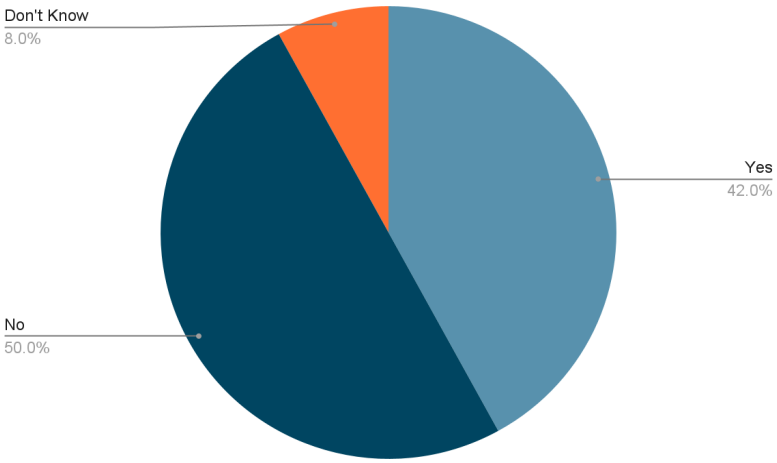

Figure 7: Participants who are or expect to be first-generation students N=12

Education Multiplier

Students were asked if they think that they inspired anyone in their family or community to go to college or further their education. 50% of students answered yes. Half of those who answered yes said they believe they inspired their children, which can lead to intergenerational increases in educational attainment. Others said they inspired friends and siblings.

73% of students said they were inspired by someone to go to college or further their education. 62.5% of those who said yes were inspired by a parent. 25% answered that they were inspired by a friend.

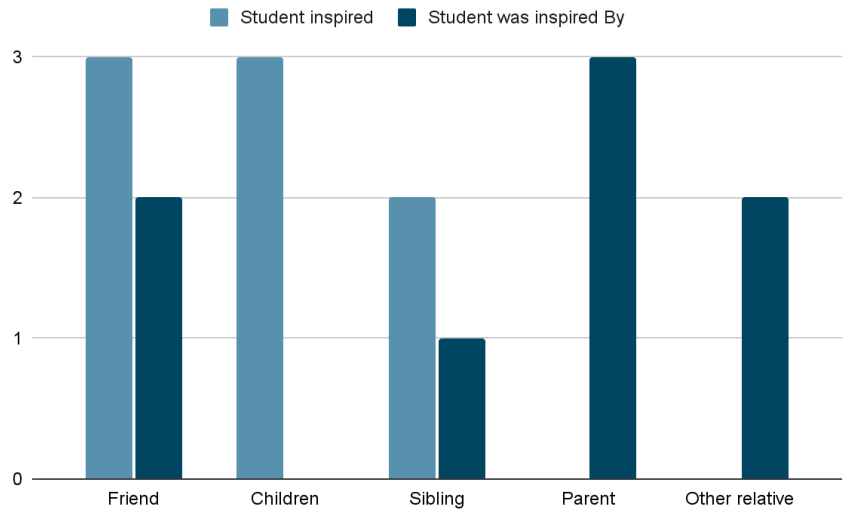

Figure 8: Who participants inspired to further their education, and who inspired the students to do so

Outcomes & Health Status

Mental Health

To learn about participants' mental health, a widely validated Rosenberg approach was used to measure respondents' level of self-esteem, using their self-reported answers to a series of specifically targeted questions.[1] We can see that of those who responded to both the beginning and follow-up survey; there is a notable increase in estimated self-esteem by 50% of the participants.

Self Esteem	Intake	Follow-up
Low	4 (67%)	1 (20%)
Normal	2 (33%)	4 (80%)
Unknown		1

Table 3: Estimated changes in self-esteem (N=6)

[1] Rosenberg's self-esteem scale - https://wwnorton.com/college/psych/psychsci/media/rosenberg.htm

Health-Related Behaviors

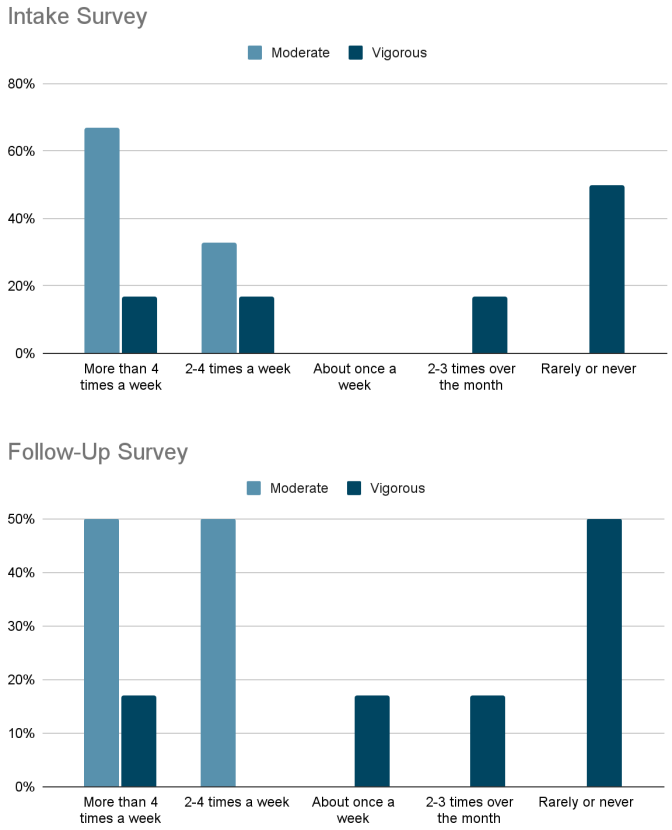

Figure [9] a and b: Frequency of moderate and vigorous physical activity before and after program participation. N=6

The participants were asked about their frequency of moderate and vigorous physical activity in the past month prior to the survey. Moderate physical activity included examples such as bowling, golf, light sports or physical exercise, gardening, and long walks. Examples of vigorous physical activity included jogging, running, swimming, aerobics, or strenuous sports.

There was a decline in vigorous physical activity, with more responding to the lower frequencies at the follow-up of the survey. Moderate physical activity also saw a small decrease in frequency by participants.

Eating Behaviors

For two of the metrics related to vegetable intake, we observed that 4 out of the 6 individuals exhibit higher scores of vegetable consumption in terms of variety and frequency of eating vegetables. Two of the remaining individuals slightly decrease their score. Both Variety and Frequency metrics were increase on average for the overall group and are represented in the following table. This aligns with results of the evaluator's previous studies.

Eating	Variety	Frequency
Intake	18.8%	13.1%
Follow-up	22.3%	16.1%

Table 4: Average change in vegetable consumption for Variety and Frequency

Body Mass Index

The Body Mass Index (BMI) of participants was calculated. Body mass index or BMI (kg/m^2) is a measure of risk for obesity that is calculated as the ratio of body weight (in kg) and height (in m^2). BMI can be categorized based on risk for obesity as follows: normal (below 24.9), overweight (25-29.9), and obese (more than 30). For the comparison group, this did not change before and after participating in the program. Half of the students were categorized as obese, 33% as overweight, and 17% as normal.

BMI Category	**N = 6 (%)**
Normal	1 (17%)
Overweight	2 (33%)
Obese	3 (50%)

Table [5]: Body Mass Index of participants (N=6)

Sources of Food

Participants were asked to rank the sources of their/their families' food from most to least amount, with 1 being most and 6 being least. From this, a normalized ranking was created to have the higher number represent a higher average ranked importance. The figure below shows that grocery stores are the most frequent place that students and their families sourced their food. These rankings did not significantly change before and after participating in the program.

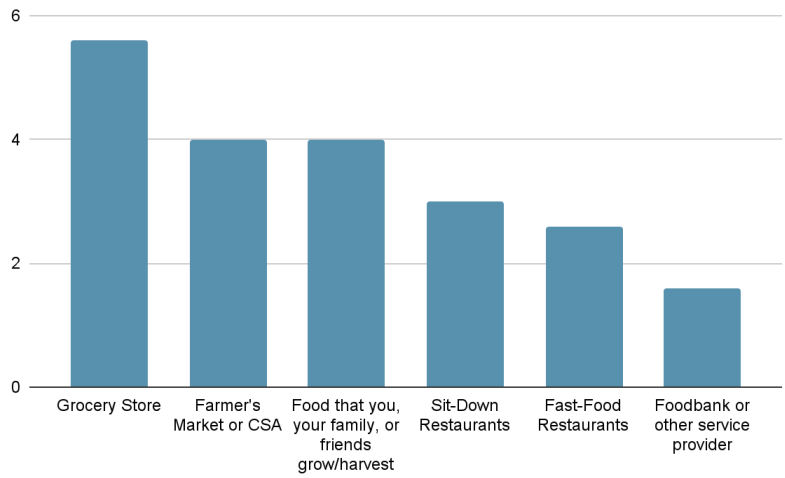

Figure [10]: Food source of participants from most to least commonly accessed. N=6

ʻĀina Connection

Participants were asked to describe their connection to ʻāina and their attitudes and practices regarding food sovereignty at the beginning and end of the program. Students reported “Strongly Agree” or “Agree” with most of the statements regarding valuing the land, their food, and nutritious choices.

There was a slight decrease from "Strongly Agree" to "Agree" after the program regarding the valuation questions. There was an increase in students who choose to eat healthy and nutritious foods and a large increase in those who grow their own fruits and vegetables. Most participants disagreed with the statement that they hunt and/or fish for their own food.

Question: In the following ways, how strongly do you connect to the ʻāina?	**Intake, N = 6**	**Follow Up, N = 6**
I think or I feel that ʻāina (land) and wai (water) are important community assets		
Strongly agree	6 (100%)	5 (83%)
Agree	0 (0%)	1 (17%)
I value local, organic, and/or sustainable agriculture		
Strongly agree	6 (100%)	5 (83%)
Agree	0 (0%)	1 (17%)
I know the value of and eat		

fruits and vegetables		
Strongly agree	6 (100%)	5 (83%)
Agree	0 (0%)	1 (17%)
I eat foods that are locally produced and/or naturally/organically grown		
Strongly agree	6 (100%)	5 (83%)
Agree	0 (0%)	1 (17%)
I choose foods that are healthy and nutritious		
Strongly agree	3 (50%)	4 (67%)
Agree	3 (50%)	2 (33%)
I grow our own fruits and vegetables		
Strongly agree	3 (50%)	2 (33%)
Agree	1 (17%)	4 (67%)
Disagree	1 (17%)	0 (0%)
Strongly disagree	1 (17%)	0 (0%)
I hunt and/or fish for our own meat/fish		
Strongly agree	1 (17%)	1 (17%)
Disagree	3 (50%)	4 (67%)
Strongly disagree	2 (33%)	1 (17%)

Table [6]: Estimated changes in connection to the ʻāina (N=6)

Food Security

For this analysis, food security was measured using an adapted questionnaire from the USDA Household Food Security survey[2]. There was a slight decrease in reported food security. At the intake survey, all of the matched participants reported no problem of food security, but this was reduced to only 83% in the follow-up, a non-statistically significant change.

Level of Food Security	**Intake, N = 6**	**Follow Up, N = 6**
No problem of food security	6 (100%)	5 (83%)
Low food security	0 (0%)	1 (17%)
Very low food security	0 (0%)	0 (0%)

Table [7]: Estimated changes in food security (N=6)

[2] https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/survey-tools/#six

Social Network

In order to understand social connectedness of individuals and extrapolate potential impacts of the program, connectivity of individuals was elicited. No statistically significant changes in social connectivity was observed from participants.

Family and Relative Relationships

Question based on interaction between participant and family (relatives)	**Intake, N = 6**	**Follow up, N = 6**
How many relatives do you see or hear from at least once a month		
Nine or more	0 (0%)	1 (17%)
Five to eight	0 (0%)	0 (0%)
Three or four	4 (67%)	2 (33%)
One or two	2 (33%)	2 (33%)
None	0 (0%)	1 (17%)
How many relatives do you feel at ease with that you can talk about private matters		
Nine or more	1 (17%)	1 (17%)
Five to eight	0 (0%)	0 (0%)
Three or four	3 (50%)	2 (33%)
One or two	0 (0%)	2 (33%)
None	2 (33%)	1 (17%)
How many relatives do you feel close to such that you could call on them for help		
Nine or more	1 (17%)	1 (17%)
Five to eight	0 (0%)	1 (17%)
Three or four	3 (50%)	2 (33%)
One or two	2 (33%)	2 (33%)
None	0 (0%)	0 (0%)

Table [8]: Changes in family social network (N=6)

Influence of Family and Relatives

Friend (non-relatives) Relationships

Question based on interaction between participant and friends (non-relatives)	Intake, N = 6	Follow up, N = 6
How many friends do you see or hear from at least once a month		
Nine or more	0 (0%)	0 (0%)
Five to eight	1 (17%)	2 (33%)
Three or four	2 (33%)	0 (0%)
One or two	3 (50%)	4 (67%)
None	0 (0%)	0 (0%)
How many friends do you feel at ease with that you can talk about private matters		
Nine or more	1 (17%)	0 (0%)
Five to eight	1 (17%)	1 (17%)
Three or four	0 (0%)	0 (0%)
One or two	3 (50%)	5 (83%)
None	1 (17%)	0 (0%)
How many friends do you feel close to such that you could call on them for help		
Nine or more	1 (17%)	0 (0%)
Five to eight	1 (17%)	1 (17%)
Three or four	1 (17%)	1 (17%)
One or two	3 (50%)	4 (67%)
None	0 (0%)	0 (0%)

Table [9]: Changes in friend social network (N=6)

Results from Instructors

Following the end of the program, the three instructors participated in 20-30 minute interviews to discuss their time developing the course and teaching the students. The instructors consisted of the primary lecturer for the online class portion, the greenhouse aquaponics coordinator, and the assistant to the aquaponics coordinator.

Instructor Backgrounds and Motivation

The primary online instructor has taught in the biology department at Leeward Community College for eight years. She had worked with the Perkins grant to create aquaponics and sustainable agriculture programs throughout the UH system. As she was not able to instruct in person due to the COVID-19 pandemic, the lectures were held online via Zoom. Over the course, there were a total of 150 online class hours from February to May. She was motivated to be a part of the program as she loves to teach and share her passion for sharing interesting information in an entertaining way.

The aquaponics coordinator had worked in the greenhouse prior to the start of the program and had been familiar with the systems used. He coordinated the lab activities that corresponded with the online classwork to allow for the students to see the theory in practice for the apprenticeship. The assistant to the coordinator has a background in entrepreneurship, food studies, and permaculture.

The coordinator was asked to take on the role after working in the greenhouse, and he found that he enjoyed teaching, sharing his knowledge, and offering the opportunity to experience this kind of work. The assistant to the coordinator had never been in an instructing position before but agreed to help with the program and found that it was a great learning experience for him.

The three instructors seemed very engaged and the right fit and combinations of multidisciplinary backgrounds for the program. They also had the expertise and qualifications necessary to instruct in the program.

Most and Least Effective/Successful Aspects of the Program

Similar to the responses of the students, instructors also noted that the hands-on work in the greenhouse was an effective tool for the students and instructors. While the online program focused on using open-sourced information for no charge, the in-person time allowed students to connect the theories taught in class with the actual implementation. As the greenhouse has many different systems in use, students were able to see the

same plants being grown in different ways and how different systems may be better or worse for certain crops and spaces.

The textbook contained all of the required theories for the course, but it was written in a European context, so translating the practices to the Hawaiian environment presented some challenges. The book had no examples in Hawaii, so these had to be incorporated into the course separately. Additionally, a student pointed out that a section of the textbook regarding the social science aspects of aquaponics presented material that was offensive to certain groups of people. The book also came with quizzes, but these often had incorrect answers or coding.

Again similar to student responses, the instructors noticed that the time commitment was tough on some students. As the wide range of participants included high school and college students as well as adults with full time jobs, some found keeping up difficult. The stipend aided attendance, but some students still struggled with the time commitment.

Some of the older students in the class wanted to know more practical knowledge about the logistics of running a small business that relied on aquaponics or hydroponics. The class did not include the specific business models, sourcing, and market analysis, so instructors were often asked these questions and had to answer to the best of their ability. *It is encouraged that future classes include aspects of business models, sourcing, and market analysis.*

Suggestions for Improvement and Long-Term Goals

Including a textbook or further incorporating Hawaiian examples and traditions was suggested by all instructors. As the textbook was created in Europe, the examples focused on that climate, including things like preparing for winters, which Hawaii does not experience. The current book was also found to be overly technical in some areas, such as describing the scientific methods and mathematics, both of which could be simplified to the level required to work with the systems. The final chapter of the book may be omitted in favor of social science examples based in Hawaii rather than the offensive material found in the book.

The wide age range of students presented fewer issues than the instructors had expected, but the goals and motivations for different age groups varied. Many of the younger students took the course to learn about aquaponics in a theoretical sense, while many of the older participants were interested in creating their own systems for their families or as a small businesses. Having a small system they can run at home through the course and maintain after these students could be very useful. Focusing more on the logistics of the market would also benefit these students. These students may also benefit

from a sustained connection following the program to be able to reach out when technical or other issues arise in their own systems. Lengthening the program could address this issue for some students to feel more confident in creating their own systems and maintaining them.

Lastly, an instructor suggested shifting the focus from a workforce training to one aimed at improving food security, as there is essentially no demand for workers with these skills. There could also be increased support for entrepreneurs looking to start their own aquaponic or hydroponic systems. This could lead into a possible long-term goal for the program to address food security. It could benefit from working with community members that have land or roof space where systems could be placed to grow food. An example on Maui could be unused sugar cane mills or roofs of car dealerships.

Connection to Land and Health Habits

Discussions in class often lead to local examples presented by the instructor or participants that are in the agricultural field. The experienced students were able to provide insight and answer questions from those less experienced in the field. Some participants came in with strong traditional knowledge of the ‘āina and shared this in discussions. Hawaiian students asked about the traditional use of such systems, and found that similar practices had been used to grow kalo in the past.

While diet was not directly discussed in class, discussions often lead to sharing of local sources for healthy and fresh produce. These would include recommendations of where to get fresh poke, to CSA and farmer markets, to finding options in food-insecure areas. Working in the system provoked many students to think deeper about where their food came from and how it ended up on their plates. Students were also able to take home fresh produce. Learning to grow fresh produce can provide increased access to healthy options for the participants. If they choose to have systems at their homes, this could benefit their diets and health.

Discussion and Recommendations

The evaluators were impressed by the ability of the team to put together the curriculum in the middle of the pandemic, as well as recruit a significant number of students into the program.

Despite the diverse cohort of students from all age ranges, some demanding more theory while others demanding more practice, the instructors were able to find the right balance to satisfy both groups of students.

Most students were satisfied with the program and gained significant knowledge on aquaponics, hands-on, in-class activities, and lectures. In addition, students improved their skills in the greenhouse, aquaculture, and horticulture. Students also felt confident that their experience provided them with learning to build their own aquaponics system for personal or commercial reasons.

Some notable findings of the evaluation include the value of life-long learning, ʻāina-based learning, and a large educational multiplier of 50% or more, which would likely lead to intergenerational increases in educational attainment. As the programs continue expanding, it is anticipated that these outcomes would continue persisting.

As a pilot, the evaluators introduced health metrics of students, and it was found that participants had an increase in self-esteem after their participation in the program. In addition, the program was able to find increases in healthier eating practices, notably increases in fiber intake for the small cohort of participants. Caution should be taken as the cohort was small and these may change across cohorts. It is recommended that instructors continue to encourage healthier eating, and when possible, continue letting students take fresh produce to their homes.

Some of the older students in the class wanted to know more practical knowledge about the logistics of running a small business that relied on aquaponics or hydroponics. If possible, it is recommended that instructors or a guest lecture is set up for students to learn more about specific business models, sourcing, and market analysis of aquaponics or hydroponics.

As the spread of COVID-19 in Hawaii continues, with record numbers expected in Fall 2021, continuous caution is recommended to meet students' enrollment and retention goals in the project's second year.

Despite the instructor’s effort to adapt a European aquaponics textbook to the local Hawaiian context, further improvements can be made to facilitate the theory into practice. The book's final chapter may be omitted in favor of social science examples based in Hawaii, rather than some materials that some students found offensive. Contacting other aquaponics programs (e.g., Waimanalo) or past aquaponics instructors (e.g., at CTHAR) to find these adaptations is recommended.

Overall, the project has already shown promising results on what can be achieved with a local, sustainable aquaponics training program. The evaluator encourages the team to draw better connections to systems change and food security. In addition, continue the engagement with stakeholders, from local nonprofit organizations to healthcare and well-being stakeholders, to make this program cost-effective and sustainable in the long term.

About the Evaluators

HIʻA is a Hawaii-based company that helps non-profit companies, community-based organizations, and other clients measure the impact of their programs and other initiatives throughout the state of Hawaii. Our services include but are not limited to the design of protocols for the effective and unbiased measurement of client-specified impacts, the micro and macro data collection from individuals and communities, data storage and management, and data integration and analysis, providing an interpretation of results to clients and the broader community. We have an unmatched caliber of scientific expertise and experience in the State of Hawaii, evaluating community- and education- projects and interacting with dozens of community-based organizations and programs, including several with an agriculture focus.

Our leadership team include four PhD scientists and a public health MA with complementary multidisciplinary expertise, from Economics and Social Sciences to Public Health and Education. Our leadership team has over 13 years of experience providing evaluations of education and non-education projects, including programs in the intersection of agriculture and education for federal and local funding agencies.

For more information please visit www.HIA.llc or contact info@hia.llc