

# Florida Agricultural and Mechanical University

TALLAHASSEE, FLORIDA 32307-6600

Exellence With Caring

SCHOOL OF THE ENVIRONMENT "OPENING DOORS TO ENVIRONMENTAL CAREERS" TELEPHONE: 850. 599. 3550 FAX: 850. 599. 8183

April 6, 2021

RE: Florida A&M University: Economic Development through Artificial Intelligence and Data Science-based Education and Training in Advanced Aquaculture

We present this request for funding to promote job growth and economic development through sustainable finfish aquaculture in Bay, Wakulla, Franklin, Okaloosa Counties, and beyond through Florida Agricultural and Mechanical University's Patent Pending Technologies. By combining the FAMU's leading edge innovations relating to aquaculture with appropriate K-21 education and certifications, we will be able to take a leadership role in the research education and training of the nation's aquaculture sector, while ensuring the protection of our Gulf waters. Requests to the Franklin & Okaloosa county commissioners to be placed on the next meeting agenda to have our proposal placed on their Triumph priority listing are being sent. Thank you for the opportunity to present our application.

If you have questions, please free to reach me at victor.Ibeanusi@famu.edu

Sincerely

### Victor M. Heanusi

Victor Ibeanusi, PhD Dh.c. (*Honoris causa*) Dean School of the Environment Florida Agricultural & Mechanical University Tallahassee, FL 32307 850-599-3550

# Contents

Section 1: Applicant Information	3
Section 2: Eligibility	5
Purpose of the Proposed Project	5
Project Details	5
Transferring Curriculum certificates to Jobs and Workforce Development:	7
A) Aquaculture Based-Curriculum development:	8
Predators and Pests	8
a) Certified Finfish Aquaculturist Program:	9
b) Aquaculture Business Skills Certification Program:	9
<b>B)</b> Arial drone swarm and Underwater drone school operational training certification: 1	1
C) Electromagnetics assisted Nutritional Enhancement for Algal Silage for Aquaculture and Ecosystem Restoration Applications	3
<b>D</b> Development of Career Themed Courses and Submission Florida Career and Professional Education (CAPE) for certification.	6
Budget Estimate:	0
Certification Estimates	4

# Section 1: Applicant Information

# Name of Entity/Organization: *Florida Agricultural & Mechanical University* **Background of Applicant Individual/Entity/Organization**:

Florida Agricultural and Mechanical University (FAMU) has a long and rich history of educating students at the undergraduate, graduate, doctoral and professional levels and enabling them to have a profound impact on society after graduation. It is the nation's largest comprehensive public land-grant research institution with approximately \$50 Million in annual research awards. Further, FAMU offers a wide array of skills and capabilities to assist our clients in meeting their research, technology, and workforce needs. FAMU is the only HBCU with a comprehensive engineering college that is jointly operated with Florida State University. FAMU is comprised of the following Colleges and Schools: Agriculture and Food Sciences, Arts, Humanities and Social Science, Allied Health, Business and Industry, Environment, Engineering, Education, Journalism, Law, Nursing, Pharmacy, and Science & Technology. It is precisely because of our comprehensive faculty base, our extensive operational support for research, and our growing graduate student population that guarantees tangible outcomes to programs such as this.

For example, for the past fifteen years FAMU has been awarded funding from the National Oceanic and Atmospheric Administration (NOAA) that established the Environmental Cooperative Science Center (ECSC), which supports research areas in Ecosystem Processes, Forecasting and Modeling, Human Dimensions, and Ecosystem Characterizations. Established in 2001 as part of the NOAA Educational Partnership Program, ECSC was charged to address ecological and coastal management issues at specific National Estuarine Research Reserves (NERR) and Florida Keys National Marine Sanctuary.

In 2016, the NOAA award continued that positions FAMU to lead one of the interdisciplinary team members of the **NOAA Center for Coastal and Marine Ecosystem (CCME)** over five years. This will allow the FAMU-led partnership to make profound national impacts on coastal and marine ecosystems education, science, and policy. Additionally, we have decades of **research** on the gulf coast region by students and faculty generating Ph.D. dissertations, including funding by faculty addressing BP oil spill remediation.

Most recently, we have established a **Center for Spatial Ecology and Restoration (CSER).** Through our partnership with the USDA Forest Service, we have received funding from the Restore Act that focuses on the development and distribution of applied geospatial technology and solutions for restoration and conservation of terrestrial and aquatic ecosystems as well as training the next generation of geospatial scientists and professional. This center could provide geospatial data describing aquaculture over geographical regions across the gulf coast region, identifying contaminant hot spots to expand the research frontier for novel discoveries that integrate systemsbased research and education for aquaculture solutions.

Following the devastating impacts of Hurricane Michael in October 2018, CSER@FAMU developed innovative techniques to assess forest damage using remote sensing, machine learning, and in-situ forest plots. CSER staff have worked closely with Microsoft to adapt and deploy these techniques into the Azure cloud computing environment so that post-disaster assessment can be done rapidly, at a lower cost, and more extensively compared to traditional approaches. While this method is still under development, initial results demonstrate tremendous promise for rapid hurricane damage assessment not only from Hurricane Michael, but also for 2020 hurricanes such as Laura, Sally, and Delta.

This remote sensing, AI, and cloud computing approach could potentially provide invaluable strategic information to first responders and land managers in the immediate aftermath of a natural disaster. It could also guide where more granular information (e.g., UAS imagery or field crew visits) should be collected in high-priority areas where damage has occurred. CSER@FAMU and our partners are leveraging AI, machine learning (ML), and deep learning (DL) algorithms in the distributed cloud to develop intelligent, cost-effective decision support systems to aid in natural disaster recovery response, as well as ecosystem restoration and management.

With the proper investment, CSER@FAMU can become a hub for a highly trained, diverse workforce in the expanding fields of data science, disaster response and natural hazard/risk assessment, sensing applications, IoT sensor arrays and natural resource management. The groundwork is already in place to rapidly expand this initiative through existing cost-share partnerships between the National Forests in Florida, and strategic partners at FAMU, UF, and Microsoft.

FAMU housed the Center for Plasma Science and Technology (CePaST), one of the premier centers for the study of plasmas in the state of Florida. CePaST is home to a highly successful team of faculty, students, and researchers dedicated to new science and new applications of theoretical, experimental, and computational plasma physics. Major programs include remote sensing research in the nation's defense, fusion, and plasma research for alternative power and advanced materials, and advanced computations research in support of plasmas and photonics physics.

FAMU also hosts the Centre for Complex Materials Design for Multidimensional Additive Processing, which promotes additive manufacturing of conventional and novel device structures and bioengineering.

In addition to the main Tallahassee campus, FAMU has several satellite campuses across Florida. These include the Crestview Campus of College of Pharmacy and Pharmaceutical Sciences (COPPS) in Okaloosa County.

### Federal Employer Identification Number: 59-0977035

### **Contact Information:**

Victor M. Ibeanusi, PhD. Dh.c (Honoris causa)

Dean, School of the Environment

Victor.Ibeanusi@famu.edu

850-599-3550

The total cost of this project: **\$16,767,008** The total amount of funding requested from Triumph Gulf Coast: **\$ 8,430,136** The total matching funds provided: **\$8,336,872** Has this been submitted for funding before? No Financial Status of Applicant: State-Funded – Part of the Florida State University System Has the applicant filed for bankruptcy in the last ten (10) years? No

## Section 2: Eligibility

#### Purpose of the Proposed Project

#### (Selected from the list provided in the Triumph Funds application)

Grants to support programs that prepare students for future occupations and careers at K-20 institutions that have campuses in the disproportionately affected counties. Eligible programs include those that increase students' technology skills and knowledge; encourage industry certifications; provide rigorous, alternative pathways for students to meet high school graduation requirements; strengthen career readiness initiatives; fund high-demand programs of emphasis at the bachelor's and master's level designated by the Board of Governors; and, similar to or the same as talent retention programs created by the Chancellor of the State University System and the Commission of Education, encourage students with interest or aptitude for science, technology, engineering, mathematics, and medical disciplines to pursue post secondary education at a state university or a Florida College System institution within the disproportionately affected counties.

#### k

Grants to support programs that provide participants in the disproportionately affected counties with transferable, sustainable workforce skills that are not confined to a single employer.

#### Project Details

#### Title:

# Florida A&M University: Economic Development through Artificial Intelligence and Data Science-based Education and Training in Advanced Aquaculture

#### Location:

Crestview, Okaloosa Impacted Sites: Bay, Franklin, Okaloosa & Wakulla.

#### Project Summary:

Aquaculture is critical to resolving the world's food insecurity and projected future food shortages. Food production needs to double by 2050 to feed the projected world population. The world's oceans represent the greatest potential source of protein by generating 30 x more yield per acre of water versus an acre of land. Aquaculture will be an ever-growing portion of the seafood industry and will enable us to have available, accessible, and affordable seafood while bringing much-needed economic development. The federal government recognizes the importance of growing the aquaculture industry. The U.S. Department of Defense has designated fish imports as a serious national security issue as finfish imports are often used for trafficking weapons and narcotics. Large-scale seafood imports also provide a basis for the use of biological weapons against the United States, emphasizing domestic production and achieve self-sufficiency in finfish production.

Global Aquaculture Market is valued approximately at USD 31.94 billion in 2019 and is anticipated to grow with a healthy growth rate of more than 7.1% over the forecast period 2020-

2027. Aquaculture products in the US market have significant growth potential over the coming five years. IBISWorld forecasts US industry revenue to increase at an annualized rate of 5.0% during the five years 2022 to 2027, reaching an estimated \$2.9 billion. The National Oceanic and Atmospheric Administration (NOAA) has stated that marine aquaculture is an important part of its strategy for building economic and environmental resiliency in coastal communities. (Ref.,

https://www.fisheries.noaa.gov/leadershipmessage/momentum- grows-aquacultureunited-states, September 2017). Seafood farming, if done responsibly—as it is in the United States—is increasingly recognized as one of the most environmentally sustainable ways to produce food and protein. Aquaculture Opportunity Areas and expanded domestic aquaculture industry are critical for the economic and environmental resiliency of our coastal communities, and national food security.

NOAA Fisheries announced federal waters off of the Gulf of Mexico (GoM) as one of the first two regions to host Aquaculture Opportunity Areas. The selection of these regions is the first step in a process designed to establish 10 Aquaculture Opportunity Areas nationwide by 2025. GoM was selected for future aquaculture opportunity area locations based on the already available spatial



Figure 1: Aquaculture Oppotunity Zones (Source: fisheries.noaa.gov)

analysis data and current industry interest in developing sustainable aquaculture operations in the region.

Aquaculture Opportunity Areas (AOAs) (Figure 1) are called for in the May 2020 Executive Order on Promoting American Seafood Competitiveness and Economic Growth. They are defined as geographic areas that have been evaluated for their potential for sustainable commercial aquaculture. Selected areas are expected to support multiple aquaculture farm sites of varying types including finfish, shellfish, seaweed, or some combination of these farm types. To identify each area, NOAA will use scientific analysis and public engagement to highlight spaces that are environmentally, socially, and economically appropriate for commercial aquaculture.

# FAMU being the host institution for NOAA's Centre for Coastal Marine Ecosystem will play a vital role in this process and will have first-hand information on such AOAs and their appropriate aquaculture designations.

Florida Agricultural and Mechanical University (FAMU) is proposing:

- 1) To lead job creation, investments, and economic growth for communities throughout northwest Florida through the creation of a vertical business model for finfish aquaculture that builds on the growing aquaculture industry in four disproportionately affected Counties.
- 2) To develop educational and training programs for students that will establish pathways to careers in the rapidly growing aquaculture industry, especially in the disproportionately affected.
- 3) To develop a business framework for the finfish aquaculture industry that will

assist small businesses in creating jobs, investments and economic growth for communities throughout Northwest Florida.

- 4) To scale-up and commercialize newly isolated strains of microalgae (patent pending) to significantly enhance the overall health and productivity of finfish aquaculture that is economically and environmentally cost-effective relative to the existing algal feedstock;
- 5) To ensure the ecosystem restoration for the area through best aquaculture practices
- 6) To implement a state-of-the-art underwater drone school technology (patent pending), that uses SASER (Sound Amplification by Stimulated Emission of Radiation) energy to ensure the protection against invasive species and harmful micro-algae, while providing real-time environmental monitoring and control.

# **Transferring Curriculum certificates to Jobs and Workforce Development:**

National security and global competitions to address food security for an ever-growing world population are creating new forces in the educational pathways for a well-trained workforce. This is especially needed in areas requiring additional ecosystems restoration, as the gulf region. EnergyWaterFoodNexusTM, is a new science enterprise established at FAMU through a global public-private partnership that seeks to provide sustainable and innovative solutions for energy, water and food security. FAMU has established a scholars-in-residence program to examine the resources needed to sustain the EnergyWaterFoodNexusTM. This program is focused on solutions that simultaneously address all three areas of sustainable energy, water and food security. The scholars-in-residence program provides eligible students with scholarship and mentorship opportunities that will contribute to building a well-trained workforce ready to solve the issues in their communities. Through funding from DuPont Foundation, we have already begun a Pathway-to-College initiative with Wewahitchka high school at Port St. Joe (Gulf county). This program will be expanded to include new scholars who understand aquaculture as a business and for job creation.

Additionally, the FAMU Center for Environmental Equity and Justice (CEEJ), along with the FAMU Cooperative Extension Program (Community Resource Development), will serve as a resource base for the Educational and Training programs. The CEEJ was established in 1994 through a Florida Legislative Act (Florida Law CH 94-219) to assist communities with disproportionate impacts from environmental hazards. Additionally, FAMU's Cooperative Extension Program has had a presence in the north Florida region for many years in areas including agriculture & natural resources. 4-H and youth development, family resource management, and community resource development. FAMU will utilize the expertise of faculty and staff in the Cooperative Extension Program, specifically the Community Resource Development extension program. The Community Resource Development program aids with initiating and implementing strategic development opportunities designed to promote community and economic growth through interaction with residents and organizations. The primary objective will be to facilitate community engagement and training of citizens and community leaders on local actions in response to coastal disasters. Such efforts will include but not limited to: ensuring integration of local advice into long-term decisions about projects and priorities; providing the public access of restoration information; and training of community leaders on ecosystem approaches to coastal disasters. The new focus on finfish aquaculture, will require training of students who understand the challenges in optimizing sustainable food production, new methods for pest control,

technologies to mitigate nitrogen and phosphate, ensuring sustainable water supply for agriculture; "closing the loop" for nutrient life cycles; innovations to prevent waste of food and energy; and maximizing biomass conversion to fuels, chemicals, food, and materials. These research areas have been identified by the National Science Foundation (NSF) as topics with knowledge gaps, requiring student training (NSF-FEW Report, 2014).

Through this funding opportunity, we will recruit a Research Scientist and Post-Doctoral Fellows that can enhance research and teaching across disciplines. These individuals must contribute to activities that will transform existing programs to meet desired outcomes of recruiting students for a trained workforce and increasing the pipeline of new students who will ultimately contribute to creating new jobs through aquaculture. To sustain this program beyond the life of this funding, two new faculty lines, which initially will be funded through this program will be absorbed by FAMU. Additionally, FAMU has pledged ~1:1 matching funds and the support of the Agricultural Extension programs to meet education and training needs. FAMU will also work with area vocational and community colleges to develop a curriculum aimed at enabling students to successfully participate in the burgeoning aquaculture industry within and outside the region.

### A) Aquaculture Based-Curriculum development:

Our proposed aquaculture farming is structured to take advantage of the biology and life cycle of a vast array of aquaculture with a focus on finfish to improve productivity. A basic understanding of these topics will greatly improve the productivity and marketability of one's product. There are several aspects of aquaculture that must be covered in a quality curriculum to train aquaculture ranchers successfully. The following is a brief note of the various aspects that need to be elucidated to the students.

# Predators and Pests

Florida waters are host to a variety or predators and pests. Many are native to this region and others were inadvertently introduced into the environment

Moreover, Coastal marine finfish farms attract a large range of species, including harbor seals (*Phoca vitulina*), grey seals (*Halichoerus grypus*), common bottlenose dolphins (*Tursiops truncatus*), cormorants (*Phalacrocorax carbo*), shags (*Phalacrocorax aristotelis*), grey herons (*Ardea cinerea*), gulls (*Larus* spp.), pelicans (*Pelecanus* spp.), grebes (*Podiceps* spp.), otters (*Lutra lutra*) and minks (*Mustela vison*). Our patent-pending underwater drone schools and aerial drone swarms identify and deter all these predators using environmentally harmless Microwave Amplified Through Stimulated Emissions of Radiation (MASER) and Sound Amplification through Stimulated Emission of Radiation (SASER) signals, providing a safe-haven for aquaculture in the designated AOAs.

Most of these predatory crab species can be trapped or collected by hand and removed from the area or potentially kept in check by the drones.

Florida A&M University proposes that we train hundreds of students especially underrepresented minorities in aquaculture with the proposed curriculum development activities.

Curriculum development is a major task and would require significant financial support to develop a quality curriculum. Therefore, the curriculum development process is at its infancy pending financial support. It is proposed that FAMU would develop two curriculum tracks

- 1. Certified Finfish Aquaculturist Program
- 2. Aquaculture Business Skills Certification Program

The details of these two curriculum tracks are given below.

# a) <u>Certified Finfish Aquaculturist Program:</u>

This certification program would comprise of three specialized courses with three credit hours each. Anyone who graduated from high school and qualified to do undergraduate studies at FAMU would be eligible to participate in this program. There will also be a required practicum once a week to the aquaculture demo sites to gain hands-on training. The specialized courses included for this certification are

- 1) EVR XXXX Basics of Small-Scale Aquaculture Farming
- 2) EVR XXXX Spawning and Rearing
- 3) EVR XXXX Basics of Aquaculture Processing

# b) Aquaculture Business Skills Certification Program:

This certification program would comprise of the same three specialized courses with three credit hours each that are part of the Certified Aquaulturist Program. Anyone who graduated from high school and qualified to do undergraduate studies at FAMU would be eligible to participate in this program. There will also be a required practicum once a week to the aquaculture farming to gain hands-on training. In addition to the three specialized courses, two additional courses already existing at FAMU (offered by the School of Business & Industry) will be utilized. They are

- 4) MAR 3023 Principles of Marketing
- 5) MAN 3025 Principles of Management

# **Example Curriculum Content**

Although the curriculum content for the three specialized courses are still under development, the following is an example course outline for Finfish Spawning and Rearing Course

# EVR XXXX Introduction and to Aquaculture Rearing

In this course, students will learn methods for spawning a variety of finfish using temperature and water quality manipulations. This activity will take about two hours per day for approximately two weeks

The students will also learn the benefits of using cutting-edge technology like the microwave annealing of algal microbial mats for tilapia feeding and the use of underwater drone swarm patrolling systems for keeping the predators in check while monitoring water quality.

# Learning outcomes

Students will be able to:

- 1. Describe the reproductive biology and growth of finfish.
- 2. Explain how finfish and other aquatic species develop.
- 3. Describe the conditions used in the commercial production of seafood.
- 4. Apply techniques used for small-scale aquaculture farming.

# **Student Performance Standards (Sunshine State Standards)**

06.03 Illustrate correct terminologies for animal species and conditions (e.g. sex, age, etc.) within those species (LA.910.1.6.1, 2, 3, 4, 5; SC.912.L.14. 19, 31, 33).

*11.01* List and explain the meaning of morphology, anatomy, and physiology (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.912.L.14.7).

11.02 List and describe the physiology of aquatic animals (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.912.L.14.11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 28, 29, 31, 32, 33, 34, 36, 40, 41, 42, 43, 45, 46, 47, 48, 51SC.912.L. 18. 7, 8, 9).

*11.10* List and describe the major factors in the growth of aquatic fauna and flora (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.7.L.17.1, 2, 3).

12.01 Recognize and observe safety practices necessary in carrying out aquaculture activities (LA.910.1.6.1, 2, 3, 4, 5; LA.910.4.2.2, 5).

*13.02* Explain how changes in water affect aquatic life (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.912.L.17.2, 3, 7, 10).

13.03 Explain, monitor, and maintain freshwater/saltwater quality standards for the production of desirable species (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

14.01 Identify factors to consider in determining whether to grow an aquaculture species (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.7.L.17.3).

14.02 Identify/describe facilities used in a grow-out operation (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

14.04 Determine the purpose and functions of a hatchery (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

14.05 Identify and describe the sexual reproductive process and methods of reproducing aquaculture organisms (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.7.L.16.3).

14.06 Identify and describe the spawning facilities used in aquaculture (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

15.01 Identify the types of growing systems and important factors in their selection, design, and use (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

#### B) Arial drone swarm and Underwater drone school operational training certification:

One of the important limiting factors in restoring any ecological system is the agricultural runoff containing pesticides and chemicals that are harmful to many organisms that are sensitive to them. The important step in the development of a new autonomous ecofriendly pest control system is made possible by improvements in artificial intelligence, holding open the possibility that groups of micro-drones (less than 6 inches) could act together under human direction. Such drone swarms would be cheap to produce and able to overwhelm the swarms of pests. The micro-drones have already demonstrated advanced swarm behaviors such as collective decision-making, adaptive formation flying, and self-healing.

In 2018, funding from the Gulf Coast Ecosystem Restoration Council (RESTORE) provided seed money to establish the Center for Spatial Ecology and Restoration (CSER), a long-term partnership between the USDA Forest Service National Forests in Florida (NFF) and Florida A&M University (FAMU). CSER@FAMU has become a collaborative academic-industry-government center of excellence through partnerships with Microsoft (through 2 AI for Earth grants), USDA Forest Service Research (RMRS, SRS), University of Florida's School of Forest Resources and Conservation (GatorEye UAS), Dow Chemicals, and many others.

Following the devastating impacts of Hurricane Michael in October 2018, CSER@FAMU developed innovative techniques to assess forest damage using remote sensing, machine learning, and in-situ forest plots. CSER staff have worked closely with Microsoft to adapt and deploy these techniques into the Azure cloud computing environment so that post-disaster assessment can be done rapidly, at a lower cost, and more extensively compared to traditional approaches. While this method is still under development, initial results demonstrate tremendous promise for rapid hurricane damage assessment not only from Hurricane Michael but also for 2020 hurricanes such as Laura, Sally and Delta.

This remote sensing, AI and cloud computing approach could potentially provide invaluable strategic information to aquaculturists. It could also guide where more granular information (e.g., UAS imagery or field crew visits) should be collected in AOAs. CSER@FAMU and our partners are leveraging AI, machine learning (ML), and deep learning (DL) algorithms in the distributed cloud to develop intelligent, cost-effective decision support systems to aid in natural disaster recovery response, as well as ecosystem restoration and management.

With the proper investment, CSER@FAMU can become a hub for a highly trained, diverse workforce in the expanding fields of data science, disaster response and natural hazard/risk assessment, sensing applications, IoT sensor arrays, and natural resources management. The groundwork is already in place to rapidly expand this initiative through existing cost-share partnerships between the National Forests in Florida, and strategic partners at FAMU, UF, and Microsoft. Moreover, this work aligns with USDA's strategic goals to strengthen the stewardship of private lands through technology and research and foster productive and sustainable use of our National Forest System Lands. Since this technology is transferrable to other industries, it also aligns with the USDA's Agriculture Innovation Agenda to stimulate innovation so American agriculture can achieve the goal of increasing production by 40 percent while cutting the environmental footprint of U.S. agriculture in half by 2050.

Currently, after integrating our hurricane damage assessment workflows into Azure using the FarmBeats interface, we now have the ability to: 1) rapidly download imagery to Azure Virtual Machines by simply inputting dates and spatial areas of interest, 2) process cloud-free imagery using Microsoft technology within Azure, 3) conduct spectral normalization of imagery in the cloud for improved modeling across spatially and temporally separated images, 4) run various statistical analyses through software packages deployed in Azure, and 5) use machine learning tools to produce multiclass probability distributions for forest identification purposes. All of this can now be done in record time.

On the other hand, drone swarms are synchronized individuals acting together as a collective organism, sharing one distributed brain for decision-making and adapting to each other like swarms in nature. They communicate and collaborate with every other and the swarm has no leader. Hence, they can gracefully adapt to swarms of pests entering or exiting the team.

By integrating FAMU's patent-pending solid-state MASER (Microwave Amplified using Stimulated Emission of Radiation) a device using the stimulated emission of radiation by exciting

atoms to amplify or generate coherent monochromatic electromagnetic radiation in the microwave range) and generating short pulses, the pests can be destroyed disabled (or) instantaneously. Laboratory studies have also identified that pulses although laser not effective to kill all the larger pests like the locust, sterilize the males and the sperm sac of the females resulting in no offspring. Moreover, by integrating night vision into the systems, pests like locusts, which cannot fly at night due to colder temperatures, can be easily targeted and destroyed.

A schematic of the proposed technology is presented in Figure 2.



Figure 2: Hybrid MASER Drone Swarm

In an underwater environment, a solid-state sound amplification by stimulated emission of radiation (SASER) (a device using the stimulated emission of sound waves to amplify or generate coherent sound waves in the ultrahigh-frequency range) device is used. The SASER generates short pulses, any biological entity can be sterilized (made nonreproductive) or destroyed (or) disabled instantaneously by applying SASER pulses in a targeted fashion. Integrating bio-sensors with SASER would act as a real-time data acquisition, monitoring, and eco-systems control tool. Laboratory studies have also identified that SASER pulses are an effective means of communication as well as a reliable 3D mapping tool. This combined with water quality sensors and LiDAR could make these schools of drones ideal underwater dwellers. Moreover, if equipped with foldable solar panels they can charge themselves and return to work autonomously. Figure 3 represents a schematic of this technology.



The curriculum for training is still under development as the development of these technologies are still in progress in these two patent-pending technologies.

# C) Electromagnetics assisted Nutritional Enhancement for Algal Silage for Aquaculture and Ecosystem Restoration Applications

Aquaculture is critical to resolving the world's food insecurity and projected future food shortages. Food production needs to double by 2050 in order to feed the projected world population. The world's oceans represent the greatest potential source of protein by generating 30 x more yield per acre of water versus an acre of land. Aquaculture will be an ever-growing portion of the seafood industry and will enable us to have available, accessible, and affordable seafood while bringing much-needed economic development. The federal government recognizes the importance of growing the aquaculture industry. The National Oceanic and Atmospheric Administration (NOAA) has stated that marine aquaculture is an important part of its strategy for building economic and environmental resiliency in coastal communities.

But decreasing fishmeal supply is a major concern for the future of the aquaculture industry. The use of algal silage as a dietary replacement for fish meal is a solution proposed by many researchers. Preparing algal silage from microalgae has the following advantages.

1) Algal biomass resources are converted into dietary materials for aquaculture.

2) the silage is acidic and therefore will have a long shelf life at room temperature. Therefore, surplus cultured microalgal silage can be preserved and utilized depending on the demand or even distributed to other aquaculture farms.

3) The silage will have several health benefits for the aquacultured organisms and therefore will result in high-quality cultured fish.

4) This microalgal microbial mat will protect and feed aquatic life.

This invention uses metagenomics techniques, that incorporate the addition of new algae and bacterial prospects to enhance the nutritional value for high yield aquaculture, including finfish production. A newly developed solid-state microwave applicator will be used not only to improve the nutritional composition of the microalgae but also to expedite the annealing process of the microalgae on the silage. New isolates have been screened for their natural abilities to produce added nutritional value comparable, if not higher, relative to industry gold standard strains. Figure 4 shows the Production of microbial biomass using wastewater. Figure 5 presents the schematic of the focused single-mode microwave equipment and Figure 6 presents a simulated microwave power distribution and the annealing effect using a multimode cavity applicator. Figure 7 presents the schematic of the floating microalgal mat in an aquaculture environment.



Figure 4: Production of microbial biomass using wastewater



Figure 5: Schematic of the focused single-mode microwave equipment



Figure 6: Simulated microwave power distribution and the annealing effect using a multimode cavity applicator



Figure 7: Schematic of a Floating Microalgal Mat in a Pond

# D) Development of Career Themed Courses and Submission Florida Career and Professional Education (CAPE) for certification.

The Florida CAPE certification list needs expansion to include evolving Florida industries/job/job titles. Many of these jobs in the Aquaculture industry need a Standard Occupational Classification (SOC) code. To serve today's evolving Aquaculture workforce needs, industry certifications developed in alignment with the industry needed. It has been documented that CAPE students who graduate with an industry certification outperform the academy students who graduate without an industry certification, with a higher placement rate in employment or postsecondary education. The curriculum developed in this project will be submitted to the FLDOE for approval and listing on the CAPE list. Moreover, these courses will be offered as Advanced Placement and Dual enrollment courses, thereby encouraging CAPE participants for post-secondary enrollment in universities.

#### **Summary of Recruitment Strategy**

Access to a secure, affordable supply of food is a basic human need. As the world's population increases from the current approximately 7 billion people to a projected level of well over 10 billion before the end of this century, new technologies for food production are needed to meet increased demand. In addition, as standards of living increase in countries with emerging economies, the types of foods produced will change. For example, by 2020 meat consumption in in different parts of the world is expected to double from 2005 levels; the increase in turn places more stress on food production, because appreciably more resources are required to produce meat than grains or vegetables. Thus, it is critical to explore the vast resources in aquaculture and to recruit and train students in this new workforce.

The recruitment plan for aquaculture certification builds upon FAMU's legacy of excellence of advancing opportunities for students to pursue careers in their chosen field. graduate and undergraduate degrees in Environmental Sciences and Environmental Studies that prepare them to address local, national and global issues. With a new Student Success Team in place, Florida A&M University School of the Environment (SOE) is poised to introduce our recruitment plan that will guide our efforts to attract, enroll, retain, and graduate high quality scholars who are competitive in the emerging environmental career field. Through a targeted and strategic emphasis on student success, SOE's recruitment plan will provide the framework for cultivating First-Time-In-College (FTIC), AA Transfers, Graduate MS Degree Seeking, and Ph.D. Candidates who are culturally diverse and uniquely prepared to address present and future interdisciplinary environmental science and policy issues. More specifically, impeding threats caused by the current Covid-19 global pandemic creates a dire need for students who understand global problems such as: climate change, population growth, land management, clean air and water quality, energy sources, natural resource conservation, and environmental health disparities. In maintaining a reputation of being a historical leader in the training of underrepresented minorities, this recruitment plan will not only support, but seek to advance the University's overall strategic goals for student enrollment, retention, graduation rates, degree production, and post-graduate outcomes.

### **Recruitment Strategies**

### 1. Summer Camps

We will conduct hands-on summer activities at four demonstration sites in the eight counties. Students will learn finfish classification and production techniques describing the health and safety issues associated with the production. Students who go through the 1-week summer boot camp will receive certificates by passing appropriate tests.

# 2. Enhance and implement effective and targeted recruitment strategies for FTIC Students and community college and other university AA transfer students.

Throughout the year we will be hosting the "Dean's Town Hall Series" that will provide the School of the Environment's response to relevant environmental topics such as sustainability, Climate Change, artificial intelligence, and geographical Information system (GIS). These discussion forums will allow us to invite and engage with prospective students, guidance counselors, community based-organizations (CBO), graduate feeder partners, and other internal/external stakeholders, while showcasing the research opportunities that exist within our school. In addition to the Dean's Town Hall Series, we will continue to host our monthly "Get to Know SoE Virtual Info Sessions." These sessions will serve as an introductory meet and greet opportunity for newly acquired prospects or applicants during each monthly timeframe. The focus of the welcome receptions is to build relationships, present our programs and research opportunities, highlight our Core Laboratories, promote scholarships opportunities that students may qualify, and showcase our academic student support services. Guests will have the opportunity to hear from the Dean, Faculty/Staff, and currently enrolled students; and receive answers to questions that may determine their enrollment decision.

# 3. Increase external partnerships with 4-year state colleges/universities—local high school directory, Regional contact list for Department that recommend student for grad programs.

This presents an opportunity for developing external partnerships and establish a contact listing of department liaisons from the eight counties who would recommend students for our aquaculture certification program.

Similarly, the above approach could be used for targeting our 2/4-year state and community college Ignite liaisons, and state and local high school college career counselors. These key influencers play an essential role in referring top scholars. Therefore, we must establish the must-current contact listings and organizing them in a database that will allow us to share our academic programs, research, and scholarship opportunities.

# 4. Grow and Expand our Social Media Presence to Engage Internal and External Stakeholders

Currently, we utilize Instagram and Facebook as our social media presence. However, our goal is to add Twitter, LinkedIn, and YouTube platforms. Several social media activities that we plan to promote include faculty, student, and alumni spotlights, testimonial, next steps, and VR360 videos, live streaming from labs, flyers for upcoming events, and promoting various annual environmental awareness causes. Additionally, we plan on having student ambassadors who will help ensure that we are posting relevant content and that we are staying consistent. **Examples:** 



### **Rebrand SoE's Website and Recruitment Brochures**

We will update the information on the SoE website to reflect updated program offerings and curriculum maps, faculty/staff profiles, student spotlights and academic program success stories, request for information (RFI) inquiry form, downloadable recruitment brochures, promo video, mini virtual reality tours and calendar of upcoming events. The stated changes are in collaboration with the University-Wide website update, scheduled for late July.



### **Calling Campaign**

Throughout the year, we plan to utilize our faculty, staff, and student peer ambassadors to contact students via a calling campaign. This calling campaign will provide a personal touch to the recruitment process and allow us to address any issues or concerns that a potential student may have while guiding them throughout the enrollment process. Additionally, we will utilize the calling campaign to contact local and state high school counselors, community-based organizations (CBO's) and reach out to colleges and schools to established new partnership opportunities. Forms will be created in Qualtrics to allow us to quantify our efforts and document our contacts.

### **Email Campaign**

Research shows that email is a favorable method for communicating with student prospects. Students have suggested that emails that were visually appealing and provided a specific call to action garnered the most response. SOE will utilize email to communicate throughout the enrollment funnel. The student will receive a Dean's letter once they are admitted into our program, and continuous email follow-up messaging will effectively convey the next steps,

promote academic program success, share scholarship information, encourage students to confirm their admission decision, and consider joining our Living Learning Community (LLC).

### **Text Messages**

Texting has become a popular method of communicating with generation-z students. Research indicates that many colleges and schools are engaging students through text messaging. SOE will implement text messaging as a convenient way to get informal messages to students. We will utilize blackboard connect to send reminders about upcoming campus events, deadline reminders, and scholarship opportunities.

# Budget Estimate:

					~ -	× 6	~ -			Matching	Amount
Budget Categories	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr /	Yr 8	lotal	Funds	Requested
Finfish Business Infrastructure:											
Building Innovation for High											
Quality Finfish Aquaculture											
Finfish Aquaculture Business											
Program - (NOAA Designated											
Aquaculture Metabolic Hubs											
demo sites setup in 4 counties) -	\$		\$		\$	\$	\$	\$	\$	\$	\$
Recruitment & On-Site Training	250,000		250,000		250,000	-	250,000	-	1,000,000	-	1,000,000
Computational and IT Upgrades											
(Virtual Algae Farm, AR/VR	\$			\$	\$	\$	\$	\$	\$	\$	\$
Systems)	100,000			-	-	-	-	-	100,000	-	100,000
	\$	\$							\$		\$
Drone Schools/Swarms	250,000	250,000							500,000		500,000
Algal Silage Infrastructure											
(Microwave assisted algal silage	\$	\$							\$		\$
production)	200,000	100,000							300,000		300,000
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Subtotal	800,000	350,000	250,000	-	250,000	-	250,000	-	1,900,000	-	1,900,000
K-12 Educational and Training											
Operations:											
K-12 Certifications for											
Aquaculture Training (summer											
camp training)- FLDOE standards	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
(100 Certifications/year)	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	400,000	-	400,000
K-12 Teachers Engagement											
(Training the teachers for											
curriculum infusion)- FLDOE											
standards (10	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
certifications/year)	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	400,000	-	400,000

20 | Page

Community College											
Engagement, and Vocational											
training/certifications											
FLDOE USINS001 Small UAS											
(sUAS) Safety Certification: Level	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
1 Training - 30 Certificates/yr	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	360,000	-	360,000
FLDOE USINS002 Visual Line of											
Sight System Operator (VSO)	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Ground - 30 Certificates/yr	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	360,000	-	360,000
Underwater Drone School											
Training (Will be submitted to											
FLDOE for CAPE Code) 30	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Certifications	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	360,000	-	360,000
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Subtotal	235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000	1,410,000	-	1,880,000
Participant Costs											
Student Stipends											
(Undergraduates - 25	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Certifications/year)	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	800,000	-	800,000
Community Outreach,											
Dissemination, Stakeholder											
Engagements (Bringing Industry											
investors for on-site		\$		\$		\$		\$	\$	\$	\$
demonstrations and tours)		50,000		50,000		50,000		50,000	200,000	-	200,000
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Subtotal	100,000	150,000	100,000	150,000	100,000	150,000	100,000	150,000	1,000,000	-	1,000,000
Salaries (incl. Fringes)											
Senior Personnel											
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Victor Ibeanusi, PI – (20%)	45,900	45,900	45,900	45,900	45,900	45,900	45,900	45,900	367,200	367,200	-
Satyanarayan Dev (Co-PI) – (13	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
wks summer)	43,200	43,200	43,200	43,200	43,200	43,200	43,200	43,200	345,600	-	345,600

Other Personnel											
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Gang Chen (1month)	18,599	18,599	18,599	18,599	18,599	18,599	18,599	18,599	148,792	-	148,792
	\$	\$	\$	\$	\$	\$	\$	\$	\$		\$
Ashvini Chauhan (1 Week)	2,968	2,968	2,968	2,968	2,968	2,968	2,968	2,968	23,744		23,744
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Research Scientist	87,750	87,750	87,750	87,750	87,750	87,750	87,750	87,750	702,000	-	702,000
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Post Doctral Fellow	74,250	74,250	74,250	74,250	74,250	74,250	74,250	74,250	594,000	-	594,000
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Project Coordinators (2)	129,600	129,600	129,600	129,600	129,600	129,600	129,600	129,600	1,036,800	-	1,036,800
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Faculty lines -2	199,800	199,800	199,800	199,800	199,800	199,800	199,800	199,800	1,598,400	799,200	799,200
	Ş	Ş	Ş	Ş	Ş	Ş	Ş	Ş	Ş	Ş	Ş
Sub total	602,067	602,067	602,067	602,067	602,067	602,067	602,067	602,067	4,816,536	1,166,400	3,650,136
Other matching funds											
FAMU University Center - EDA										Ş	
Grant (20%)										200,000	
EANIL Boach EDA Crant (20%)										\$ E40.000	
FAIVIO REACTI - EDA Grant (20%)										540,000	
and Postoration USDA Forost											
Service - RESTORE act grant										¢	
(20%)											
NSE - CREST Center for Complex										500,000	
Materials Design for											
Multidimensional Additive										¢	
Processing (20%)										1 000 000	
NSF EiR - Microbiome Research										_,000,000	
Grant (20%)										\$240,000	
Projected Min. Match Grant										\$	
Funds over the 8 years										2,500,000	

Salary + Fringes for 2 permanent											
Faculty lines for years 9-15											
(Supported by Triumph Fund for										\$	
years 1-4)										1,398,600	
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Core Lab Manager (0.15 FTE)	8,250	8,250	8,250	8,250	8,250	8,250	8,250	8,250	66,000	66,000	-
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Recruiter (0.2 FTE)	11,334	11,334	11,334	11,334	11,334	11,334	11,334	11,334	90,672	90,672	-
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Core Lab Instrumentation	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	160,000	160,000	-
Maintenance and service	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
contracts	13,500	13,500	13,500	13,500	13,500	13,500	13,500	13,500	108,000	108,000	-
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Subtotal	53,084	53,084	53,084	53,084	53,084	53,084	53,084	53,084	424,672	6,803,272	-
										\$	
Total Matching Funds										8,336,872	
											\$
Total FAMU Request											8,430,136

# Certification Estimates

Certitification	Testing Center	CAPE Code (If Applicable)	Total Projected Number
K-12 Aquaculture Training Certifications	FAMU		800
K-12 Teacher Training Certifications	FAMU		80
	Unmanned Safety		
sUAS Safety Certification	Institute	USINS001	240
Visual Line of Sight System Operator (VSO)	Unmanned Safety		
Ground	Institute	USINS002	240
SASER Drone School Certification	FAMU	(Will be applied for)	240
		<b>Total Certifications</b>	1600