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Building the Capacity of Aquaculture and the Blue Economy in the Caribbean

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ABSTRACT

Despite a global increase in aquaculture, the Caribbean remains at 0.05%. Aquaculture is commonly associated with the intensive culture of salmon in developed countries and the culture of tilapia and shrimp in developing countries. The suit of species to be cultured in the region goes beyond these given the diverse ecosystems and may include species such as conch, marine finfish, sea urchins, sea cucumbers, aquarium species, oysters, mussels, seaweeds and other aquatic plants, to name a few. Many blue foods are rich in bioavailable micronutrients and can be produced more sustainably. For Caribbean countries, aquaculture has the potential to positively address the problems of nutrition and food insecurity, the unsustainable exploitation of marine resources, and socio-economic inequalities. Conventional approaches to promoting aquaculture have largely failed. Most components necessary for aquaculture development in the region remain underdeveloped, including human and technical resources and the general knowledge required to take advantage of its opportunities. For instance, vast coastal areas have hardly been explored for mariculture / blue foods development which can become the cornerstone of coastal communities. Additionally, given the critical state of important marine ecosystems such as coral reefs and mangroves due to overexploitation, the potential for aquaculture as an alternate source of fish protein and alternative livelihood activities has yet to be taken seriously. The Caribbean Aquaculture Education and Innovation Hub (CAEIH) seeks to leverage and strengthen this framework through scientific research, with the introduction of aquaculture curriculum in secondary and tertiary institutions, and partnership initiatives to realize regional targets such as the CARICOM commitment to a 25 percent reduction in food imports by 2025 and the global 2030 agenda. In this way, we intend to identify and monitor key performance indicators at all levels of human and technical capacity in aquaculture production including the participation of women and youth.

KEYWORDS: *aquaculture, mariculture, technical skills training, STEM, women in science visibility, information dissemination, social media*

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1. INTRODUCTION

More than 100 million people in the wider Caribbean region live on or near the coast. The Caribbean Sea supports three of the region's major fisheries, reef fish, Caribbean spiny lobster and conch, and is the foundation of the region's tourism industry (UNEP 2019). This fragile ecosystem is competing with economic and social demands as well as natural stresses and threats. Many once-abundant species are now threatened or endangered. Hurricanes and tropical storms are becoming more frequent and more severe, resulting in great destruction and loss of lives, leaving both the coastline and local communities more vulnerable to future shocks. The World Bank Senior Economist Pawan Patil reported that "In the Caribbean Sea, seventy percent of beaches are eroded due to destroyed reefs, sea level rise, and excessive coastal development and eighty percent of living coral is now dead and lost (UNEP 2019).

Aquaculture and its subsector mariculture has the potential to bridge this gap between sustainable fisheries, marine conservation and food production. The primary aquaculture activities in the Caribbean are tilapia (*oreochromis niloticus*) and shrimp (*macrobrachium rosenbergii*), freshwater ornamental fish and aquaponics.

Over the past three decades, the mariculture subsector has been explored as a lucrative alternative livelihood opportunity. However, there has been a significant increase in the number of seaweed (known locally as seamoss) farmers entering the market and seaweed production over the past four years. This is largely due to the low cost of production, increased knowledge of nutritional benefits of the algae, the growing access to foreign markets and the high quality of seaweed being produced. The focus has been on the growing of seaweed species *Kappaphycus alvarezii* and *Eucheuma isiforme*.

The Food and Agriculture Organization (FAO 2022), stated that aquaculture has the potential to feed and nourish the world's growing population. Their vision for improving aquatic food systems has three goals – sustainable aquaculture intensification and expansion, effective management of all fisheries, and upgraded food and value chains. The 2022 edition of The State of World Fisheries and Aquaculture – Towards Blue Transformation – builds on this narrative by presenting quantitative evidence of the growing role of fisheries and aquaculture in providing food, nutrition, and employment. However there are many challenges for the aquaculture and mariculture subsector in the Caribbean. Primarily for the smaller Eastern Caribbean Islands the lack of water and land space for development for tilapia and shrimp ponds, and the lack of regulations and technical assistance for farmers.

This report highlights further changes needed in the aquaculture sector to address the challenges of feeding the region effectively, equitably and sustainably.

2. CONSTRAINTS AND CHALLENGES TO AQUACULTURE IN THE CARIBBEAN

Despite the potential for aquaculture growth, there are constraints and challenges in most Caribbean countries. Pond aquaculture production has slowed and current production levels are similar to those in the mid-1990s. The growth that Belize and Jamaica saw in the early 2000s has declined significantly mainly due to declines in global market prices of species culture, diseases, cheap fish imports and the lack of enabling policy and legal frameworks in support of the sector (FAO regional report)

Most CARICOM States have limited land and freshwater resources. With the availability of land and freshwater, Suriname, Guyana, Belize and Jamaica have the potential to develop inland aquaculture. Most Caribbean States however have large expanses of marine space which offer the potential for development of marine based aquaculture or "mariculture". Cage culture

of snapper and cobia, seaweeds, mangrove oyster (*Crassostrea spp*), Caribbean Spiny Lobster, *Panulirus argus*, queen conch, sea cucumber and sea urchins are just some of the species being considered for cultivation for food as well as for conservation purposes.

Increases in sea level rise, extreme weather events and storm surges will damage fisheries, aquaculture infrastructure, and seamoss cultivation lines, leading to losses and increased conflict.

The availability of freshwater, technology transfer; feed access and availability; small-scale farmers – “new” technical assistance; governance and political willingness; and, application of the Ecosystem Approach to Aquaculture is lacking.

FAO (2022) discussed other barriers facing aquaculture production systems such as governance, investment, innovations and capacity building; key to improved aquaculture systems. Technical innovations such as genetic improvements in breeding programmes, feeds, biosecurity and disease control – coupled with coherent policies and appropriate incentives along the entire value chain. Innovative aquaculture practices in aquafeeds and feeding, digitalization, and the promotion of efficient and pro-environment practices are examples of sectors that should be given priority. Implementing these solutions requires adequate capacity and skills, training, research and partnerships, and can benefit from developments in information and communications technology and the wider access to mobile applications and platforms (FAO 2022).

From aquaculture sub-sector analyses, the high startup, equipment, and maintenance cost keeps the pond aquaculture sector a lot more exclusive as opposed to aquaponics and seaweed farming. These costs as well as cost of disaster preparedness and management, continue to pose economic challenges to aquaculture farmers, and if left unaddressed will lead to further economically unsustainability of sector. More support by training, financing and capacity building would improve sector.

A list of the areas lacking which are needed for aquaculture development are:

1. Insufficiently trained and skilled farmers in farm management, production, post-harvest handling, marketing, etc.
2. Regulations and checks for appropriate site selection
3. Insufficient technical assistants for farm visits
4. Insufficient data collectors e.g., water quality, soil tests, environmental data etc.
5. Inadequate access to funds for aquaculture development.
6. Absence of a national emergency / disaster management plan for aquaculture.
7. Insufficient access by farmers to suitable credit and insurance programmes to meet capital expenditure
8. Insufficient funds to address repair of damaged farm infrastructure, crop losses from floods and droughts, and loss of crops due to praedial larceny amongst other things.
9. Absence of suitable business plans to guide farmers in decision making and farm management.
10. High capital investment for startup (ponds, culture lines, tanks, pipelines, snorkel equipment including wet suits)

3. THE WAY FORWARD

Changing the regional perception of Aquaculture

One of our greatest resources as we know are our people. Currently, we have very few secondary or tertiary schools in the Caribbean which have a curriculum for aquaculture sciences, there is a need to increase the technical aquaculture training in our youths creating a pool of talent to assist in making the industry sustainable. One recommendation in the development of aquaculture in the region is to include these sciences within the primary and secondary schools' curriculum. We also should look into the idea of giving aquaculture and mariculture separate consideration from fisheries. Each sector has its own needs that need to be examined and expanded upon as well as looking at how they overlap.

Capacity building for skilled technical workforce

To help the sustained development and growth of the industry, a tremendous emphasis must be placed on the creation of a skilled and certified team of aquaculture managers and farmers. Capacity development is a process by which an organization strives to improve the skills of professionals needed as a priority to strengthen the aquaculture sector in the Caribbean. Skills such as aquaculture development, fish health, marine spatial planning, data collection and analysis, are needed. These skills need to be imparted to teachers, extension officers, farm managers and entrepreneurs, through routine training both locally and internationally.

If they are able to participate in regional and international conferences, attend trade and technology fairs and engage in research both at the hatchery and at the farms, aquaculture officers will ensure delivery of the highest quality service to the clients who include the enquiring public, students, subsistence, and commercial farmers.

The aquaculture manager, extension officers, technical assistants must be always able to provide the client with accurate and relevant information and in a timely manner. The staff of the Aquaculture Division must be capable of assisting the client develop his industry in a manner that best meets his needs, and within his resource capabilities. For this reason, the Aquaculture team must be fully able to conduct the necessary research to give the client the best possible support that will ensure a successful enterprise.

What needs to be the focus

The attention to skilled persons in nutrition, aquatic animal health and phycology are needed. Areas of support included, amongst others, fisheries and aquaculture policy development, fisheries and aquaculture legal framework reviews and updates of legislation, small-scale aquaculture development, aquaponics, seaweed technical assistants and aquatic animal and plant health management.

Extension agents are need to develop the manuals & workshops and technical assistants with technical degrees and hands on experience that actually visit the farms and sites on a very regular basis. These persons could have their own business and separate from government where they are paid by the farmer and included as a business cost in their plans from experience this is an important requirement for growth especially for startup farmers.

Regional data is lacking hence more research scientists that know how to do proper data collection, analysis and reporting are needed.

Lastly more entrepreneurs willing to start businesses in sectors that are not covered. For example phycologists and engineers to name two.

Farmer field schools or demonstration farms

The establishment of Farmer field schools or demonstration farms will enable farmers to learn from each other. These “Centres of Excellence” will provide a platform for transparent and inclusive research, as well as skills development and knowledge exchange. By establishing such training centres, access to information and training will be much improved. The development of the demonstration centres will rely on farmers willing to cooperate and make their farms available to farmers in the region. There are of course incentives as these farms will receive more than routine support from the Aquaculture extension officers and will ensure various levels of investment in the form of new technologies and equipment for routine operations. Formal / legal arrangements would be made between the government and the farmer to ensure clarity with regards to ownership of equipment and access to farm facilities.

Establishment of an Aquaculture Farmers’ Cooperative

There is a need for an associations or cooperatives where farmers can get together discuss challenges, share resources and network with stakeholders. For the sector to improve economically, the support of major stakeholders with Cooperatives is of utmost importance. A virtual network would be beneficial where new and old farmers are able to meet on a regular basis. Technical Assistants can also visit smaller groups of cooperatives at various farm sites.

Training manuals

The current manuals available throughout the Caribbean are:

- Aquaculture extension manual
- National vocational qualification standard in tilapia production
- A National Vocational Qualification (NVQ) standard
- Sustainable Seaweed Cultivation

Assessors have been trained to teach and give training workshops, however along with trainers, there is a need for the current training manuals for all production levels from 2014 to be updated to reflect current 2023 practices.

Manuals to be updated should include the following:

1. Good Management practices for the production
2. Biosecurity and preventative management practices
3. Antimicrobial and chemical usage
4. Diseases per specie
5. Site selection
6. Managing flood prone areas
7. Developing efficient water management systems
8. Climate smart water pumps
9. Water filtration systems
10. Solar powered farm equipment
11. Environmental standards for farm operations
12. Quality control
13. Equity in access to natural resources
14. Climate change awareness and training
15. Disaster preparedness and contingencies

Biosecurity and Surveillance

There is a need for an active biosecurity and surveillance plan for imported fish. If aquaculture is to increase prevention of outbreaks and the spread of disease, there should be prepared for with a biosecurity plan for all activities. The number of technical assistants should have the knowledge and training of basic animal and plant health management.

Aquafeeds Research

Research on using local materials for feed formulation and on farm aqua feed production is needed. There is much interest in using local ingredients to reduce the cost of imported fish feeds. Success in this effort rests primarily with nutrition research and improved feed manufacturing technology.

Alternative /affordable energy sources (to run pumps and aerators)

Support to the Engineering Division to work on climate smart technology for aquaculture.

The business of Farming

Funding is available to do an aquaculture operation once you can prove that it's going to be feasible. It is recommended that prior to starting an aquaculture venture a detailed plan should be prepared to include the costs of technical assistance, environmentally sustainable and climate smart production systems.

The Caribbean Aquaculture Education & Innovation Hubb

The Caribbean Aquaculture Education & Innovation Hubb (CAEI) is a ground-breaking project that brings together science, technology, business, entrepreneurship, and policy to address the needs for the improvement of aquaculture in the Caribbean. CAEIH prioritizes capacity building through the support of webinars and a training program for teachers, farmers and other stakeholders. The goal of this organization is to collaborate with Caribbean scientists, Universities and companies to address some of today's most pressing issues. CAEIH also collaborates with aquaculture professionals through the sponsorship of industry and private institutions and professionals. This capacity building program is virtual and will include onsite training in the future.

The importance of the project also stems from the need to support regional engagement of women and youth in aquaculture to meet strategic goals for food security, environmental sustainability, and develop livelihoods in the CARICOM region. Launched in 2023, CAEIH aims to drive innovation and research in key economic sectors in the CARICOM region. It is dedicated to the growth and development of aquaculture in the Caribbean through the advancement and provision of education, scientific and technical solutions, research, training, public awareness and conservation actions. Together we plan the way forward in promoting climate resilience, environmentally sustainable and conservation practices in the field of aquaculture and investigate strategies for collaborative research through networking and information management.

Aquaculture Network

Having a network is one of the fastest ways to get information and to collaborate with other persons in the field. Networking is the exchange of information and ideas among people with a common profession or special interest, usually in an informal social setting. Networking provides a quick access to a vast number of resources in the network.

Many farmers work in isolation. Farmers do not like to share information and are very competitive with the little information that they have accumulated (anecdotal). Farmers believe that this will help them be more successful in their business. However, by not working together and sharing resources and information, this one of the many reasons that is holding back the aquaculture industry. It is difficult to compete with the knowledge and resources that have already been established in Asia and Europe. Whereas before 2020 many persons did not have access or did not know about zoom and social media, now even the most rural farmer had a phone and access to zoom making it possible to start a virtual network. The Caribbean Aquaculture Network (CAN) was formed to promote and enable linkages and collaborations among aquaculturists, aquaculture professionals, and academic scholars both within the Caribbean region and globally. The goal of CAEIH is to build linkages and collaborations with Caribbean aquaculturists and regional and global academics, entrepreneurs, industry and government professionals. CAN will bring together a group of motivated and published scholars, entrepreneurs, industry players and government professionals to build a network between academics and practitioners. We do this using social media and zoom.

Gender and Youth Inclusion

In 2023 the Women in Caribbean Aquaculture (WiCA) was created to introduce more women into aquaculture, and support those already working in the sector. The majority of students studying science in the Caribbean are women. So this group was formed to highlight their work and encourage leadership skills for the next generation.

WICA by women scientists of Caribbean origins who are dedicated to the growth of aquaculture in the Caribbean region. However, we strive to be inclusive of women not born in the Caribbean but who are dedicated to the growth of Caribbean aquaculture. Members of the group are aquaculture professionals specializing in marine conservation, farming, engineering, research, education, aqua - veterinary medicine, fish nutrition, feed manufacturing, governance and entrepreneurship.

Using an integrated approach, the scientists at CAEIH work together along with governments and stakeholders from academia, communities, the private sector, regional and global agencies, to introduce Aquaculture Sciences into the STEM curriculum of secondary and tertiary education.

The vision is to fill the technical knowledge gap with a young generation of scientists that will develop sustainable marine seafood solutions and nutritious aquatic animals and plants for communities

4. CONCLUSION

Aquatic foods are increasingly recognized for their key role in food security and nutrition, not just as a source of protein, but also as a source of essential omega-3 fatty acids and bioavailable micronutrients. The aquaculture sector needs more access to finance at reasonable interest rates to encourage more economically viable participation both for local and potential foreign

market. Given the extremely high cost of startup and equipment maintenance as well as the high vulnerability of the sector to climatic eventualities, further training and resources need to be made available to owners to become more resilient and help mitigate disaster leading to cost reduction of business.

A Caribbean Blue Revolution is needed and is possible. Aquaculture development can increase fish and seafood production by the CARICOM if the essential investments are made to enable aquaculture policy and legal frameworks, supported by applied research, capacity building and information.

LITERATURE CITED

Aquaculture in States – A review. CRFM publication

Competition As Potential Hindrance to Aquaculture Development: A PRIVATE SECTOR PERSPECTIVE CPSO Sandiford Edwards – Technical Expert Caribbean Regional Fisheries Mechanism (CRFM) Technical Working Group Meeting 30 June 2022

FAO. 2022. The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO. <https://doi.org/10.4060/cc0461en>

Fish farmers of the Caribbean: Wealth of potential for aquaculture in the Caribbean -- ScienceDaily January 10, 2019
SUBREGIONAL OFFICE FOR THE CARIBBEAN ISSUE BRIEF #10 OCTOBER 2014 Securing fish for the Caribbean

UN Environmental program. Nature Action: Restoring the Caribbean to the paradise that it used to be
<https://www.unep.org/news-and-stories/story/restoring-caribbean-paradise-it-used-be>