Report of the

FAO TECHNICAL WORKSHOP ON ADVANCING AQUAPONICS THROUGH STRENGTHENED VALUE CHAINS

Christ Church, Barbados, 11–14 December 2018
Cover photograph: Kristina Adams of Adams Aqualife (Barbados) presenting the newly constructed aquaponic demonstration facility to national and international participants (©FAO/Stankus).
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This report describes the activities and outputs of the FAO technical workshop entitled “Advancing Aquaponics through Strengthened Value Chains”, an activity under the Technical Cooperation Project (TCP/SLC/3601) Towards a Caribbean Blue Revolution in response to the request from the Governments of Antigua and Barbuda, Bahamas, Barbados, St. Kitts and Nevis. Participants from Grenada, Saint Lucia and Trinidad and Tobago were supported through another FAO project (GCP/SLC/202/SCF) Climate Change Adaptation in the Eastern Caribbean Fisheries Sector (CC4FISH).

The workshop was held in Christ Church, Barbados, in the period 11–14 December 2018.

This report was prepared by Austin Stankus, Jose Manuel (Pepe) Fernandez Polanco, and Bree Romuld.

ABSTRACT

A technical training workshop on advancing aquaponics was held in Christ Church, Barbados, in the period 11–14 December 2018. Twenty seven international participants were present from seven countries (Antigua and Barbuda, Bahamas, Barbados, Grenada, St. Kitts and Nevis, St. Lucia and Trinidad and Tobago). This activity was supported under two UN FAO-funded projects: Towards a Caribbean Blue Revolution and Climate Change Adaptation in the Eastern Caribbean Fisheries Sector Project (CC4FISH).

The four-day workshop was convened by FAO and consisted of lectures, participatory group sessions and hands-on activities supported by aquaponics and value chain experts from FAO and supported by local subject matter experts and other contributors.

The workshop concluded with several findings and recommendations. Technical production is strong among the farmers present; however, incoming farmers need technical backstopping and training programmes for basic production technologies. There are no more than 10–20 aquaponic farmers in any Caribbean country, of which only 1–5 are commercially oriented. Access, availability and affordability of inputs are the biggest blocking issues to further development of the aquaponic sector. Based on two case studies, the profit is between 8–15 percent of the yearly operating expenses and the return on investment to payback the capital expenses is 10–20 years. Fish sales were higher than vegetable sales in the two farms by a factor of 2:1, although not all farmers take advantage of the fish sales. No farmers reported problems with sales; indeed most farmers believe that markets can absorb increased production, but comprehensive market analyses were recommended.

Considering the similarities among farms in this region, it was suggested to create the Caribbean Aquaponic Association, an informal network to share information and lessons among practitioners.
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ACKNOWLEDGEMENTS

Numerous individuals contributed to the successful organization and implementation of this technical workshop which resulted in the present publication. All of them are gratefully acknowledged for their efforts and contributions during the preparatory phase and the workshop itself.

Special thanks go to Adams Aqualife and Nature’s Pride for their hospitality during the field trips, the Ministry of Maritime Affairs and the Blue Economy for the support provided to the organization of the workshop, and to Ms Celestine Moe and other colleagues of the FAO Subregional Office for the Caribbean for their unwavering support.

We would like to thank our many colleagues who kindly provided background information, articles and expertise, and assistance with travel and other logistical and financial arrangements.
# ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BAS</td>
<td>Barbados Agricultural Society</td>
</tr>
<tr>
<td>CSA</td>
<td>Community Supported Agriculture</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td>GAPs</td>
<td>Good Agricultural Practices</td>
</tr>
<tr>
<td>GAS</td>
<td>Government Analytic Service (Barbados)</td>
</tr>
<tr>
<td>HAACP</td>
<td>Hazard Analysis and Critical Control Points</td>
</tr>
<tr>
<td>HORECA</td>
<td>Hotel, restaurants and catering</td>
</tr>
<tr>
<td>IICA</td>
<td>Inter-American Institute for Cooperation on Agriculture</td>
</tr>
<tr>
<td>N/CVQ</td>
<td>National/Caribbean Vocational Qualification</td>
</tr>
<tr>
<td>RAS</td>
<td>Recirculating Aquaculture Systems</td>
</tr>
<tr>
<td>RFID</td>
<td>radio-frequency identification</td>
</tr>
<tr>
<td>SIDS</td>
<td>Small Island Developing States</td>
</tr>
<tr>
<td>SWOT</td>
<td>Strengths, Weaknesses, Opportunities, Threats</td>
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BACKGROUND

Aquaponics is an emerging technology that supports integrated aquaculture and vegetable production. It combines the two most efficient methods in their respective fields: recirculating aquaculture systems (RAS) and hydroponics. Aquaponics combines these two proven technologies in order to gain synergy, increase revenue and decrease inputs. In traditional RAS, both water and fish wastes are discarded, adding to production costs and leading to environmental impacts in some cases. On the other hand, hydroponics requires the constant exchange of water and additions of chemical fertilizers. Aquaponics combines these two production systems: nutrient rich aquaculture water is recirculated through standard hydroponic growing beds. All of the nutrients required by the plants are supplied through the fish wastes, thereby eliminating the need for fertilizer. The plants clean the water for the fish, thereby eliminating the need for water exchanges. Aquaponics is a labour-saving technique, saving traditional agriculture work such as ploughing, tilling and digging, and is therefore appropriate for all genders and many age groups. In addition, aquaponic systems can be located inside the home thereby providing a secure means of income generation and nutritional security.

With aquaponics, individual farmers and cooperatives are able to improve their diets through the addition of nutritious fruits and vegetables rich in micronutrients and essential minerals; likewise fish, besides its being an important source of protein. Beyond improving diets, aquaponics offers an opportunity for income generating activities. Further, it can be conducted with limited space and without any arable land, making this technology appealing for urban and peri-urban agriculture, even finding success on rooftops, balconies and degraded land parcels.

Aquaponics is a way to grow high-value crops intensively. However, access to markets willing to pay premium prices for high quality crops is necessary. Aquaponics has relatively high construction and operating costs. Without access and leverage in the markets, these costs cannot be recuperated, and the aquaponic venture may not become profitable. Indeed, many aquaponic businesses around the world have failed – typically because of inadequate business planning and marketing operations rather than issues with production.

This practical workshop aimed at supporting sustainable development of aquaponics through improving market access for farmers. It included the active exchange of ideas from farmers, retailers, hospitality services (hotel, restaurant, cafés), and other key stakeholders. This activity was supported under two UN FAO-funded projects: Towards a Caribbean Blue Revolution and Climate Change Adaptation in the Eastern Caribbean Fisheries Sector Project (CC4FISH).

Objectives

The main objective of this workshop was to strengthen stakeholders’ ability to identify and assess market opportunities, understand their respective market requirements and how to tap into the opportunities, for improved market access and strengthened value chains. Moreover, basic principles of value chain constraints and leverage points were discussed to initiate groundwork towards an industry platform. As a result of this workshop, participants improved their ability to operate aquaponic businesses, identify and exploit markets, and engage with other members of the value chain.

The workshop outputs were as follows:

- Develop common knowledge of marketing and promotion for aquaponics production highlighting the opportunities while identifying the risks, costs and other issues that prevent wider market penetration
- Identify high potential crops, niche markets as well as value addition opportunities in local markets
- Engagement with local buyers to better understand market preferences and requirements
• Strengthen producers’ understanding of key points of sale, including retailers and restaurants
• Conduct value chain mapping to identify key stakeholders, key constraints and possible areas for stakeholder collaboration as part of industry development efforts
• Carry out business planning, identify risks, and brainstorm ways to overcome constraints
• Identify opportunities for alternative revenue streams for aquaponic producers, such as education, training and agritourism
• Identify opportunities for value-addition of aquaponic products
• Document the proceedings of the workshop for dissemination to participants and interested parties.

COUNTRY SELECTION AND PARTICIPANT IDENTIFICATION

Twenty seven (27) international participants were present from seven (7) countries (Antigua and Barbuda, Bahamas, Barbados, Grenada, St. Kitts and Nevis, St. Lucia and Trinidad and Tobago).

Participants included the farmers that previously participated in FAO aquaponic activities. Specifically, this included those farmers selected to build the demonstration systems in each respective country; namely, representatives from Indies Greens (Antigua and Barbuda), Bahamas Agriculture and Marine Science Institute (the Bahamas), Adams Aquafarms (Barbados) and Greenleaf Farms (St. Kitts and Nevis). Additional farmers and country representatives were invited as resource persons, notably those that supported the preparation of country-level sector and value chain analyses.

A representative from the Fisheries Division or Crop Production division was nominated by their Ministry of Agriculture or Ministry of Fisheries (or equivalent).

All participants attending this workshop had previous experience in aquaponics, recirculating aquaculture or hydroponics. The participants are expected to bring the lessons learned back to their home country and include these aspects in the eventual national level aquaponic trainings and other activities to strengthen the aquaponic sector.

Representatives from various stakeholder groups were invited as resource persons to share their experience on aspects of the value chain, and included retail buyers, government advisors in food safety, and restaurant owners.

FAO undertook a convening role, bringing participants together, at the same time serving as Secretariat and logistical facilitator.

A list of participants is included as Appendix C, a group photo is included as Appendix D, and selected photographs are included as Appendix J. Relevant press releases are referenced in Appendix K.

OPENING REMARKS

Opening remarks were presented by Lystra Fletcher Paul, FAO Subregional Coordinator for the Caribbean, and are included in Appendix E.

The opening remarks reviewed the global situation of agriculture and its role in nutrition, livelihoods and culture. It highlighted agriculture in water scarce areas. It discussed the potential of aquaculture in light of static fisheries production, and ended with a reminder of the global need to develop innovative practices of local food production that can include aquaponics.
WORKSHOP PROGRAMME

The four-day workshop was convened by FAO and consisted of lectures, participatory group sessions and hands-on activities supported by aquaponics and value chain experts from FAO and supported by local subject matter experts and other contributors.

The workshop was designed to focus on value chain strengthening, including supply side dynamics, marketing channels, and the enabling environment. Production was not the focus of this workshop, and all technical training for this project was carried out in a previous workshop:

A valuable group session saw participants create conceptual maps and characterize the Caribbean aquaponic value chain which had never before been described. Additional time was dedicated to network building, and soft skills including advocacy, training and discussions. Initial activities towards a regional network, called the Caribbean Aquaponics Association, were discussed.

The agenda is included as Appendix A.

The workshop was broken down as follows. Appendix B contains an extended programme with summaries of each session.

**Day 1 (Value Chain Overview)**

Keynote speech by the FAO Subregional Coordinator, and welcome remarks were followed by detailed overview of aquaponics and introduction of teaching team and facility. Overview included strengths and weaknesses of aquaponics, specifically related to markets.

Various marketing channels were discussed, including retailers, wholesalers, direct sales to consumers, and direct sales to restaurants. A business case was presented on a long-running aquaponic farm. A group session was facilitated to map the value chain actors (Appendix F). Once mapped, each linkage was discussed, noting the opportunities and constraints.

**Day 2 (Market Assessment and Buyer Perspective)**

The day’s objectives were to understand the requirements of different market buyers including food safety standards, certification and traceability as well as creating and strengthening commercial linkages/partnership. A presentation was given by a regional retailer, providing an overview of their procurement strategy and initiative to support local production, as well as requirements for vendors. Food preferences in the Caribbean were discussed, noting differences between the various segments of the population (e.g. tourist, expats, and permanent residents). Value addition aspects were presented in terms of both the fish and vegetables, followed by a moderated discussion on food safety and certification implications.

Food safety should be the primary responsibility of the producer. In this session, food safety risks associated with aquaponics were covered by two presenters, a fisheries officer from FAO and a local food microbiologist from the Ministry of Agriculture. The first presentation looked at the importance of ensuring fish safety in order to prevent cross-contamination and measures were suggested that could be introduced to minimize hazards. Producing safe crops was covered by the next presenter, where production and post-harvest water quality were seen as critical control points. Water testing to screen for the presence of human pathogens was proposed as a means of ensuring that only safe water is being used. Harvesting techniques and farming practices currently adopted throughout the region were also discussed as these could be potential sources of contamination if not done correctly. Participants
were reminded of the importance of implementing Good Agricultural Practices (GAPs) to help reduce microbiological risks and a hand hygiene exercise was carried out to illustrate how microorganisms could be transferred to fresh produce and equipment from contaminated hands.

**Day 3 (Field trip)**

The group traveled to the aquaponic demonstration site of Adams Aquafarms. Participants had a chance to see the design, operation and management of the site. This is the site of the demonstration unit supported by FAO funding, and used for national level training activities. The owner/operator provided a description of the marketing and sales avenues used. The group then traveled on to Nature’s Pride, a commercial hydroponic farm growing lettuce (romaine, red and green oak leaf, frisee, watercress), kale, herbs (sweet basil, Thai basil, spearmint, tarragon, dill, fennel) and miscellaneous other crops.

Alternative revenue streams were discussed, including offering training, agritourism and educational services. The educational aspects were further documented, including recommendations and suggestions of how to support the inclusion of aquaponics in secondary and tertiary schools. These lessons should be included in the eventual national level trainings.

**Day 4 (Moving forward)**

The day’s objectives were to finalize the draft value chain and capture discussions on priority areas for follow up actions as summarized above. The group conducted a SWOT analysis, a summary of which is included in Appendix G. A government panel session was convened with the representatives from each country, tasked to discuss the role of government in providing an enabling environment for aquaponics and presenting ongoing and pipeline activities. Finally, participants were divided into four priority areas and prepared draft action plans. Calls were made for the development of certain documents for later dissemination, including a list of priority crops, marketing analysis methodology, requirements to become an agritourism site, and others (Appendix H). A reprinting of the FAO Technical Manual on Aquaponics (Appendix I) was requested.

**FINDINGS AND RECOMMENDATIONS**

The findings and recommendations hereafter presented were gathered by FAO acting as Secretariat during plenary discussions, summaries of the value chain and sector analyses and synthesis of group work.

**Supply chain**

- Access, availability and affordability to inputs are the biggest blocking issues to further development of the aquaponic sector. The inputs that need the most work to address are:
  - Feed
    - There are no regional feed manufactures producing aquaculture feed.
    - Farmers are using imported feed (e.g. Ziegler, Skretting), but the input shops on the islands do not always have feed available.
    - Imported feed benefits from exemptions from import tax, but it is still expensive.
  - Seed
    - There are no hatcheries in the region to supply new farmers, nor to conduct selective breeding to improve the local farmed-types.
    - All farmers are using tilapia (primarily unconfirmed hybrids between *Oreochromis niloticus* and *O. mossambicus*).
    - Some experimentation ongoing with other aquaculture species (e.g. crayfish, koi).
Equipment
- Few retailers are available in-country for necessary aquaculture equipment, meaning that everything needs to be imported.
- Equipment is exempt from import tax, provided that the farmer registration number is provided and imported directly by the farmer. However, for small orders bought from retailers this exemption cannot be applied.
- In some countries, individual farmers can import equipment on their own registration number duty-free, and then redistribute to secondary farmers provided the second farmer is in the process of becoming registered. This mechanism can be harmonized and strengthened.

Production
- Technical production is strong among the farmers present, however, incoming farmers need technical backstopping and training programmes for basic production technologies.
- There are no more than 10–20 aquaponic farmers in any Caribbean country, of which only 1–5 are commercially oriented.
- Based on two case studies, costs of production are dominated by labour, electricity and feed, which collectively amount to 45 percent. Packaging and delivery (including labour) account for an additional 25 percent of costs.
- The profit is between 8–15 percent of the yearly operating expenses, and the return on investment to payback the capital expenses is 10–20 years. The value of fish sales was higher than that of vegetable sales in the two farms by a factor of 2:1.
- Most farms are using a cost-based pricing model, where the profit margin can adjust to rising costs. However, as the businesses grow a different pricing model may be needed.
- Some farms do not sell the aquaculture product (tilapia), which loses a large revenue streams.

Market linkages
- The market demand for aquaponic products is strong. No farmers reported any problems with sales; indeed most farmers believe that markets can absorb increased production.
- Consumer acceptance of tilapia is two-fold: some customers prefer marine fishery products, however, tilapia sells well and at a comparable price.
  - A market analysis on consumer behaviour is required
- Farmers will need to take an active role in developing relationships with various market channels.
- The most common market channels currently used are:
  - Direct to consumer
  - Retailer (local/regional supermarkets)
  - Restaurants (small-medium), based on personal relationships
- The target markets for future development were identified as:
  - Export
  - Public procurement (hospital, school, prison, military)
  - Hotels, Restaurants, Catering (HoReCa) (medium-large), influenced by production volume
  - Community Supported Agriculture (CSA)
  - Fish processors and packing houses, though currently these processors are focused on fisheries products, some may have unused capacity and could accept aquaculture products
- Technical requirements and barriers to trade need to be made clear by the buyers, and communicated effectively to the producers. These requirements may be related to:
• Health and safety, certification and traceability
• Packaging, handling and distribution
• Crop selection, seasonality and reliability

• Bargaining power of the farmers is limited because of the small volumes, unorganized farmers groups, and the buyers can turn to import.

• When working with restaurants, a factor is “fixed” vs “daily” menus, because daily menus can adjust and be more flexible to changing availability of crops and seasonality of local production whereas fixed menus are more rigid and chefs demand reliable availability of ingredients.

**Food safety**

• Aquaponics does not have well-established food safety guidelines specific to the industry.

• Farmers are recommended to follow the general GAPs for aquaculture and horticulture production, and the most important identified practices are good water and good hygiene techniques.

• It was recommended to be conscientious of visitors and tour groups which can act as vectors.

• Intrusion of warm-blooded animals (monkeys, birds, rats and mongoose) is an identified risk but no solutions are obvious. For outdoor aquaponic systems, improving biosecurity measures by placing nets around the produce/crops as a means of preventing contamination from animals and pests was suggested.

**Establishment of the Caribbean Aquaponics Association**

• Considering the similarities among farms in this region, it was suggested to form informal networks so that information and lessons can be shared among the participants.

• Publishing success stories or farm profiles of good examples of aquaponic farms and share them across the network in order to raise visibility and awareness.

• Document and share problems (and solutions) among the network was regarded as useful as well.

• National chapters, led by one or two champions, would periodically report to the regional association which would serve as a sharing and communications hub.

**Competition among farmers (same country)**

• There is little competition among farmers within individual countries, and no competition between countries.

• There is a general willingness to share best practices, collectively import seeds and equipment, and enter into collective marketing opportunities.

• One notable exception is unwillingness to transfer aquatic genetic resources of farmed-types (improved tilapia) without established access and benefit sharing agreements.

**Demonstration farms**

• It was requested that FAO support, both financially and technically with backstopping missions, follow up activities including the construction of demonstration units and training programmes in each Member country in attendance. It was recommended for FAO to prepare possible sourcing and lists of appropriate materials for the construction of demonstration units.
Education

- All participants agreed that aquaponic curricula should be included in education programmes at various levels.

Agritourism

- There are strong opportunities for using aquaponics as an agritourism event.
- Several farmers are already offering tours to both local and tourist demographics.
- Request for a list of requirements for becoming agritourism site, which will be developed by FAO in collaboration with IICA, tourism authorities and others.
- Agritourism is seen as a way to spread risk and increase revenue streams. There is risk of disease intrusion so biosecurity needs to be considered.

Enabling environment

- Widespread public interest in buying local.
- Government incentives to reduce food bill.
- Concessions and import tax exemptions available.
- Farmers are registered with Ministry of Agriculture or Ministry of Fisheries (or equivalent).
- There are limited veterinary services available, and no farms have been inspected.
- There are no food safety requirements, and no farms have been inspected.
## APPENDIX A – WORKSHOP AGENDA

### DAY-1: Tuesday 11 December

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenter(s)</th>
</tr>
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<tbody>
<tr>
<td>08:30 – 08:45</td>
<td>Opening remarks</td>
<td>L. Fletcher Paul (FAO)</td>
</tr>
<tr>
<td>08:45 – 09:00</td>
<td>Roll call and individual introductions</td>
<td>All participants</td>
</tr>
<tr>
<td>09:00 – 09:30</td>
<td>Introduction to food systems</td>
<td>J. Polanco (FAO)</td>
</tr>
<tr>
<td>09:30 – 10:00</td>
<td>Overview of aquaponics: opportunities and constraints</td>
<td>Stankus (FAO)</td>
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<tr>
<td>10:00 – 10:30</td>
<td>Coffee break</td>
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<tr>
<td>10:30 – 12:30</td>
<td>Sustainable markets for locally produced food in the Caribbean</td>
<td>B. Romuld (FAO)</td>
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<tr>
<td>12:30 – 14:00</td>
<td>Lunch</td>
<td></td>
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<tr>
<td>14:00 – 15:00</td>
<td>Principles and tools for value chain assessment</td>
<td>J. Polanco (FAO)</td>
</tr>
<tr>
<td>15:00 – 16:00</td>
<td>Group exercise: mapping the value chain of aquaponics</td>
<td>All participants</td>
</tr>
<tr>
<td>16:00 – 17:00</td>
<td>Costs of production (a case study)</td>
<td>K. Adams (Adams Aquafarm)</td>
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### DAY-2: Wednesday 12 December

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<th>Activity</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td>08:30 – 09:30</td>
<td>Improving market access for locally produced aquaponic products in St. Lucia</td>
<td>D. Demille (Massy Stores)</td>
</tr>
<tr>
<td>09:30 – 10:30</td>
<td>Food safety, traceability and certification schemes</td>
<td>Y. Diei Ouadi (FAO)</td>
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<td></td>
<td></td>
<td>K. Brathwaite (GAS)</td>
</tr>
<tr>
<td>10:30 – 11:00</td>
<td>Coffee break</td>
<td></td>
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<tr>
<td>11:00 – 12:00</td>
<td>Eating local: opportunities and constraints for restaurants</td>
<td>S. Golesorkhi (Lemongrass Grill)</td>
</tr>
<tr>
<td>12:00 – 12:30</td>
<td>Moderated discussion</td>
<td>J. Polanco (FAO)</td>
</tr>
<tr>
<td>12:30 – 14:00</td>
<td>Lunch</td>
<td></td>
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<tr>
<td>14:00 – 15:00</td>
<td>Business of aquaponics (a case study)</td>
<td>D. Francis (Indies Greens)</td>
</tr>
<tr>
<td>15:00 – 16:00</td>
<td>Agri-entrepreneurship and innovative youth engagement</td>
<td>E. Harvey (IICA)</td>
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<tr>
<td>15:30 – 16:00</td>
<td>Catalysing agribusiness through market connection</td>
<td>J. Paul (BAS)</td>
</tr>
<tr>
<td>16:00 – 17:00</td>
<td>Market connections for aquaponics (moderated discussion)</td>
<td>J. Polanco (FAO)</td>
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### DAY-3: Thursday 13 December

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<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td>08:00 – 12:00</td>
<td>Tour of aquaponic site at Adams Aquafarm and hydroponic farm at Nature’s Pride</td>
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<tr>
<td>12:00 – 14:00</td>
<td>Return to venue and lunch</td>
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<tr>
<td>14:00 – 14:30</td>
<td>Sustainable agriculture: youth and community groups</td>
<td>C. Lane (Nature Fun Ranch)</td>
</tr>
<tr>
<td>14:30 – 15:00</td>
<td>Commercialization of small scale aquaponics – lessons learned from around the Caribbean</td>
<td>A. Desrochers (Solanum Consulting)</td>
</tr>
<tr>
<td>15:00 – 16:00</td>
<td>Alternative revenue streams: education, training and agrotourism (moderated discussion)</td>
<td>A. Stankus (FAO)</td>
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</tbody>
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### DAY-4: Friday 14 December

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<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:30 – 09:30</td>
<td>Guidelines for strategic business planning</td>
<td>J. Polanco (FAO)</td>
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<tr>
<td>09:30 – 10:30</td>
<td>Group work: business planning for an aquaponics company</td>
<td>All participants</td>
</tr>
<tr>
<td>10:30 – 11:00</td>
<td>Coffee break</td>
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<tr>
<td>11:00 – 12:30</td>
<td>Group work: business planning for an aquaponics company</td>
<td></td>
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<tr>
<td>12:30 – 14:00</td>
<td>Lunch</td>
<td></td>
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<tr>
<td>14:00 – 15:00</td>
<td>Role of Government towards an enabling environment</td>
<td>Gov’t reps (all countries)</td>
</tr>
<tr>
<td>15:00 – 16:00</td>
<td>Support and elements of an industry platform</td>
<td>B. Romuld</td>
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<tr>
<td>16:00 – 17:00</td>
<td>Workshop closing</td>
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APPENDIX B – EXPANDED PROGRAMME

DAY-1:

Opening remarks

Opening remarks were presented by the FAO Subregional coordinator and served to put the workshop in the larger context of FAO’s work, and set the stage for the workshop programme.

Introduction to food systems

A food system is the path that food travels from field to fork. It includes the growing, harvesting, processing, packaging, transporting, marketing, consuming, and disposing of food. It also includes the inputs needed and outputs generated at each step and the broader enabling environment.

By taking into consideration the broader system in which the aquaponics industry operates, the sustainable food systems lens provides a better understanding of the root causes, rather than symptoms of the fundamental issues that are holding development of the sector back as well as the opportunities.

Key principles of a system approach to developing sustainable food systems include:

• Recognising the breadth of actors, components and interlinkages in the agricultural sector.
• Understanding the key factors of improving the performance of our food systems (root causes, value chain analysis).
• Understanding the role of collective action to address constraints and leverage existing and future opportunities.

Overview of Aquaponics: opportunities and constraints

This session started with a 5-minute overview of aquaponics, though the workshop assumes that all participants are well aware and knowledgeable of aquaponics.

The opportunities for aquaponics are numerous for consumers, governments and the private sector.

For consumers, the benefits include:

• Fresh and nutritious vegetables and fish;
• Local production for reliable supply of vegetables;
• Higher options and diversity of vegetables available.

For Governments, the benefits include:

• Reduction of food imports for fresh vegetables;
• Low water usage;
• Sustainable development option for marginal lands.

For private sector, the benefits include:

• Competitive production costs for premium quality product;
• Niche marketing potential and value added products;
• Technology is proven, and experience available.

However, aquaponics can be hard to adopt, hard to put into practice. There are constraints, or blocking issues. This is true in all countries to some extent, – and more so in developing countries. Some of these blocking issues include:
• Expensive initial start-up costs compared to soil-production or traditional hydroponics;
• Complicated technically: knowledge of fish, plants and bacteria is required for each farmer – in addition to construction, plumbing, distribution, business;
• Compound risk: mistakes can cause catastrophic collapse;
• Complicated as a business: financial and market analysis for a successful business;
• Existing materials must be adapted to local conditions;
• Energy: cost and access;
• Requires reliable access to inputs, fish seed and plant seed and market leverage;
• Local, harmonized policy support.

Any intervention needs to consider all of these potential blocking issues.

**Sustainable markets for locally produced food in the Caribbean**

Agricultural industries should be market-led if they are to be sustainable over the long-term. Actors along the entire value chain need to generate sufficient revenue to justify investment in their operations. Consequently, efforts to promote agricultural development need to take into consideration the dynamics, trends and opportunities within fresh and processed agricultural markets. In particular, farmers and processors require information and technical support to better enable them to meet consumer requirements. This presentation outlined common markets in the Caribbean and their relative size, and opens discussions on consumer requirements.

**Principles and tools for value chain assessment**

Value chain mapping is a process that identifies the main activities associated with a company’s service or product line and is often used in corporate strategy in order to identify performance improvement opportunities.

A quick overview was provided on the concept of value chain, flows, mapping stages and flows, cost benefit analysis, competition and bargain power. These concepts and tools were put in practice in the following session with the case study of aquaponics.

**Group exercise: Mapping the value chain of aquaponics**

The objective of this session was to produce a first approach to the value chain description of the aquaponic industry in the Caribbean area. The goals are:

a) Identify participating agents and alternative supply chains (upstream and downstream);

b) Identify flows along the value chain (goods & services, money, information…);

c) Identify sources of costs and incomes and estimate margins;

d) Identify potential bottlenecks (technical barriers, bargain power, consumer behaviour…).

This was a group work session, where small teams were supported by FAO facilitators, with the results shared with plenary. The work included the identification and description of the following, *inter alia*:

<table>
<thead>
<tr>
<th>Inputs / Supplies</th>
<th>Market Outlets</th>
<th>Value Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Seed</td>
<td>• Direct to consumer</td>
<td>• Training and education</td>
</tr>
<tr>
<td>• Feed</td>
<td>• Wholesaler</td>
<td>• Agritourism</td>
</tr>
<tr>
<td>• Fry</td>
<td>• Processor</td>
<td>• Consulting</td>
</tr>
<tr>
<td>• Equipment</td>
<td>• Direct to restaurant</td>
<td></td>
</tr>
<tr>
<td>• Labour</td>
<td>• On-farm café/restaurant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Retail chain (market)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Farmers market</td>
<td></td>
</tr>
</tbody>
</table>
At the end of the session main agents and links in the value chain of aquaponics in the Caribbean region were identified and described. During the following days, participants kept on with the discussions and a draft map of the value chain was presented on the last day to collect last inputs. The resulting value chain map from this exercise is presented in Appendix F.

**Costs of production (a case study of Adams Aqualife)**

During this session an owner/operator of a Barbadian aquaponic and recirculating tilapia farm shared her perspectives of the cost of production with the participants. This presentation compared what was discussed in the previous exercise, and augmented and built upon those results with a more extensive case study. Presentation also included a discussion of the FAO Aquaponic calculator tool on how well it modelled the costs of the system.

The outline of the presentation was as follows:

- Cost categories;
  - Production inputs (seed, feed, power, water)
  - Land (lease)
  - Overhead (lights, communications)
  - Labour (fringe benefits, etc.)
  - Taxes, regulatory matters
  - Harvesting and packaging inputs (bags, equipment, chillers, etc.)
  - Distribution (trucks, drivers)
  - Depreciation of shade cloth, liners and pumps
  - Others

- Breakdown of costs, by category;

- Hidden costs;

- Cost tracking and use of log books and software;

- Factors influencing costs, such as:
  - Scale of production (e.g. how many labourers do you need for a certain size farm)
  - Seasonality (e.g. high vs low tourist season, temperature)

- Supplier arrangements;

- Reliability of inputs.

**DAY-2:**

**Improved market access for locally produced aquaponic products in St. Lucia**

This session presented the perspective of a regional retailer (supermarket) on their role in improving market access for local producers. The presentation touched on the consumer preferences and behaviours in the region with focus on different large demographics. There was identification of most important (value and volume) vegetable crops, as well as a discussion on the relative importance of certification and branding.

**Food safety, traceability and certification schemes**

Food safety is a scientific discipline describing handling, preparation, and storage of food in ways that prevent food-borne illness. The occurrence of two or more cases of a similar illnesses resulting from the ingestion of a common food is known as a food-borne disease outbreak.

In food processing (meat processing, fresh produce processing), the term traceability refers to the recording through means of barcodes or radio-frequency identification (RFID) tags and other tracking media, all movement of product and steps within the production process. One of the key reasons this is such a critical point is in instances where an issue of contamination arises, and a recall is required.
Where traceability has been closely adhered to, it is possible to identify, by precise date/time and exact location which goods must be recalled, and which are safe, potentially saving millions of dollars in the recall process. Traceability within the food processing industry is also utilised to identify key high production and quality areas of a business, versus those of low return, and where points in the production process may be improved.

A presentation was provided by the microbiologist in the Government Analytic Services (GAS) regarding food safety. Food safety, traceability and certification are important aspects for all food systems, and are commonly cited as blocking issues for small-scale producers to enter into certain markets. This presentation outlined some of these aspects, and how to address them. Of particular relevance was the lack of specific guidelines for aquaponics and limited certification and inspection provisions. A demonstration of the importance of proper handwashing techniques was provided using ultraviolet dye.

**Eating local: opportunities and constraints for restaurants**

Brief presentation from a local restaurant highlighted opportunities and constraints for direct sales to restaurants.

**Business of aquaponics (a case study of Indies Greens)**

During this session an owner/operator of an Antiguan aquaponic farm made a presentation on business planning, including aspects of cash flow, sustainable growth, investment, and revenue streams.

The presentation included the following:

- Presentation of the operating costs, sale price of products and relationship to the cost of production.
- Selection of products, customer awareness campaigns.
- Relative importance in revenue from different sides of the business (vegetables vs fish vs consulting).
- Indication of key business planning metrics, such as capital expense, operating expense, production and revenue.
- Definitions of success and considerations in upscaling.
- Largest challenges.

**Agri-entrepreneurship and innovative youth engagement**

As the specialized agency of the Inter-American System for agriculture, the Inter-American Institute for Cooperation on Agriculture (IICA) supports the efforts of the Member States to achieve agricultural development and rural well-being. IICA’s Medium Term Plan 2018-2022 has as one of its priority strategic programmes, support to youth with respect to capacity building in agricultural production, agroprocessing and agrotourism, as well as in accessing domestic and regional markets. The presentation shared the experience of IICA Barbados’ Youth Farm in National/Caribbean Vocational Qualifications (N/CVQ) certification in aquaculture, and the promotion of entrepreneurship through linkages with tourism, in particular culinary tourism.

**Catalysing agribusiness through market connection**

The Barbados Agricultural Society (BAS) is an agricultural organisation, which is over 150 years old. It was established in 1845 by an Act of Parliament in Barbados and seeks to represent the interests of the agricultural sector in all relevant forums. The Society is the secretariat for seven commodity groups representing over 500 farmers with women comprising 30 percent of the total. The BAS almost on a
daily basis maintains some form of relationship with the various industries and sectors that make our economy. The society works closely with these sectors in a continuous effort to help develop and protect our agricultural industry. The linkages often allow the relevant stakeholders to collectively develop strategies and solutions to the various issues that affect us at any given point in time.

- Tourism and International Transport
- Foreign Affairs and Foreign Trade
- Education Youth Affairs and Sports
- Labour and Social Security

BAS is also the implementing agency in a project working directly with the hospitality industry to engage with local producers to meet the food service needs for the tourism sector. This presentation outlined the work of BAS in general, and specifically where applicable to aquaponics.

**Market connections for aquaponics (moderated discussion)**

This session was a moderated discussion on the various markets, issues blocking access to markets and recommendations on how to build better linkages. Outputs of this discussion were used to inform the finalization of the value chain mapping and the final group exercises.

**DAY-3:**

**Tour of aquaponic and hydroponic sites**

Workshop participants attended a site visit to Adams Aqualife farm. This is the site of a recirculating green water tilapia production and aquaponics demonstration farm. The tour included discussion on material flow on the farm (operational management), specifically highlighting harvesting, storage and distribution and their relationship with different retail avenues.

The workshop then travelled to Nature’s Pride hydroponic farm. This site is approximately 1-acre of hydroponic production using the Nutrient Film Technique. Vegetable production included kale, lettuce, basil, herbs, scallions and a few others. The farmer sells primarily to restaurants and direct to customers.

**Use of sustainable agriculture in community groups**

This session was an introduction to use of sustainable agriculture for youth and community groups, and the role that aquaponics can have. A presentation was provided by Nature Fun Ranch, a Youth and Community Group, which uses Nature, Fun, Adventure and Learning for holistic development.

**Commercialization of small scale aquaponics – lessons learned from around the Caribbean**

Aquaponics farming is an ideal system for many Small Island Developing States (SIDS) that suffer from freshwater scarcity and limited land availability; it can use up to 90 percent less water than traditional irrigation systems and can produce crops intensively on a small land area. Although there are several small-scale aquaponics farmers and backyard aquaponics enthusiasts throughout the Caribbean, commercial-scale aquaponics production is limited in the region. Many groups and individuals share similar challenges, which impede their ability to expand activities and grow their business towards a commercial model. These challenges were discussed based on interactions with several small-scale aquaponics farmers in the Caribbean.

Other important aspects to outline are the fact that aquaponics are innovative systems of high interest to youth and they can play a significant role to increase food security and to mitigate negative impacts of climate change on farms throughout the region. Scaling-up and increasing access to aquaponics farming
in the Caribbean offers an array of opportunities at many different levels. Therefore, there is a need to synthesize findings from local, regional and international experiences and lessons learned so as to provide a better understanding of the models that are more likely to be both profitable and sustainable within the context of SIDS in the region.

*Alternative revenue streams: education, training and agritourism (moderated discussion)*

The last session of the day was a moderated discussion regarding 1) integrating education, training and tourism aspects to an aquaponic business and 2) using aquaponics in non-profit settings. Outputs of this session informed the finalization of the value chain mapping, notably the session on alternative value chains and market creation.

**DAY-4:**

*Guidelines for strategic business planning in the food industry*

Strategic planning is a process intended to provide guidelines for companies and organizations in order to be ready to face future events in the most profitable way. The process starts with the analysis on the current situation and follows with the design of policies and actions towards a given goal and the implementation of control tools. The analysis is undertaken both internally and externally, identifying the opportunities and threats the organization will be facing, and the internal ability to successfully face them. A realistic approach is critical for the definition of goals and the design of successful actions. Once the goals (e.g. vision, mission) are clear, the plan proposes the different actions to be implemented in the different systems conforming the organization (e.g. finance, production, marketing). Finally, control tools must be designed and implemented, to be aware of the level of achievement and potential deviations at internal or external changes, which may require a revision in the plan.

*Group work: business planning for an aquaponics company*

This group work produced a SWOT (Strengths, Weaknesses, Opportunities and Threats) diagramme with feasibility approach in simulating a plan for an average company, performed a brief internal and external analysis and specify realistic short-term goals.

*Role of Government towards an enabling environment*

A panel discussion was held for Government representatives regarding the role of Government in supporting aquaponic development. The discussion covered initiatives to improve the enabling environment, integration with other active agencies, and recommendations on how to bring together initiatives. A group discussion followed the presentations.

*Support and elements of an industry platform: collection of recommendations*

Following the comprehensive overview of the challenges and opportunities for a sustainable aquaponics industry in the Caribbean, the question arises as to how to provide strategic support to develop the industry moving forward. Given the range of stakeholders involved in this nascent industry, no single entity has the resources or authority to bring about all the necessary change. This session discussed the options and requirements involved in establishing and facilitating a national-level multi-stakeholder industry platform that can align stakeholders behind a common vision agenda, provided strategic coordination, and generated a momentum for collective development of the industry.
APPENDIX C – LIST OF PARTICIPANTS

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Group photo of participants of the workshop “Advancing Aquaponics through Strengthening Value Chains”, which was held in Christ Church, Barbados, 11–14 December 2018.
APPENDIX E – FAO WELCOME REMARKS

The following FAO opening address, reproduced here in its entirety, was presented by Ms Lystra Fletcher Paul FAO Subregional Coordinator for the Caribbean on the occasion of the workshop Advancing aquaponics through Strengthening Value Chains, 11–14 December 2018 in Christ Church, Barbados.

Ladies and Gentlemen,
1. On behalf of the Food and Agriculture Organization of the United Nations, it is my pleasure to welcome you to Barbados to this workshop on Advancing Aquaponics through improved market access. Thank you for taking the time from your busy schedules to be here.
2. Ladies and gentlemen, Caribbean Small Island Developing States (SIDS) are facing unprecedented challenges to food and nutrition security as well as natural resource management. Although we have made significant progress in reducing the incidence of undernourishment in the region, there are still approximately 7 million undernourished people. Even more troubling is the increasing prevalence of overweight and obesity which has been linked to the incidence of chronic non communicable diseases, which is the leading cause of deaths in the region. In addition, our natural resources, including soil and freshwater, are overexploited, and the impacts of changing climate are likely to exacerbate the pressure on our natural resources.
3. These challenges are far too great for one agency, organization or country to solve. Closer cooperation and integration are needed so that all stakeholders can support Caribbean SIDS in addressing these issues while helping the region achieve the Sustainable Development Goals (SDGs), including SDG 1: no poverty; SDG 2: zero hunger and malnutrition; SDG3: good health and well-being; SDG8: decent work and economic growth; and SDG12: sustainable consumption and production patterns.
4. The main objective of this workshop is to engage with members of the aquaponics value chain to strengthen your ability to identify, understand and assess markets and learn how to tap into the opportunities for improved access to these markets. Moreover, the training will discuss the basic principles of value chain analysis and identify ways to build the groundwork required to develop a viable industry.
5. This training will also emphasize FAO’s major streams of work: supporting innovative practices and the adoption of new technologies. We will also focus on enabling inclusive and efficient value chains and integrated food systems that seek to enhance Efficient Resource Use through aquaponics. At the same time, we will address the principles of protecting natural resources, improving livelihoods and increasing resilience to climate change.
6. As a result, you will improve your capacity to operate aquaponic businesses, identify and exploit markets, and build sustainable relationships with your key stakeholders.
7. Aquaponics farming has many benefits. First, it seeks to produce fish and vegetables, together and efficiently, using minimal inputs. For example, as an integrated technology, aquaponics reduces the usage of freshwater, which is a limited resource in the region with associated high costs. Secondly, aquaponics farmers with limited land and water have a chance to grow food. It gives small-scale farmers the potential to earn supplementary income, and allows commercial farmers to create a viable business. Thirdly, aquaponics supports safe production as no fertilizers or chemical pesticides are required.
8. In addition, aquaponics provides an opportunity for women and youth to be involved in the food production, and the daily tasks are labour-saving. Aquaponics encourages healthy and diverse diets, by making fresh and nutritious vegetables more accessible and available to families. This is especially important in the Caribbean where obesity affects nearly one-fifth of the population.
9. But Aquaponics is not without its challenges and these will be discussed during this workshop. For example, aquaponics requires dependable electricity, reliable access to fish seed, plant seed and good quality water. In addition, any commercial aquaponics venture requires sound
financial and business planning with significant technical expertise. Farmers need to have both an entrepreneurial spirit and an agricultural background – and this is why you are here. Further, we need a local technical base and a regional network to provide on-going support and extension.

10. Increasing production is not enough, strong connections with the consumer ensures sustainability. Here in Barbados and in many other countries consumer demand is driving change. People are willing to pay premium prices for nutritious, high quality and safe food. It is therefore, important to connect the producer and the consumer, overcome barriers to trade, and understand the social and economic factors which affect the producers and consumers’ livelihoods as well as the environment in which they operate so that we facilitate and enable sustainable food systems.

11. Encouraging integrated food systems can also help to reduce the region’s food import bill, which currently stands at $4 billion USD annually and is simply too high. An enabling environment will allow the smooth flow of supplies to meet the demand, and to encourage all people, from hospitality services to public institutions, to consume locally produced, healthy nutritious fish and vegetables.

12. In closing, I would like to acknowledge that this training is being made possible under the aegis of two projects. First, a regional technical cooperation programme (TCP) project, called, “Towards a Caribbean Blue Revolution” which supports sustainable aquaculture development and value chains in Antigua and Barbuda, Bahamas, Barbados and Saint Kitts and Nevis. The second is the Climate Change Adaptation in the Eastern Caribbean Fisheries Sector project, also known as (CC4FISH), which includes a component to strengthen sustainable aquaculture development.

13. I would also like to thank all of you for taking time to attend (we are aware that travel at this time of year is a challenge). We hope that during the next 4 days, you will form a strong network so that even after you return to your respective countries you will continue to share your experiences and learn from one other. We would also like to hear what further needs are envisaged to support aquaponic development, and how FAO can provide assistance, technical or otherwise to support you. Over the next few days, we will record your recommendations to guide our future activities to develop aquaponics across the Caribbean.

14. Finally, I would like to thank my FAO colleagues for organizing this workshop, as well as our hosts, the Ministry of Maritime Affairs and Blue Economy for their hospitality and support, but even more so for their earnest desire to share their experiences of aquaponics with the wider Caribbean. I wish you a successful and fruitful workshop.
The following description of the supply chain of aquaponics in the Caribbean is the result of discussions among participants and resource persons during the workshop. General concepts of value chain analysis were introduced on the first day before a discussion session. Participants were divided in groups which outlined draft diagrams of the market maps addressing the different countries, products and agents. A first map of the value chain, resulting from combining the contributions of each group, was then shared among participants for inputs and harmonized during a participatory session on the last day of the workshop.

The generic value chain (Figure A.1) comprises all the common levels and agents which can be found in any supply chain. Production factors (inputs) are provided to farmers by domestic or international suppliers. Farmers may sell their products, whether fish or fresh produce, direct to consumers, or through the usual local market channels, or even export to overseas markets.

The enabling environment mainly refers to regulations, supporting institutions and infrastructures and other development actions and programmes. Combined actions are undertaken by national and international bodies since international trade is present in the value chain in different ways. Supporting services can be provided by private and public institutions. These include research and innovation, market consultancy, and financial advice and funding among other activities related to business management and technical advisory services (extension).

Inbound logistics

In general, farm operations are dependent on imports. These imports comprise production factors and inputs as well as competing products in the downstream channels and markets. Suppliers and farmers import goods and services which are allocated to farm operations. Traders and processors import other foodstuffs of the same category or other potential substitutes and complements, affecting the
market performance of aquaponic products. Imports may come from the regional or the global market (Figure A.2). Equipment and feed are usually purchased from international companies directly by the farms or through regional subsidiaries or representatives. Seeds and fingerlings can be accessed in the regional markets, supplied by domestic hatcheries and farms. However, international companies also play a significant role in this market. Some farms may export some production inputs like fingerlings or seeds to the regional markets, although the quantities are not sufficient to cover the regional industry demand.

Outbound logistics and services

The outbound system of a value chain refers to the downstream agents and activities involved in making Caribbean aquaponic products accessible to final consumers (Figure A.3). Two main groups of agents can be considered according to the volumes sold to their own customers and their proximity to final consumers. These two groups are commonly known as wholesale, in the first level following farms, and retail, one level before final consumers. Wholesale agents trade large volumes of product aggregating production from different sources and selling them to retail companies or institutions adding some level of processing in more or less extent. Retailers sell small volumes of product to final consumers in different ranges of processing from raw to ready to eat.

The wholesale level includes also processing companies due to the volumes traded by industrial businesses, but their role and motivations differ from the pure commercial wholesalers. Both may be supplied by different local and regional farms as well as imports. Wholesalers classify and aggregate products, including processors’ outputs, and sell them to retail companies with minor transformation which usually does not go beyond classification and packaging. Processors, instead, significantly transform the products resulting in a more differentiated food category identified with their own brands. Wholesalers may transfer farmers’ brands and additional information to their customers which may reach final consumers, increasing their awareness about Caribbean aquaponics. Although some farmers do some minor processing in the farms, participation of industrial processors may be required if increasing market share at the retail level is to be considered.
Wholesalers and processors may sell their products directly to retailers as well as to distributors. Distributors are companies or individuals operating with a given range of products acquired in large volumes of different products and sold in smaller quantities usually combined with other foods or complementary products.

Different kinds of organizations coexist at the retail level. Along with commercial companies, institutions pay their role in providing ready to eat foods for final consumers. These intuitions include hospitals, schools and prisons. Like commercial retailers, they purchase relatively large volumes of product which can be acquired from the wholesale or directly from the farm. Commercial retailers include supermarket chains, traditional outlets and the hospitality industry. Traditional retailers are focused in locally grown products. Purchases are fragmented by outlets resulting in small volume contracts and so, bargain power rarely distorts the market due to the multiplicity of actors with different motivations for purchase. Imported foods are more frequent in supermarkets, covering a relevant market share. Supermarkets concentrate purchases and are commonly supplied by local large processors and wholesalers or directly import from international companies. Hotels, restaurants and catering services are supplied by other retailers, typically traditional or supermarkets, but can also directly purchase to the farms as well as any other retail category.

Farmers can directly access any level in the value chain as well as international markets. Although most of the farm sales are acquired by wholesalers and retailers, direct sales to institutions, hotels and restaurants and direct sales to consumers provide alternative opportunities for increasing value and revenues. Farmers also provide educational and recreational activities with guided visits to the facilities, which enlarge their direct contact with final consumers.

**Concluding remarks**

In terms of levels, agents and flows, the value chain for aquaponics in the Caribbean region is as complex as any other food value chain in developed countries, providing similar challenges and opportunities. The industry and market are strongly dependent on imports. The export volumes, instead,
are minor compared with domestic sales, making farmers revenues highly dependent on the conditions of the local market. Increasing supermarkets’ market share may increase competition from imported foods and bargaining power from retailers. Traditional retailing and the hospitality industry provide opportunities for fresh, locally produced foods and the potentiality of developing strong niche markets. The ability of farmers to directly access any level of the value chain provides a significant advantage for diversifying products, markets, risks and revenues.
APPENDIX G – SWOT ANALYSIS FOR THE AQUAPONIC INDUSTRY IN THE CARIBBEAN

One analysis of an industry is to investigate the strengths, weaknesses, opportunities, and threats (SWOT) related to business project planning, and is commonly referred to as a SWOT analysis. It provides a reference framework for specifying businesses’ objectives and identify the internal and external factors affecting favourable and unfavourable toward the achievement of the strategic objectives.

The theoretical concept and foundations were introduced in the morning session on the last days of the workshop, previous to a discussion session in which participants proposed and confronted different aspects related to the internal and external factors affecting the strategy of the business. On the internal side, strengthens and weaknesses were identified, considering the main competitive advantages and disadvantages of the business. On the external side, opportunities and threats for the development of aquaponics in the region were developed together. A list of the most relevant issues identified by the participants is discussed in the following sessions.

Internal analysis: Strengths (Box 1)

The majority of strengths listed are the result of the technical advantages of aquaponics in comparison to other food production alternatives. These refer to efficiency of production and resource usage, flexibility and adaptability of production. These advantages also result in the higher ability to control environmental impacts. In contrast, market-related advantages were lower in number, with knowledge, experience and proximity to markets the only references to this business aspect.

The ability to increase and promote environmental and safety standards as a tool for increasing demand in quantity and value were considered. Some social advantages such as the potentiality as a source of high quality employment and governmental support were also mentioned in this section.

<table>
<thead>
<tr>
<th>BOX 1</th>
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</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
</tr>
<tr>
<td>• High land and water efficiency. More “crop per drop” (and per area)</td>
</tr>
<tr>
<td>• Can be located in places where traditional farms are less possible or convenient</td>
</tr>
<tr>
<td>• Higher output per input (time), and therefore labour-saving practice</td>
</tr>
<tr>
<td>• Less need to consider crop rotation (pests/soil tiredness)</td>
</tr>
<tr>
<td>• Quicker recovery after flooding and rain from mild/moderate storms compared to soil farms (not relevant to hurricanes)</td>
</tr>
<tr>
<td>• Adaptable (crop choice) to changing market demands, and can address market demands for high environmental or safety standards</td>
</tr>
<tr>
<td>• Resilient and adaptable to impacts of climate change</td>
</tr>
<tr>
<td>• Ability to plan for output volume (know how much product enters market)</td>
</tr>
<tr>
<td>• Higher security to reduce theft, depending on location</td>
</tr>
<tr>
<td>• Lower environmental impact (zero or little waste released)</td>
</tr>
<tr>
<td>• Controlled environment production (less weather dependency). Lower “in field” crop loss compared to soil farm</td>
</tr>
<tr>
<td>• Less or none (hazardous) insecticide, fungicide, with more restricted usage</td>
</tr>
<tr>
<td>• No herbicide</td>
</tr>
<tr>
<td>• Regional experience available in production and market (and all aspects)</td>
</tr>
<tr>
<td>• Job creation, interest to youth farmers, in both agriculture and associated high-tech (smart) farming</td>
</tr>
<tr>
<td>• Generally high level of government support</td>
</tr>
</tbody>
</table>
Internal analysis: Weaknesses (Box 2)

High costs and investments counterbalance the technical advantages enumerated in the previous section of strengths, as well as increased financial limitations and insurance complexity. Such economic and financial weaknesses reduce the ability of increasing scale according to demand in a market with strong relevance of imports. Limitations are also on the labour force side. Lack of skilled labour and the need of high technical knowledge appear as another brake for the development of the industry. On the marketing side, lack of accurate information and market analysis and low product differentiation and identification were mentioned as gaps impeding successful growth of market share and consumer’s product appraisal. Farmers agree that the lack of cooperation at the industry level and competition across farmers result in decreasing bargain power in the supply chain.

### BOX 2

**Weaknesses**

- High capital investment (high financial risk to threats)
- Long return on investment
- High operating expenses, especially electricity, water and labour
- High cost of technology
- Complex insurance arrangements (infrastructure yes, but limited amount of crop/stock replacement)
- Insufficient scale to supply (penetrate and leverage) the market
- Reliance on imported inputs (unreliable and high cost of import)
- Disease can spread throughout system (all eggs in one basket)
- Limited ability to meet HACCP and food safety regulations
- High tech knowledge needed
- Some highly skilled labour needed (unskilled labour still needed too)
- Limited analysis on markets available (no studies)
- Lack of (low) product differentiation, value addition and identification
- No Good Agricultural Practices (GAPs) available from competent authority
- Competition among farmers decreases bargain power in markets
- Difficulties in forming cooperatives, collectives, associations (or other mechanisms) among farmers

External analysis: Opportunities (Box 3)

Increasing market concerns about safety, environment and ethical issues appears as opportunities to capitalize on the technical and social advantages of aquaponics. Consumer’s interest for locally produced foods and additional social values provided by local companies in the field of gender and age labour inclusion increase the opportunities for increasing product value and consumers’ loyalty. Complementary activities such as tourism and education provide opportunities for additional sources of revenues. Funding opportunities may be also available at regional level.
External analysis: Threats (Box 4)

Fish consumption is decreasing in some relevant population segments and strongly dependent on economic factors which may affect prices and profits. Competition from imports and negative perceptions of tilapia and aquaponics not only affect market performance but also the ability to compensate retailers’ bargain power. Lack or limited regulations framework also result in uncertainty for farmers and an inconvenience for long term investment projects.

Summary and conclusions

Far from being a comprehensive analysis of the current strategic situation of the aquaponics industry in the Caribbean, the exercise provided an overview of the main concerns and assurances taken into account by the involved agents when considering their business strategy. In the light of the discussions, some general ideas were derived.
The aquaponic industry in the Caribbean has important productive advantages and efficiencies compared to competing sources of protein. However, growth ability is limited by high investments and operating costs, which counterbalance the advantages related with production efficiency. Further, it is also difficult to recruit labour with the required levels of qualification. Although funding opportunities appear to exist, there are some difficulties and complexities, which when added to the lack of a clear regulatory framework, increase uncertainty when considering business growth.

On the market side, farmers are aware of their advantages in regard to production efficiency, control and adaptability. However, the way in which such advantages could revert in market returns is not quite clear. It is acknowledged that increasing market concerns about safety and environment is an opportunity for market growth, but the way in which such opportunities can be taken is not yet well developed. Although there is interest in the markets for locally produced foods, these segments are not yet well developed and need further effort in consolidation. Limited effort in product differentiation and identification, combined with negative communication and consumer’s acceptance increase the difficulties in increasing traders and consumers perceived value. Imported foods are the main competitors, but also competition exists across local producers. Lack of industry organization and coordination among with competition across farms, increases traders bargaining power.
APPENDIX H – REQUESTED DOCUMENTS

A collection of documents were requested as a supplement to the FAO Aquaponic Technical Manual (Appendix I). These documents will be developed and disseminated by FAO acting as Secretariat, with invitations to contribute sent to key actors. A comment period will be provided during which the documents will be sent to all participants and other regional stakeholders. Comments will be provided through E-mail and video conferencing, facilitated by the nascent Caribbean Aquaponic Association. Finalized documents will be published as an FAO Fisheries and Aquaculture Circular, and disseminated through relevant networks.

The list of requested documents and a short description is hereafter provided:

<table>
<thead>
<tr>
<th>List of crops for Caribbean Aquaponics</th>
<th>Provide the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Most valuable crops by country</td>
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<tr>
<td></td>
<td>• Least valuable crops by country</td>
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<tr>
<td></td>
<td>• Easiest crops to grow</td>
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<td></td>
<td>• Hardest crops to grow</td>
</tr>
<tr>
<td></td>
<td>• Methods of growing each crop (temperature and nutrient requirements)</td>
</tr>
<tr>
<td></td>
<td>• Packaging and handling instructions</td>
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<thead>
<tr>
<th>Requirements for becoming Agritourism site</th>
<th>Draft list includes:</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>• Facilities (bathroom, shade, water)</td>
</tr>
<tr>
<td></td>
<td>• Signage (fire exit)</td>
</tr>
<tr>
<td></td>
<td>• Safety equipment (fire extinguisher, first aid)</td>
</tr>
<tr>
<td></td>
<td>• Insurance</td>
</tr>
<tr>
<td></td>
<td>• Parking and accessibility</td>
</tr>
<tr>
<td></td>
<td>• No trip hazards</td>
</tr>
<tr>
<td></td>
<td>• Biosecurity (hand wash, foot wash, separate areas for tours and production)</td>
</tr>
<tr>
<td></td>
<td>• Sales of value-added products (lunch, juice, souvenir, packaged food)</td>
</tr>
<tr>
<td></td>
<td>• Photogenic (landscaping, place for selfies, hidden pipes)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Health and safety</th>
<th>Provide updates to existing GAPS:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• National regulation</td>
</tr>
<tr>
<td></td>
<td>• Resources for testing and compliance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School curricula</th>
<th>Provide outline of school curricula highlighting how aquaponics can be used in the classroom.</th>
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<thead>
<tr>
<th>Consumer behaviour and market analysis</th>
<th>• Acceptance of tilapia as substitution product</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>• Import of foreign tilapia (quantity and value)</td>
</tr>
<tr>
<td></td>
<td>• Vegetable preferences</td>
</tr>
<tr>
<td></td>
<td>• Demographic analysis</td>
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</tbody>
</table>
APPENDIX I – FAO AQUAPONICS MANUAL AND PUBLICATION PORTFOLIO


Small-scale aquaponic food production. Integrated fish and plant farming


Aquaponics is a symbiotic integration of two mature disciplines: aquaculture and hydroponics. This technical paper discusses the three groups of living organisms (bacteria, plants and fish) that make up the aquaponic ecosystem. It presents management strategies and troubleshooting practices, as well as related topics, specifically highlighting the advantages and disadvantages of this method of food production. This publication discusses the main theoretical concepts of aquaponics, including the nitrogen cycle, the role of bacteria, and the concept of balancing an aquaponic unit. It considers water quality, testing and sourcing for aquaponics, as well as methods and theories of unit design, including the three main methods of aquaponic systems: media beds, nutrient film technique, and deep water culture. The publication includes other key topics: ideal conditions for common plants grown in aquaponics; chemical and biological controls of common pests and diseases including a compatible planting guide; common fish diseases and related symptoms, causes and remedies; tools to calculate the ammonia produced and biofiltration media required for a certain amount of fish feed; production of homemade fish food; guidelines and considerations for to establishing aquaponic units; a cost-benefit analysis of a small-scale, media bed aquaponic unit; a comprehensive guide to building small-scale versions of each of the three aquaponic methods; and a brief summary of this publication designed as a supplemental handout for outreach, extension and education. Aquaponics is an integrated approach to efficient and sustainable intensification of agriculture that meets the needs of water scarcity initiatives. Globally, improved agricultural practices are needed to alleviate rural poverty and enhance food security. Aquaponics is residue-free, and avoids the use of chemical fertilizers and pesticides. Aquaponics is a labour-saving technique, and can be inclusive of many gender and age categories. In the face of population growth, climate change and dwindling supplies of water and arable land worldwide, developing efficient and integrated agriculture techniques will support economic development.

The manual can be downloaded from the following web link (English version): www.fao.org/3/a-i4021e/index.html.
Additional publications from FAO can be found at the following links:

<table>
<thead>
<tr>
<th>FAO Aquaponic Portfolio</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Link</strong></td>
<td><strong>Brief Description</strong></td>
</tr>
<tr>
<td><a href="http://www.fao.org/3/a-i4021e.pdf">www.fao.org/3/a-i4021e.pdf</a></td>
<td>FAO Aquaponic Technical Manual (English)</td>
</tr>
<tr>
<td><a href="http://www.fao.org/3/a-i5337e.pdf">www.fao.org/3/a-i5337e.pdf</a></td>
<td>FAO Aquaponic Workshop Report – Osimo, Italy</td>
</tr>
<tr>
<td><a href="http://www.fao.org/3/a-i5543e.pdf">www.fao.org/3/a-i5543e.pdf</a></td>
<td>FAO Aquaponic Workshop Report – Bogor, Indonesia</td>
</tr>
<tr>
<td><a href="http://www.fao.org/3/a-i6851e.pdf">www.fao.org/3/a-i6851e.pdf</a></td>
<td>FAO Multistakeholder workshop report – Bogor, Indonesia</td>
</tr>
<tr>
<td><a href="http://www.fao.org/3/a-i4504e.pdf">www.fao.org/3/a-i4504e.pdf</a></td>
<td>FAO Fisheries and Aquaculture Newsletter #53 (page 52)</td>
</tr>
<tr>
<td><a href="http://www.youtube.com/watch?v=Cp-fyoZxwAo">www.youtube.com/watch?v=Cp-fyoZxwAo</a></td>
<td>YouTube video of Aquaponic farm in Limo, Indonesia</td>
</tr>
<tr>
<td><a href="http://www.youtube.com/watch?v=558nSVsL5nI">www.youtube.com/watch?v=558nSVsL5nI</a></td>
<td>YouTube video of Aquaponic farm in Cijeruk, Indonesia</td>
</tr>
<tr>
<td>teca.fao.org/keywords/aquaponics</td>
<td>FAO TECA (keyword aquaponic) on simple aquaponic practices – French, Spanish and English</td>
</tr>
<tr>
<td><a href="http://www.fao.org/3/a-i4741e.pdf">www.fao.org/3/a-i4741e.pdf</a></td>
<td>FAO report on Women’s work burden (aquaponics on page 26)</td>
</tr>
<tr>
<td><a href="http://www.fao.org/3/a-i5620e.pdf">www.fao.org/3/a-i5620e.pdf</a></td>
<td>Resilience promising practices - aquaponics</td>
</tr>
<tr>
<td><a href="http://www.fao.org/3/a-i5555e.pdf">www.fao.org/3/a-i5555e.pdf</a></td>
<td>State of the World Fisheries and Aquaculture (aquaponics on page 101)</td>
</tr>
</tbody>
</table>
APPENDIX J – SELECTED PHOTOS OF THE WORKSHOP

Kristina Adams of Adams Aquafarms presents the aquaponic demonstration facility

Grow-out tanks for tilapia are covered with bird netting to prevent predators

Young tilapia showing the strong red colouration against the greenwater culture

Derek Connell of Nature’s Pride hydroponic farm towers over dill plants ready for harvest

A worker collects basil wearing gloves and apron, demonstrating how hydroponics can be labour saving, as this woman does not need to stoop to harvest

Vibrant cultivars of leaf lettuce have strong market demand in high-end restaurants
Facilitator presenting on the integrated nature of food systems and the importance of cohesive strategies

A health and safety demonstration from the Ministry of Agriculture demonstrates the importance of proper handwashing techniques

Group work sessions brought together farmers and actors several countries to discuss common issues and opportunities

Two Barbadian farmers discuss hydroponics with a representative from the Ministry of Agriculture

Participatory action plan development

Hydroponic farm in St. Thomas showing kale and red/green lettuce in front of coconut grove
APPENDIX K – SELECTED PRESS RELEASES AND NEWS CLIPS

Prensa Latina – FAO to Strengthen Aquaculture’s Role in the Caribbean.


St. Kitts and Nevis Observer – FAO Workshops Focus on Strengthening Caribbean Aquaponics Farming.

A technical training workshop on advancing aquaponics was held in Christ Church, Barbados, in the period 11–14 December 2018. Twenty seven international participants were present from seven countries (Antigua and Barbuda, Bahamas, Barbados, Grenada, St. Kitts and Nevis, St. Lucia and Trinidad and Tobago). This activity was supported under two UN FAO-funded projects: Towards a Caribbean Blue Revolution and Climate Change Adaptation in the Eastern Caribbean Fisheries Sector Project (CC4FISH).

The four-day workshop was convened by FAO and consisted of lectures, participatory group sessions and hands-on activities supported by aquaponics and value chain experts from FAO and supported by local subject matter experts and other contributors.

The workshop concluded with several findings and recommendations that aim to strengthen the aquaponic sector across the Caribbean region.