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Report of the

SUBREGIONAL WORKSHOP TO PROMOTE SUSTAINABLE AQUACULTURE DEVELOPMENT IN THE SMALL ISLAND DEVELOPING STATES OF THE LESSER ANTILLES

Vieux Fort, Saint Lucia, 4–7 November 2002

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PREPARATION OF THIS DOCUMENT

The FAO Fisheries Department has embarked on a programme of promoting sustainable increases in the production of food fish from aquaculture activities in developing countries, including Small Island Developing States (SIDS). Mindful of the status of the world's marine capture-fisheries the goal of the department has been to assist SIDS to position themselves to mitigate food insecurity, while at the same time ensuring that their aquaculture practices are compatible with their ecosystems. In the case of the SIDS of the Lesser Antilles the assistance took the form of a workshop to examine the past and ongoing aquaculture experiences and to elaborate the institutional and policy constraints and opportunities for sustainable aquaculture development, in the future.

This report is the record of the proceedings of that workshop. It also includes the national aquaculture-status reports of the countries that were represented and the papers presented by resource persons.

The report was prepared by the FAO Subregional Office, in close collaboration with the Development Planning and the Inland Water Resources and Aquaculture Services of FAO, Rome.

Distribution:

All FAO Members and Associate Members
Participants at the Session
FAO Fisheries Department
Fishery Officer in FAO Regional Offices

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ABSTRACT

The workshop was organized by the FAO Subregional Office for the Caribbean in collaboration with the Development Planning and Inland Water Resources and Aquaculture Services of the FAO Fisheries Department, Rome. It was hosted by the Government of Saint Lucia, and attended by 15 participants from seven countries, four regional institutions and the FAO Fisheries Department.

The syntheses of the national experiences and status of aquaculture development in the Lesser Antilles reflected a significant level of diversity in the scale of activities among the island nations; they also revealed many similarities in the results and present status of aquaculture development in the subregion. The case studies elicited very positive comments and enquiries from the country representatives.

In the plenary deliberations, to identify the constraints to and opportunities for developing aquaculture sustainably in the subregion, participants recognized the need to rank the aquaculture development activities based on individual country-priorities and stage of development.

The workshop agreed that participants would consult with the decision-makers in their respective countries and communicate a priority-list of needs for possible technical assistance to the technical secretary of the workshop. It was also agreed that such a list would be used to identify common themes that could form the basis for a possible subregional Technical Cooperation Programme (TCP) project proposal.

CONTENTS

SUMMARY OF RECOMMENDATIONS AND PROPOSAL FOR FURTHER ACTION

The workshop participants noted the results of the many previous attempts to develop aquaculture in the subregion. They also identified the following steps that should be taken to facilitate the development of sustainable aquaculture in the SIDS of the Lesser Antilles:

1) Incorporate aquaculture into national development plans and strategies;
2) Formalizing an aquaculture development policy (including environment and fiscal incentives);
3) Legal framework development; Establish small-scale pilot projects for technology transfer and its evaluation;
4) Economic feasibility studies and marketing analysis for aquaculture proposals;
5) Allocate resources (government commitment) for aquaculture;
6) Strengthen aquaculture related institutions (including monitoring and regulatory systems, capacity building, research);
7) Appropriate technology (development & dissemination);
9) Identify reliable sources of inputs and create access to inputs (broodstock, feed, fingerlings, equipment);
10) Establishing administrative procedures for smooth Evaluation and Approval of projects;
11) Code(s) of Best Practice development (under private-public partnerships); and
12) Attract private sector involvement/investment.

The participants recommended that the steps should be prioritized taken in the order suiting the stage of development of aquaculture in a particular subregional country.

They also recommended that a concerted effort should be made to raise the awareness of the opportunities for sustainable aquaculture development among potential aquaculture stakeholders, decision-makers and natural resources managers in the Lesser Antilles.

It was suggested that an immediate follow-up activity to the workshop could take the form of a Technical Cooperation Programme (TCP) project proposal based on the common priority-needs communicated to the workshop secretariat by the countries that participated.

PART I - MEETING REPORT

BACKGROUND AND OBJECTIVES

1. At the special FAO Ministerial Conference on Agriculture in Small Island Developing States (SIDS) held in 1999, the participating countries expressed their commitment to pursue efforts to achieve food security and to implement development policies and programmes which would secure the sustainability of agriculture, forestry and fisheries sectors in SIDS. Specific to aquaculture, the Ministerial Conference recognized the need to collaborate with the international and scientific communities in both the public and private sectors to:

- Introduce or strengthen aquaculture and inland fisheries where feasible and appropriate;
- Ensure that aquaculture practices are compatible with their ecosystems; and
- Establish networks to facilitate exchanges of technical information.

2. FAO included under its current Programme of Work for the 2002-2003 biennium a sub-programme activity on aquaculture development. For the Caribbean region it is intended to promote aquaculture and inland fisheries and increase their contribution to the achievement of food security. Therefore, a number of case studies and analyses of key aspects of aquaculture and inland fishery production have been carried out. Some of the outputs of these activities, specific to the SIDS of the Lesser Antilles, include contributions towards:

- Identifying and analyzing constraints and commercial and or small-scale rural aquaculture development;
- Identifying mechanisms for promoting regional and subregional information exchange, in aquaculture development and management strategies; and
- Identifying opportunities for promoting sustainable and listing the policy and legal initiatives that governments can use to promote sustainable aquaculture development.

3. Efforts to promote aquaculture development among the SIDS of the Lesser Antilles were initiated in the early 1980s. In 1993 the Italian-funded FAO-AQUILA II project on 'Support to Regional Aquaculture Activities in Latin America and the Caribbean' (GCP/RLA/102/ITA) recognized the different potentials for developing aquaculture in the region following a review of the industry. Subsequently, in co-operation with the Caribbean Community (CARICOM) Secretariat, a project on Caribbean Aquaculture Development (CARAD), aimed at institutional strengthening and increasing co-operation among regional institutions was prepared.

4. The main objectives of the CARAD project proposal are still relevant. However, since the project did not attract the anticipated funding it was not implemented. In a real sense, therefore, the present workshop can be considered as an attempt to use the approach suggested in the original CARAD project proposal to refocus on the status of, and the elements of relevance to, aquaculture development in the SIDS of the Lesser Antilles.

5. At the Twenty-first session of the FAO *Committee on Fisheries* (COFI), held in Rome, March 1995, "some delegations underscored the potential importance that the development of aquaculture might play in future in SIDS. It was noted that aquaculture could

be vital for food and economic development, and could permit a reduction in fishing effort where this was called for". At the same Session, several delegations considered that FAO assistance to SIDS should focus on six main areas, among which was "aquaculture and inland fisheries conservation, management and development". Although the issue of aquaculture development in the SIDS was raised during various subsequent sessions it never managed to gain a priority status, which made it difficult for FAO to support aquaculture development in the SIDS through regular budget funds.

6. In view of the above, FAO organized the Workshop on the Development of Sustainable Aquaculture in the Small Island Developing States of the Lesser Antilles with the aim of assisting the participating governments in their decision making processes related to aquaculture development strategy and policy development. The proceedings and conclusions are detailed in this report.

ATTENDANCE

7. The workshop was attended by 15 participants from seven countries in the region, from four regional institutions, and from the Fisheries Department of the Food and Agriculture Organization of the United Nations (FAO) and the FAO Subregional Office for the Caribbean (FAO SLAC). The countries represented included Antigua and Barbuda, Barbados, Grenada, Saint Vincent and the Grenadines, Saint Kitts and Nevis, Saint Lucia and Trinidad and Tobago. The representatives from the Bahamas and Dominica did not attend, but submitted updated reports on the status of aquaculture in their respective countries. The list of participants is attached as Appendix B to this report.

PROCEEDINGS

Opening Ceremony

8. The workshop started with an opening ceremony in which Mr Randolph Walters, Fishery Officer in the FAO Subregional office for the Caribbean, welcomed the participants on behalf of the Director General of FAO, Dr Jacques Diouf and from the Assistant Director-General of the FAO Fisheries Department, Mr Ichiro Nomura. He proceeded to explain the purpose of the workshop and provide a historical background on FAO's past activities in support of aquaculture development in the subregion.

9. He thanked the Government of Saint Lucia for hosting the workshop and introduced its representative to deliver welcoming remarks and to officially open the workshop.

10. Following the introduction, the Chief Fisheries Officer of the Ministry of Agriculture, Forestry and Fisheries of Saint Lucia, Mr Vaughn Charles, conveyed regards from the Honourable Minister, Mr Calix George. The speaker thanked FAO for having organized the workshop in Saint Lucia and extended a warm welcome to the participants. He then took the opportunity to discuss the importance of food security and the potential contribution aquaculture can play in achieving food security in the SIDS of the Lesser Antilles. The speaker stressed the opportunities for aquaculture with regard to providing products to the tourism sector on the islands and to the Saint Lucia school-feeding programme.

11. The speaker mentioned the recent initiatives taken by the Saint Lucia Fisheries Department in producing fish feeds and support to farmers with these feeds and fingerlings. He highlighted the difficulties that aquaculture operators have experienced in sourcing affordable commercial feeds to ensure competitiveness with marine capture fisheries.

12. He also mentioned the potential for regional-level co-operation under the Caribbean Regional Fisheries Mechanism (CRFM), and the high priority given to aquaculture in the medium term plan of the CARICOM Fisheries Unit. In closing, he expressed the hope that the workshop recommendations will include ideas on how to get the costs related to running an economically viable aquaculture enterprise down and how to increase aquaculture production.

Working Session

13. Mr Walters was elected as chairperson for the workshop. The agenda was discussed and subsequently adopted. The agenda is attached as Appendix A to the present report.

Presentation of Technical Papers

14. The working session was opened with a synthesis of national experiences and status of aquaculture development in the Lesser Antilles following the same format used in the AQUILA II project in order to ensure historical comparisons (see Part II of the report). A Compendium of Fisheries Statistics (extracted from FAO Fishstat Plus) containing the aquaculture production for the Lesser Antilles SIDS and the Bahamas, was distributed as a workshop document. The participants were acknowledged for having submitted their country reports in advance, making it possible to elaborate the synthesis. While noting that national reports and the production figures in the compendium had minor differences, most participants provided some clarifications to their country's status and related personal experiences.

15. The following reports were subsequently delivered:

Marketing Opportunities for Aquaculture Products in the Lesser Antilles

16. Mr Raymon Van Anrooy, FAO Fishery Planning Officer, made a presentation focusing on the following issues:

- Trade in fishery products by SIDS of the Lesser Antilles and Bahamas;
- Markets for aquaculture products in the USA and the EU;
- Current trends in and prospects for fish consumption; and
- Issues of importance to commercially oriented aquaculturists.

17. The discussion which followed focused on fishery product quality standardization, food safety and export barriers encountered, as some of the SIDS of the Lesser Antilles are (still) not allowed to export fishery and aquaculture products to the EU. Many participants conceded that there was a local market for aquaculture products, which cannot be satisfied at present from local production. They also identified issues such as: the relative high prices of aqua-feeds, inadequate and unreliable support systems and infrastructure and access to credit as major dis-incentives to aquaculture development in the subregion.

18. The importance of the CARICOM and Organization of Eastern Caribbean States (OECS) organizations in assisting ways of improving access to the regional and international markets was recognized. The full presentation is included in Part III of the report.

Aquaculture Development of Red Drum (Sciaenops ocellatus) in Martinique and the French West Indies

19. Mr Jean Claude Dao of the IFREMER (French Research Institute for Exploitation of the Sea) station in Martinique presented a report on the status of mariculture development of red drum (*Sciaenops ocellatus)* in the French island. He described the techniques used in red drum culture including broodstock maintenance and spawning, larval rearing and grow-out management.

20. The presentation continued with an overview of the steps being taken to improve rearing techniques of the red drum using marine cages and the strategies adopted by IFREMER in transferring the technology to the private sector. Finally, he described some of the risks of mariculture activities and the solutions developed during the pilot phases; he also suggested some of the basic requirements and conditions that can facilitate the transfer of the red drum aquaculture technology to other Lesser Antilles islands. The presentation is included in Part III.

21. During the discussion some participants requested additional information on the extension services being supplied to farmers and the experiences with hurricane damage to the grow-out cages. Mr Dao indicated that there are eight collaborating farmers to whom IFREMER provides extension services, including juveniles for use in grow-out facilities. The speaker also reported that the cages can be submerged to minimize hurricane damage.

Tilapia Production Systems for the Lesser Antilles and other Resource-Limited Tropical Areas

22. The paper was presented by Mr James Rakocy of the University of the Virgin Islands (UVI). He started by presenting background information on the situation with respect to resources that tropical islands may lack (water supply, soil type, declining supplies from capture fisheries and topography) or have in limited amounts available to justify the establishment of tilapia production systems. He discussed three tilapia production systems: 1) cage culture in small ponds; 2) greenwater tank culture; and 3) aquaponics, a system that combines fish culture with plant culture. The speaker reviewed the techniques, materials, methods (including costs) and the results of his work (at the UVI) with floating cages in ponds to intensively produce marketable tilapia.

23. Mr Rakocy continued to describe the processes involved in the construction and operation of greenwater tank culture producing tilapia. He highlighted the processes of bio-conversion, mechanical aeration and bio-filtration, but cautioned listeners of the need for regular monitoring of this system. He also advised participants that the greenwater tank system has recently been adjusted and is now available for commercial aquaculture in small islands.

24. In describing the aquaponics system, for intensive tilapia production in combination with hydroponic vegetables and other crops such as culinary herbs and medicinal plants, the speaker indicated that the tilapia provided most of the nutrient requirements for plant growth

in the system. He described the various adjustments and changes that had to be made to the system while changing components such as tilapia stocking density and vegetable plant species.

25. The speaker detailed that the selection of the most suitable tilapia production system would depend on the local circumstances. He described that the various systems can be applied on different scales, which make them suitable to contribute to rural family diets and income as well as to large-scale commercial tilapia aquaculture. He argued that hydroponics plants extend water use and reduce discharge to the environment; hence integrated systems require less water quality monitoring than individual systems and that the cost savings can increase profit potential.

26. The speaker concluded that large-scale projects would require some preliminary experience or the availability of advance technical supervision and training, at the outset. The presentation appears in Part III of the report.

Scallop Culture in Bermuda: A Model for the Lesser Antilles?

27. Ms Samia Sarkis-Hillier of the Bermuda Biological Station for Research (BBSR) delivered this presentation. She presented the technical details of the aquaculture development process of two local scallop species (*Argopecten gibbus* and *Pecten ziczac*) in Bermuda. She also described the strategies used to carry the process to commercial production as well as to cultivate acceptance at the local markets.

28. The speaker indicated that the environmental, administrative and socio-economic conditions existing in Bermuda were suitable to facilitate the development of scallop culture, from the experimental to the commercial stages. Some of the conditions she mentioned included: good water quality, no income tax and the potential of embargo on imported similar products, and high local prices for seafood and high market demand.

29. In addressing the question of the feasibility of replicating scallop culture in the Lesser Antilles, Ms Sarkis-Hillier indicated that the turn-key technology is available, the species are tropical, and the hatchery facility costs are relatively low. She cautioned that issues such as zoning of aquaculture areas, leasing of the seabed and environmental monitoring of water quality and aesthetics would have to be considered at the outset.

30. Many participants expressed interest in having access to the scallop culture technology, particularly the participant from Antigua and Barbuda who indicated that "fisheries officials in her country were concerned about a noticeable increase in harvesting pressure on a native bivalve (*Lucine* sp.)". She speculated that it might protect the wild bivalve stocks from over exploitation if the technology proved adaptable for culturing them. Ms Sarkis-Hillier indicated that arrangements to establish pilot projects to transfer the scallop culturing technology to the Turks and Caicos Islands and Cuba were being pursued.

Enabling Policy Frameworks for the Promotion of Sustainable Aquaculture in the Lesser Antilles

31. Mr Raymon Van Anrooy presented the paper, on this topic. It was intended that the presentation would serve as a departure point for the plenary discussions. The speaker commenced his presentation by giving same background on the macro-economic and

aquaculture sector specific policies that could facilitate sustainable aquaculture development in the Lesser Antilles. The full presentation can be found in Part III. The main issues discussed by the speaker were:

- Macro-economic and sectoral policies (e.g. COFI, CCRF, CRFM, Good governance);
- Farm level policies (e.g. related to input subsidies, grants, research and extension);
- The relevance of the Code of Conduct for Responsible Fisheries (CCRF) to aquaculture development in the SIDS of the Lesser Antilles; and
- The pre-requisites for aquaculture development in the SIDS.

32. The subsequent discussion focused on aquaculture development experiences of the SIDS of the Lesser Antilles. A country by country overview was requested by some of the resource persons. The information presented during these overviews complemented the earlier information in the 'Regional synthesis'.

33. The discussions showed that there were significant differences in the levels of aquaculture activities between countries in the region; at the same time they also revealed many similarities. For example, the sentiments expressed may be summarized as follows:

- all the countries had some level of aquaculture activities and failures in the past;
- some countries have very little ongoing aquaculture activities at present;
- generally, there is very limited land space available for inland aquaculture development, so mariculture is seen as the best option;
- acceptance of tilapia among consumers is generally low (except for red tilapia);
- some governments want to diversify their countries' agricultural sector (away from banana and sugar cane) and consider aquaculture as one of the options;
- aquaculture is barely mentioned in national fisheries laws, which are generally outdated.

34. Notwithstanding the diversity of experiences expressed, there was consensus among the participants that the aquaculture technologies described in the case studies could improve their respective aquaculture development status. Some enquired about the possibilities of setting-up pilot projects in their countries. The FAO officers responded by suggesting that one possible vehicle which can be used to facilitate the transfer of aquaculture technology among the countries was the FAO Technical Cooperation Programme (TCP). It was suggested that after participants had consulted further with their national fishery administrators formal communications could be initiated to seek to access facilities such as the FAO-TCP or other possible sources of international assistance.

PLENARY DISCUSSIONS ON POLICIES AND INSTITUTIONAL STRATEGIES FOR AQUACULTURE DEVELOPMENT IN THE LESSER ANTILLES

35. In addressing this agenda item, it was originally intended that the participants would be separated into two groups for each to focus on the following tasks:

- to identify the subregional aquaculture policy constraints and opportunities; and

- to identify the institutional constraints and opportunities in the subregional aquaculture development practices.

36. Because of the limited number of participants, it was suggested to work together instead of dividing into smaller groups as the initial agenda had detailed.

37. The plenary discussion elaborated on the critical issues and realities of aquaculture development in the SIDS of the Lesser Antilles. The participants identified the overall objectives of aquaculture as "Contributing to the achievement of food security" and "Contributing to the sustainable use of the aquatic resources of the Lesser Antilles"; they identified the direct objective as "achieving increased aquaculture production in the Lesser Antilles".

38. The plenary acknowledged various important steps that should be taken to reach the objectives of developing the aquaculture sector. Recognizing the fact that there is hardly any aquaculture development taking place in the SIDS of the Lesser Antilles at present, the following steps were suggested:

A. Incorporate aquaculture into national development plans and strategies;
B. Formalizing an aquaculture development policy (including environment and fiscal incentives);
C. Legal framework development;
D. Establish small-scale pilot projects for technology transfer and its evaluation;
E. Economic feasibility studies and marketing analysis for aquaculture proposals*;
F. Allocate resources (government commitment) for aquaculture;
G. Strengthen aquaculture related institutions (including monitoring and regulatory systems, capacity building, and research);
H. Appropriate technology (development and dissemination*);
I. Identify reliable sources of inputs and create access to inputs (broodstock, feed, fingerlings, equipment);
J. Establishing administrative procedures for smooth Evaluation and Approval*;
K. Code(s) of Best Practice development (under private-public partnership); and
L. Attract private sector involvement/investment*.

After considerable discussion the steps marked with (*) were seen as being covered already by the other steps, and therefore could be left out.

The constraints and opportunities identified for each of the recommended steps are the following:

A. ***Incorporate aquaculture into national development plans and strategies***

Constraints:

- Not enough priority is given to CCRF follow-up on aquaculture related issues
- No aquaculture strategies and plans available to incorporate into general development plans
- Aquaculture has not been considered a priority by the national governments
- Institutional capacity to develop aquaculture strategies and plans is not available

Opportunities:

- Demonstrate to Government that aquaculture can contribute to the achievement of food security, generating income and creating employment
- Emphasize that aquaculture should be part of any diversification strategy, can contribute products for the tourism sector and for export
- Develop institutional capacity to formulate aquaculture strategies and plans
- National fisheries departments should take lead in development of sectoral plans, with stakeholder consultation/involvement
- Comply with international agreements/guidelines (such as the CCRF)

B. ***Formalizing an aquaculture policy development (including environment and fiscal incentives)***

Constraints:

- No clearly defined/documented policies on aquaculture (including fiscal incentives and environmental incentives)
- Limited number of aquaculture strategies available to build policies on
- Limited incentives packages to promote aquaculture development
- Limited local experiences to guide policy formulation in aquaculture
- Competition for limited resources (e.g. with tourism, agriculture and capture fisheries sectors)
- In some instances, national policy strategy is away from agriculture and similar activities
- Limited zoning is carried out (land, water, coastal)
- (Results of past projects suggest that there are limited options available)

Opportunities:

- Focus on integrated approach of development
- Draw on existing experiences within the region as well as beyond in relation to policy development at national and regional levels
- Providing incentives to small-sector as aquaculture do not have to be costly for the government
- Strengthen and promote regional cooperation in aquaculture development (including trade arrangements)
- Include aquaculture in the zoning policies & processes.

C. ***Legal framework development***

Constraints:

- Existing fisheries legislation includes only limited references to aquaculture
- Limited institutional capacity to formulate proper aquaculture legislation
- Limited and outdated laws
- No enforcement of existing regulation
- Laws related to water (access) rights are not in place (yet)
- Laws are not harmonized within the region
- Limited consultation between concerned agencies and with stakeholders

Opportunities:

- Upgrade existing fisheries legislation with specific reference to aquaculture, CCRF and relevant treaties and agreements
- Establish clear regulatory and monitoring systems
- Establish clear and simple administrative procedures to facilitate implementation
- Develop mechanisms for consultation with stakeholders
- Encourage harmonization of legislation within the region through existing (sub) regional bodies such as CRFM and OECS - Environmental and Sustainable Development Unit (ESDU).

D. ***Establishment of small-scale pilot projects for technology transfer and its evaluation***

Constraints:

- Negative attitudes as a result of many bad experiences in aquaculture in the past
- Limited private sector involvement in past experiences and projects
- Ineffective human resource management to make pilot projects a success
- Inadequate resources to allow government officers to implement pilot projects properly
- Lack of information and training in existing technologies
- No proper evaluation procedures/mechanisms to validate results of experiences
- No follow-up mechanism to implement successes
- Proper documentation, preservation and transfer of information has been lacking
- Cultural bias towards/against certain products/species
- Lack of proper feasibility studies, including market analysis
- Insufficient planning involved in technology transfer
- Lack of accountability
- In some instances limited participation of relevant government agencies in past experiences and projects.

Opportunities:

- Existing technologies available in the region
- Establish mechanism or networks for exchange of information (including documentation), utilizing existing agencies such as CRFM, OECS, etc.
- Develop a planned approach for technology transfer (including exchange of information, skills, personnel) taking in consideration traditions and cultural biases
- Develop monitoring and reporting systems to ensure accountability and transparency
- Promote and encourage private sector stakeholder participation in projects
- Develop and promote public education and awareness programmes
- Conduct economic feasibility studies including market, financial and business analysis at different stages of implementation

F. *Allocate resources (government commitment) for aquaculture*

Constraints:

- Lack of or inadequate resources for aquaculture development
- Competition for government resources between sectors
- In some cases lack of political will within the government to make commitments to the sector
- Lack of aquaculture advisory/stakeholders bodies to advise the government
- Insufficient data and information available to adequately inform government
- Information/data flow between departments of fisheries and Government is not functioning properly
- Inadequate project formulation/preparation/planning capacity within fisheries departments

Opportunities:

- Develop/establish aquaculture advisory committees
- Improve information and data collection and analysis systems
- Improve strategic planning and decision making processes
- Demonstrate commitment to development of aquaculture by providing and accessing available funds.
- Encourage and support regional collaboration and information exchange for greater cost effectiveness
- Encourage private sector and financial institutions to invest in aquaculture by providing specific incentives

G. *Strengthen aquaculture related institutions (including monitoring and regulatory systems, capacity building, and research)*

Constraints:

- Poor strategic and human resources planning in fisheries departments
- In some cases only a limited number of aquaculture staff available
- Lack of collaboration between fisheries departments and other departments (e.g. environmental) and research and training institutions
- Limited transfer of knowledge at national level after regional initiatives resulting in lack of continuity
- Inadequate support systems and infrastructure for aquaculture development
- Inadequate funding for institutional development

Opportunities:

- Facilitate strategic and human resource planning processes within fisheries departments
- Further improvement of regional collaboration between fisheries departments in the area of aquaculture
- Strengthen and/or create regional centres of excellence in aquaculture research and training
- On-going opportunities for capacity building of fisheries/aquaculture staff
- Encourage governments to appoint national focal points for aquaculture development to promote networking and ensure continuity and information exchange

- Identify possible sources of funding (public and private, NGOs, donors) for institutional strengthening

I. ***Identify reliable sources of inputs and create access to inputs (broodstock, feed, fingerlings and equipment)***

Constraints:

- Lack of high quality broodstock, appropriate feed, fingerlings and equipment in sufficient quantities at national level
- High relative costs of inputs related to (the production and transport of) small quantities required
- Inadequate planning of production processes and related to ordering of necessary inputs
- Lack of participation/consultation with and among stakeholders in the planning process

Opportunities:

- Ensure that support systems are in place through proper planning
- Centralize purchasing wherever possible
- Identify aquaculture enterprises at national and regional level which can assist in sourcing and accessing inputs
- Establish vertical chain cooperation (e.g. between feed industry, aquaculturists, processors) in the aquaculture products chain

K. ***Code(s) of Best Practice development (under private-public partnership)***

Constraints:

- Lack of knowledge of CCRF and specifically the articles on aquaculture development
- Lack of knowledge on standards for food safety and health issues (HACCP, ISO, CODEX, etc.)
- Lack of understanding of implications of not adhering to codes of best practice
- Lack of organization among aquaculturists (private sector)
- Weak linkages between public and private sector aquaculture stakeholders

Opportunities:

- Improve the image of the sector and its products among consumers
- Raise awareness on CCRF and related aspects among stakeholders
- Fisheries Departments need to provide training regarding CCRF issues and standards
- Promote good management practices in the whole industry
- Encourage the formation of private sector organizations/associations
- Strengthen public sector monitoring and inspection systems to include the development of aquaculture products

39. During the review of the identified constraints and opportunities (above), the plenary recognized that most countries were at different stages in their development of aquaculture, and suggested that care should be taken to prioritize the 'steps' according to their individual stages of development. In addition, concerted awareness raising activities on the potential of aquaculture (among policy makers, managers, present and potential stakeholders) were

identified as critical. Continuous awareness rising is also considered important in order to not lose the momentum created by the workshop.

40. The most emphasized issue among the opportunities identified by the plenary was the need for governments to establish clear transparent aquaculture development policies using mechanisms for consultation with other stakeholders (nationally as well as subregionally). Regional co-operation and exchange of experiences and technology was the second most recurrent issue in the opportunities identified by the plenary. The participants also identified a need to focus on an integrated approach to aquaculture development to ensure its role in contributing to food security and agricultural diversification, where applicable and to ensure compliance with international agreements and guidelines.

CONCLUSIONS

41. The representatives of the various countries were the government aquaculture officers. It is expected that their lines of communication with the Ministers responsible for national fisheries sector development, will ensure the transmission of the workshop results to the appropriate level of national decision-making. Further follow-up on the workshop relative to the re-initiated promotion of aquaculture will depend largely on the interest the returning officers will receive from their Ministries. The CARICOM Fisheries Unit representative agreed to follow up on the workshop at regional level, and especially mentioned that the CRFM could take up the task of functioning as a network for collection and dissemination of information on aquaculture in the region.

42. Many of the participants stressed the urgent need for the development of an aquaculture policy framework and requested information on how to get access to FAO technical support specifically for aquaculture; and technology transfer and policy development; some asked about the possibilities of co-operating with countries and institutions in the subregion where aquaculture pilot projects have been successful. Responding to this the FAO officers provided information on the FAO Technical Cooperation Programme and its guidelines for project proposal formulation.

43. At the end of the workshop it was concluded that this initiative to organize a workshop on sustainable aquaculture development, was highly appreciated by the represented countries and that it is of utmost importance to follow up on what was discussed. New insights into the constraints and opportunities related to aquaculture development in the SIDS of the Lesser Antilles have created awareness on which activities to undertake new initiatives can be based.

APPENDIX A

AGENDA

Monday, 4 November 2002

09.00 AM	Registration
09.30 AM	Opening Ceremony
10.00 AM	*Coffee break*
10.15 AM	Election of Chairperson and Adoption of Agenda, Introduction of participants
10.30 AM	Discussion of the synthesis of national experiences in aquaculture development in the Lesser Antilles
11.20 AM	The marketing opportunities for aquaculture products in the Lesser Antilles
11.50 AM	The experiences of developing commercial aquaculture in the Lesser Antilles: Case Studies from St Croix, Martinique and Bermuda • The experiences and potential for developing Red Drum (*Sciaenops ocellatus*) culture in the Lesser Antilles. IFREMER, Martinique
12.30 PM	*Lunch*
14.30 PM	Case Studies (continued) • Tilapia production for the Lesser Antilles and other resource-limited tropical areas: Cage culture in small ponds, Green water tank culture, and Aquaponics. St Croix, USVI.
15.15 PM	*Coffee break*
15.30 PM	General discussions on the presentations by participants, with references to individual country experiences
17.00 PM	Adjournment

Tuesday, 5 November 2002

09.00 AM	Case Studies (continued) • The experiences of taking the culturing of scallops to a commercial phase in small islands: Case study of the Calico Scallop in Bermuda: A model for the Lesser Antilles?

10.15 AM	*Coffee break*
10.30 AM	Enabling policy framework for the promotion of sustainable commercial aquaculture in the Lesser Antilles
11.15 AM	Discussions on the aquaculture development experiences of each of the participating countries
12.30 PM	*Lunch*
14.00 PM	Discussions on the aquaculture development experiences of each of the participating countries (continued)
15.45 PM	*Coffee break*
16.00 PM	Briefing on the formation composition and mode of operation/ deliberations of the working groups or plenary session
17.00 PM	Adjournment

Wednesday, 6 November 2002

09.00 AM	Plenary session discussions on the strategies (steps to take) to develop sustainable aquaculture in the SIDS of the Lesser Antilles
10.30 AM	*Coffee break*
10.45 AM	Continuation of plenary session
12.30 PM	*Lunch*
14.30 PM	Plenary session discussions on constraints and opportunities for sustainable aquaculture development in the SIDS of the Lesser Antilles
17.00 PM	Adjournment

Thursday, 7 November 2002

08.30 AM	Plenary discussions to finalize/amend the outcome of the discussions on sustainable aquaculture development in Lesser Antilles
10.00 AM	Approval of first draft workshop report Closing remarks and coffee break

APPENDIX B

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PART II

NATIONAL AQUACULTURE STATUS REPORTS

The information provided in the following National Reports were provided by country representatives during the workshop. Their publication, herein, does not imply any expression of or opinion on the accuracy, quality or veracity of the said information, by the editors or the FAO.

NATIONAL REPORT
OF
ANTIGUA AND BARBUDA

by

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I. GENERAL INFORMATION

Geography and Economy

Area	440 km²
Length of coastline	153 km
Shelf area	3 568 km²
Terrain	Antigua - A relatively high south western volcanic portion with a central diagonal plain and a north eastern limestone region Barbuda - A low relatively uniform topography with highlands reaching an elevation of 30 m
Climate	Tropical
Population	59 355 (1991 census) 75,741 (2001 census)
Annual growth rate	16.3% (1991-2001)
Languages	English
Work force	26 753 (1991) 27% Public Sector, 0.03% Agriculture and Fisheries, 17% Hotels and Restaurants, 55.97% rest
Unemployment rate	3% (1991)
GDP	US$M 669.88 (2000) at market prices
GDP growth rate	0.06% (1992-2000)
GDP per capita	US$ 9 319.85 (2000) at market prices
Central Budget	US$ 224 428 478.65 (2002)
Currency unit	Eastern Caribbean Dollar US$ 1.00 = EC 2.71 (May 2002)
Agriculture	0.4% of GDP at factor cost (2000)

Fisheries Data

Commodity balance (1999)

Fish for direct human consumption	Production	Imports	Exports	Total supply	Per caput supply
	'000 mt live weight				kg/yr
	1.36	2.11	0.055	3.42	48

Estimated employment

Primary sector	987 fishermen and women 46% full-time 54% part-time and subsistence
Secondary sector	30 vendors, 6 boat builders

Gross value of fisheries output (at ex-vessel prices - 1999)

US$8.1 million

Trade (1999)

Value of imports	US$ 9.0 million
Value of exports	US$ 0.5 million

II. STATUS OF AQUACULTURE PRODUCTION

Background

Antigua and Barbuda's earliest attempts in the late 70s, at freshwater aquaculture were in the production of tilapia and catfish but these proved unsuccessful due to the constraints of low rainfall. In the early 1980s, UNDP/FAO Aquaculture Development and Coordination Programme and the Western Central Atlantic Fishery Commission fielded two missions to the region to examine its aquaculture potential. The mission noted that Antigua had "many sheltered bays and suitable adjacent lands for the culture of juvenile snappers and groupers in cages". Also identified was a demand for mariculture for high quality fish, crustaceans and sea moss for local consumption and for export.

In 1985, the Smithsonian Institute, at the request of the Peace Corps and with funding from the US Agency for International Development, chose Antigua as a pilot site for the production of the Caribbean King Crab, *Mithrax spinosissimus.* The area chosen was Nonsuch Bay, in the north eastern portion of the island, and afterward moved to Valley Church in the southwest. The successful adoption of the project was given a good prognosis but due to the high cost of grow out using tanks, and non-acceptance of *Mithrax* as a substitute for lobster, the project did not attract any investment.

Some experimental work was also done on the production of the Spiny lobster, *Panulirus argus,* in the Valley Church area at the same time. Results of this work were never shared with the Fisheries Division.

Other past projects included the culture of sea moss in Barbuda funded by the Canadian International Development and Research Centre. This was a two-year pilot project and though the project showed potential no private investors showed interest. Another project, the Antigua Shrimp Culture was financed by the Eastern Caribbean Mariculture Ltd, USAID,

Bank of Antigua and the Caribbean Food Co-operation. The farm was located at Nonsuch Bay and had a quarantine/nursery laboratory and 6 two hectare grow-out ponds, supported by a 10-hectare reservoir. In 1985, commercial production of shrimp started using *Penaeus vannamei and Penaeus monodon.* The output was sold locally but yields were low, 0.36-0.57 metric tones per hectare, and there was difficulty in obtaining disease free juveniles (Fisheries Development Plan 2002-2005). The company has since gone out of business in Antigua.

Within the past year there have been about three proposals for aquaculture projects for the production of conch, lobsters, sea urchins, tilapia, sea cucumbers and aquarium fish. These proposals are still in the planning stage.

In the early 1990s there has been the culture of sea moss on an experimental scale by three persons in Antigua, and in 2000 one grower has gone commercial and has the potential to produce 200 lbs dry weight per day. However, due to low demand locally and the inability presently to access regional markets, this potential has not been realized. One other grower produces only for family and village consumption.

Contribution to national fisheries production

This is negligible. In 2000 only 666 lbs was sold valued at US$ 7 490. This is considered an insignificant contribution to the fisheries sector in the economy.

Species being cultured and the technologies used

The sea moss species cultured were *Eucheuma* and *Gracilaria.* Currently only *Eucheuma* is being grown. The sea moss is grown on lines in a shallow bay. Pieces of the moss are twisted into long lines of nylon rope and after a few weeks the moss is harvested leaving a portion of the moss in the rope for new growth to occur.

III. HANDLING AND MARKETING OF AQUACULTURE PRODUCTS

Processing of aquaculture products locally

Processing of the sea moss into a beverage is carried out by the local investor at his home. The sea moss is also packaged and sold dried.

Social acceptance of aquaculture products locally

Social acceptance of aquaculture products is limited to using the sea moss as a beverage. Local folklore has it that the drink has aphrodisiacal properties so it is drunk mainly by men.

Marketing of aquaculture products locally and externally

Handling and marketing of sea moss is done by the local investor himself and he is presently able to commit funds to tapping the only local market. He however has a website. How many sales this generates is unknown.

IV. EXISTING POLICY, PLANNING & MANAGEMENT OF AQUACULTURE

Government's involvement in aquaculture development

Government's involvement in aquaculture development is mainly advisory and to give subsides. Proposals are passed on to the Fisheries Division from the Minister for input.

However, there are no trained aquaculturalists on staff. Generally, investors request a lease of government land.

Private sector involvement in aquaculture

All of the project proposals which have been put forward have come from private investors. Most of the investors have been local with additional funds being raised from non-local investors.

Monitoring and regulatory practice for aquaculture activities

Presently there are no monitoring and regulatory practices for aquaculture activities.

Strategy (existing/planned) for future development

The Fisheries Development Plan 1999-2003 recognises the need for mariculture for the following reasons:

- to diversify the narrowly based economy;
- to increase the use of available and not fully utilized natural species;
- to present opportunities for the development of aquaculture suited for small holders/fishermen and private entrepreneurs and multinational companies;
- to increase foreign exchange;
- to reduce fish imports; and
- to re-establish fisheries where over-fishing seems to be taking place.

To be noted, however, is that current fisheries legislation does not provide for "leasing and partitioning" a section of a bay to be used for mariculture projects. Thus far the only type of secure operation would be on land and that would incur high electricity costs. Also, as pointed out above, the Fisheries Division has no one trained in aquaculture. Current fisheries legislation does not address the development of aquaculture.

NATIONAL REPORT
OF THE
COMMONWEALTH OF THE BAHAMAS

by

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I. GENERAL INFORMATION

Geography and Economy

Area	13 935 km²
Length of coastline	3 000 km (est.)
Shelf area	116 550 km²
Terrain	Flat
Climate	Sub-tropical
Population	300 000 (2000 census) 309 000 (est. 2001)
Annual growth rate	1.7% (2000)
Languages	English (official) and some Creole among Haitian immigrants
Work force	153 310 (2001) - Majority employed in Government, hotel and restaurant, and financial sectors
Unemployment rate	7.5% (2000)
GDP	US$ 1 755 million (1988) US$4.9 billion (2000)
GDP growth rate	2% (1988)
GDP per capita	US$ 15 900 (2000)
Central Gov't revenue	US$ 1.1 billion (2001/2002) est.
Currency unit	Bahamian Dollar US$ 1.00 = B$ 1.00 (Oct 2002)
Agriculture	Exports: US$34.4 million (1989). Products: vegetables, lobster, fish
Industry	Types: tourism, banking, petroleum, pharmaceuticals, rum
Trade	Exports: Non-oil exports US$ 1 billion (1988) - salt, aragonite, timber, beverages and chemicals. Oil exports US$ 2.3 billion (1988). Imports: US$ 1.6 billion (1988) - manufactured goods, oil, chemicals, machinery and transport equipment, food, live animals, beverages, tobacco.

Fisheries Data

Commodity balance (1997)

Fish for direct human consumption	Production	Imports	Exports	Total supply	Per caput supply
	'000 mt live weight				kg/yr
	5.1	2.2	2.6	4.7	16.5

Estimated employment (1995 Fisheries Census)

Primary sector	8 800 full-time
Secondary sector	200 full-time and 100 part-time

Gross value of fisheries output (At ex-vessel prices - 2001)

US$ 64.8 million

Trade (2001)

Value of imports	Not Available
Value of exports	US$ 72.3 million

II. STATUS OF AQUACULTURE PRODUCTION

Species cultured and technologies

Inland aquaculture

At present only one (1) facility in operation, Lucayan Aquaculture Company, Freeport Grand Bahamas, producing *Penaeus vannamei* in four (4) hectare size ponds making a total of ten acres in production. Post larvae imported from Central America for growout. Annual yield of 29 486.50 pounds of shrimp marketed during 2001.

Coastal aquaculture

None of the firms mentioned in the section under Coastal Aquaculture are presently operational.

Aquaculture technologies

The Technical Mission established by the Republic of China on Taiwan ceased operation in 1997.

Aquaculture statistics

29 486.50 pounds of Shrimp (*Penaeus vannamei*) were produced in the Bahamas during 2001 with a value of Bds$ 182 000.00

III. POLICY MAKING, PLANNING AND MANAGEMENT

The Department of Fisheries (DOF), which falls under the Ministry of Agriculture, Fisheries and Local Government (MAF), is responsible for the management of the fishery industry and for the implementation of fisheries policies and developmental objectives. The Department's objectives for fisheries management are:

- to ensure the optimum utilization of the fisheries resources for the benefit of the Bahamian people;
- to promote the development of local fisheries; and
- to improve the technical capabilities and social well-being of the local fisherman.

The Department of Fisheries is divided into four technical units (Research and Development, Resource Management, Resource utilization and Law Enforcement) and one administration unit. Presently the Department has no office dealing exclusively with aquaculture matters, although high priority has been attached to the development of this sector of the fishery industry. The policy of the Government of the Bahamas is not to invest directly into aquaculture production. However, through the regulatory role of the DOF, it promotes the development of aquaculture mainly through technical assistance and incentives (e.g. duty-free concession on imported equipment). The Department of Fisheries is headed by a Director supported by a total staff of about 50, out of which only tow have a background in aquaculture training and fieldwork. The above mentioned officers are responsible for all matters related to aquaculture with the Department.

The aquaculture industry is presently not regulated however a draft Aquaculture Act was prepared in 1984 with the assistance of FAO. The Act was prepared at a time when aquaculture in The Bahamas was at an early stage of development, although it would have provided the Government with the legal framework for controlling and directing the development of the industry, it was not introduced as part of the overall fisheries regulations.

In addition to what is stated in the document, there is a renewed interest by the government to develop aquaculture especially in the Family Islands.

Also, aquaculture is regulated under the present Fisheries Resources (Jurisdiction and Conservation) Regulations, 1986.

IV. TECHNICAL CAPABILITIES

Education and training

The College of the Bahamas does offer a marine biology course.

Research

Presently there are no institutions conducting research in aquaculture. Caribbean Marine Research Centre has discontinued the aquaculture research component at their facilities in Lee Stocking Island, Exuma.

Technical assistance and extension

Little government support in terms of technical assistance and extension services has been provided to the private sector operating commercial aquaculture ventures. Although the Department of Fisheries has been encouraging the promotion and development of the industry in the Bahamas through attractive investment conditions (e.g. land and sea areas lease/purchase agreement, duty-free importation of equipment and fish feed, etc.). The shortage of technical staff and the absence of a research/training facility made it almost impossible for the Department to provide technical support to interested parties. However, the Government hopes that the newly completed shrimp culture centre will enable the staff of the DOF to acquire technical experience, particularly in shrimp culture, so that an extension and technical assistance service can be provided to local and foreign investors.

The Government still offers technical support for project development and duty-free concessions for approved projects.

V. POTENTIAL FOR AQUACULTURE DEVELOPMENT

Physical potential

With regard to its natural resources, Bahamas enjoys a number of important advantages, which favour the establishment of aquaculture operations.

The landform is generally acceptable for aquaculture since large areas of level or gently sloping land above the water table occur in many of the islands. Factors which may constrain pond construction are: (i) the insufficient tidal range to permit filling of ponds at high tide and drainage at low tide, and (ii) the composition of land which is almost pure limestone. These constraints could be overcome by using pumps to manage water supply and by constructing lined earthen ponds, which would, however, considerably affect the initial investment cost as well as running expenses of the ponds, respectively.

Freshwater is available in sub-surface lenses ranging from 20-40 metres in depth in the northern Bahamas to 3-12 metres in the drier southern islands. Apart from these freshwater lenses, no rivers and few ponds exist, therefore significantly reducing the possibility of rearing freshwater species on a large commercial scale. Good quality seawater, on the other hand, is available in abundance, either from the surrounding sea or from wells.

In addition to the above resources, the Bahamas is rich in bays and channels of moderate depth (also relatively well protected from surf and storms), where floating culture structures could be installed and maintained.

In summary, it appears that the essential natural resources for marine aquaculture are abundant, while the potential development and expansion of freshwater aquaculture is limited by the lack of large supplies of freshwater.

Species

An increased interest in aquaculture projects is presently being manifested by the private sector. However, most of their attention is directed to the culture of marine shrimp. On the other hand, taking into account a number of geo-physical factors, which determine the possibility of commercial aquaculture activities in The Bahamas, it appears that the potential

exists mainly for mariculture operations. Although research would still be required to improve the culture technology of some species (e.g. dolphin fish, pompano, grouper, snapper, sponges), the culture of other species such as *Gracilaria, Eucheuma*, queen conch (the latter for restocking depleted areas) and brine shrimp could be attempted. This is possible as a result of favourable environmental conditions and relatively well known culture technologies applied in other countries around the world (e.g. *Eucheuma* culture in the Philippines).

Finance

To date the Bahamas Development Bank (BDB) has not financed any aquaculture operations, although one loan application was submitted for a project in Freeport. Although the above loan application has not yet been approved, the BNB appears to be willing to support the aquaculture industry at normal commercial rates. So far the Bank has been approached mainly for loans for fishing vessels and processing plants.

VI. FISH HANDLING, PROCESSING AND MARKETING

Most of the products derived from aquaculture practices are presently for the local fresh market and sole mainly to restaurants (shrimp) through a very simple marketing system. However, locally produced shrimp is currently facing a marketing problem as it appears that the market is somewhat monopolized by one company that imports into the country frozen shrimps produced elsewhere in the region. With regard to processing, most of the existing plants efficiently handle and process products derived from the capture marine sector for the export markets. No plant is specifically handling aquaculture products possibly due to the small and unreliable quantities presently produced. However, should the production from aquaculture considerably increase, the present facilities might be willing to purchase the raw material for processing.

VII. CONCLUSIONS AND FUTURE DEVELOPMENTS

Aquaculture in the Bahamas has attracted a number of investors. However, although its large areas of level land, good sources of saltwater, shallow seawater free from pollution, favourable temperature and good export market potential in the United States, it appears that the development of the sector has progressed rather slowly. The reasons, which may have affected the growth of the industry, may have been multiple, possibly including lack of technology; shortage of investment capital; lack of freshwater; and rich capture fishery industry. It seems that the aquaculture sector in the Bahamas, although yet to become an important industry in terms of production output and revenue, has a good developmental potential particularly with regard to mariculture operations.

Aquaculture in the Bahamas seems to be attracting the attention of both local and foreign (mainly from the USA) investors. However, although a number of environmental and socio-economic factors would favour its development, the industry as a whole is still at an early stage of development. In order to further promote and encourage investments in the sector, the following actions should be promoted in the short term:

- formulation of a national aquaculture policy and action plan;
- upgrading the public sector in order to better assist the private sector with regard to information and technical assistance as well as extension services;

- identification of suitable inland and coastal areas for aquaculture projects in terms of their physical characteristics and economic suitability;
- promote and establish links with other countries in the region more advanced in the development of their aquaculture industry; and
- Promote research and information exchange on marine finfish culture utilizing land-based and marine facilities (e.g. tanks, raceways, floating and submerged netcages, etc.).

NATIONAL REPORT OF BARBADOS

by

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I. GENERAL INFORMATION

Geography and Economy

Area	430 km²
Length of coastline	90 km (est.)
Shelf area	320 km² (est.)
Terrain	Flat, rising to a ridge in the centre
Climate	Tropical
Population	267 900 (2000)
Annual growth rate	0.2% (2000)
Language	English
Work force	138 700 (2000)
Unemployment rate	Total: 9.2%, 11.3% female; 7.4% male (2000)
GDP	Bds$ 4 290 8 million at factor cost; Bds$ 28.7 million from fishing (2000)
GDP growth rate	3.5% (2000)
GDP per capita	$ 16 170 (2000)
Central Gov't budget	- NA -
Currency unit	Barbados Dollar US$ 1.00 = BD$ 2.00 (2000)
Agriculture	4.4% of GDP; includes fishing 0.7% (2000) Products - Sugar, food crops
Industry	9% of GDP (2000). Types: food, beverages, textiles, paper, chemicals, fabricated products, pharmaceuticals, rum.
Trade	Exports: $ 545.7 million (f.o.b., 2000) Imports: $ 2,312.1 million (c.i.f., 2000)

Fisheries Data

Commodity balance (2000)

Fish for direct human consumption	Production	Imports	Exports	Total supply	Per caput supply
	'000 mt live weight				kg/yr
	3.12	3.4	0.27	6.23	23.3

Estimated employment (2000)

Primary sector	2 200 full-time and part-time fishermen
Secondary sector	3 800 in fisheries related activities - fish vendors, boat-builders, fish processors & fishery administration staff

Gross value of fisheries output (At ex-vessel prices - 2000)

US$ 7.5 million

Trade (2000)

Value of imports	US$ 17.5 million
Value of exports	US$ 2.3 million

II. STATUS OF AQUACULTURE PRODUCTION

Species cultured and technologies

Inland aquaculture

Tilapia

During the early 1980s a pilot tilapia fish farming project was set up at Greenland, St. Andrew by the Fisheries Division with support from USAID. The Nile tilapia *Oreochromis niloticus,* imported from Jamaica was used. The project was aimed at assessing the feasibility of commercially rearing tilapia in the island. This project did not succeed and ended in 1989 due to inadequate water supplies, fish thefts, poor soil quality, lack of security and limited market demand.

In the 1950s, the then Fisheries Officer D. Wiles reportedly introduced *Oreochromis mossambicus* too many of the existing bodies of freshwater on the island. Several private individuals from the 1980's until about 1999 have carried out small-scale freshwater culture in small concrete tanks of local *O. mossambicus*, generally, with little success. These enterprises were typically integrated with small-scale agriculture, (e.g. irrigation of fruit trees, christophene vines, etc.) and production from these facilities amounted to only a few kilograms overall the life of these projects. One aquaculture venture used hybrid, *O. mossambicus* tilapia brood-stock and juveniles imported from Canada to assess the feasibility of intensive tilapia culture in Barbados using a re-circulating water system. The fish were fed an imported catfish ration. This project eventually failed due the high cost of electricity, water and labour.

Shrimps and prawns

Several private sector proposals to raise fresh water prawns and shrimps have been drawn up, but none have gone beyond the project formulation stages.

Coastal culture (mariculture)

Seamoss

Consett Bay is one of the few areas in Barbados where there is a protected bay suitable for seamoss farming. A project to culture sea moss was conducted by Government and fisherfolk from the Consett Bay area during the period February and March 1996. The seed species used was (*Gracilaria* sp.) imported from St. Lucia. It grew rapidly for about six weeks before suddenly disappearing from the long lines on which it had grown, reportedly having been stolen. In 1998 efforts were made to encourage fishers from the area to recommence culturing sea moss at Consett Bay. By December 1998 about 200 pounds (wet weight) was harvested from four PVC rafts. No sea moss has been cultured at this site since February 1999. The cessation of the activities is attributed to lack of interest on the part of the fishers involved, who do not seem inclined to assume the role of farmers. However, it has been demonstrated that this location can be used for seamoss farming, if motivated individuals can be found to culture the plants.

One private individual also started to cultivate *Gracilaria* species in 1996 at Half Moon Fort on the Northwest of the island. He progressed from using long-lines, to several designs of PVC rafts. The final design used commercially was 10 x 10 feet square and 1.5 feet deep with the sides and bottom covered with netting to prevent grazing by reef fish. The operator reported production figures of about 1800 and 700 pounds (dry weight) for 1998 and 1999 respectively. He started in 1998 with twenty (20) rafts and by the end of the year had increased the number of rafts to thirty-five (35). His level of production for 1998 varied between 40–60 pounds of dry seamoss per week. Each raft was reported to produce about 10 pounds of dried seamoss per harvest. This project was scaled down from mid 1999 after the operator could no longer find any one willing to work on the farm and he has since ceased production entirely.

An interesting fact concerning the mariculture of *Gracilaria* species at both of the sites mentioned was that thousands of juvenile lobsters were often found settled in the growing moss. This suggests that there is a potential for lobster mariculture enterprises in conjunction with seamoss culture.

Finfish

The rearing of the dolphin fish or mahi mahi (*Coryphaena hippurus*) was started by a private enterprise (Caribbean Aqua Farms) in November 1994. Juveniles were imported from Florida and stocked in offshore cages off Half Moon Fort, St. Lucy. The fish did not thrive and end production was very low. In 1997, mariculture activities at this facility were mainly related to the importation of fertilized dolphin eggs for hatching. However, this did not prove to be successful due to high larval mortality. Attempts were also made with little success to get dolphin captured around Barbados to spawn in captivity onshore. During 1998 this facility was basically inactive. Mariculture activities recommenced in mid 1999 under new management and red drum, (*Sciaenops ocellatus)* were cultured. The fertilized eggs were imported from Martinique and hatched out in an onshore hatchery. Juveniles were later stocked in the offshore sea cages for grow-out with some success. However, by June 2001, this project was winding down for repairs to the facilities and has been basically inactive since the end of 2001.

No coastal or inland aquaculture activities of note are currently being undertaken in Barbados.

III. POLICY MAKING, PLANNING AND MANAGEMENT

It is proposed to include aquaculture regulations among the suite of fisheries regulations to be introduced in the near future. The regulations will set out the requirements for aquaculture enterprises with emphasis on environmental management.

The Barbados Aquaculture Association was formed in 1991 under the umbrella of the Barbados Agricultural Society aimed at being a focal point for public and private sector interests in aquaculture sector development. However, its main role was never defined and the association has not been active in aquaculture related activities.

IV. TECHNICAL CAPABILITIES

Education and training

An aquaculture research centre was opened at the University of the West Indies (UWI), Cave Hill in 1987. One doctoral (PhD) student worked on tilapia larval production and rearing activities. This work has since been completed. The building is no longer used for aquaculture purposes and no one is currently actively involved in aquaculture research anywhere in the island.

The Caribbean Conservation Association continues to promote programmes aimed at formulating and implementing solutions to environmental problems. It also seeks to provide consultancy services related to natural resource development as well as to implementing natural resource projects.

Research

As mentioned earlier, an aquaculture project was established at the Greenland Agricultural Station in 1983 and lasted until 1989. The 0.63 acres of ponds and a hatchery are no longer used for applied aquaculture research. The Fisheries Division is not presently in a position to carry out any applied aquaculture research due to lack of facilities and trained personnel.

Technical assistance and extension

The Fisheries Division's technical assistance and extension activities are confined to providing available information to persons interested in aquaculture and monitoring the activities of aquaculture operations. UWI no longer provides technical support, but the former Ph.D. student continues to offer advice on an ad hoc basis to interested persons. The Analytical Services Laboratory can assist with the analysis of soil and water samples.

V. POTENTIAL FOR AQUACULTURE DEVELOPMENT

Physical potential

The development of aquaculture in Barbados would certainly be aided by the favourable tropical condition, which includes a high temperature and salinity stability all year round. However, other factors severely limit these developmental possibilities.

With regard to the land, it has been shown that the limited supply of both freshwater and suitable soil types is a major constraint to the development of fish farming in Barbados at a significant scale. The permeable nature of coral rock, which forms 86% of the island, allows water to percolate into the soil thus reducing surface run-off, especially during the dry season, and the formation of significant freshwater bodies. The dearth of bodies of surface water is therefore a main constraint on inland aquaculture development. Nevertheless, with agreement from Barbados Water Authority, ground water could be pumped to the surface and used for fish rearing. Presently, a great number of private wells exist on the island for agriculture irrigation, and the association of agriculture and aquaculture activities could offer a more rational use of the pumped water.

Even artificial ponds cannot be cheaply constructed at most areas around the island due to the porous nature of the coral rock-cap. This is a major factor limiting the development of inland aquaculture activities. Only two main areas with appropriate soil characteristics have been identified in the country where artificial ponds can be dug. They are the Scotland District and in St. George Valley, in the northern and central parts of the island, respectively. The two areas have various patches of clay, silt-clay and sand-clay layers, variable, however, in depth, soil plasticity and permeability.

With regard to the coastline, various sides of the islands have specific and predominant characteristics. The East Coast is exposed to wind driven currents and strong wave action. Coral reef development along this coast is generally poor, with only a few patches. There is a high degree of urbanization in the southern part of the coast. Cliffs with a few small bays characterise the eastern coastline in both the southern and northern quadrants. The west and south coasts, despite being the most protected areas and potentially the most suitable for mariculture are highly urbanized and cater mainly for the important tourism industry.

Species

Such unfavourable geographical conditions seriously limit the type of aquaculture and the species that can be reared. The commercial culture of marine finfish and shrimp on a large-scale are unlikely to develop due to the absence of suitable physical resources (land space, lagoons, and protected bays). The development of submergible marine netcages could be the only alternative although it would be extremely costly and technically demanding due to the exposure of the coastline and narrowness of the continental shelf.

Taking into account the physical factors, which greatly determine the possibility of commercial aquaculture development in Barbados, the limited potential exists for the following types of culture:

- bivalve culture along the south and west coast;

- rearing of juvenile queen conch (*Strombus gigas)* for reseeding of shallow water areas;
- seamoss (*Gracilaria* spp.) cultivation using long-lines;
- culture of indigenous ornamental fish species;
- culture of the Asian freshwater prawn in land-based concrete tanks;
- culture of tilapia in land-based concrete tanks; and
- red drum (*Sciaenops ocellatus*) and dolphin fish culture in sea cages.

VI. CONCLUSIONS AND FUTURE DEVELOPMENTS

It should also be noted that Barbadian consumers prefer marine fish. Introducing freshwater fish, shellfish and even non-native marine fish to the local market will only be commercially successful if accompanied by an intensive promotion effort. Therefore, any aquaculture enterprise in Barbados will have to factor in the costs of marketing their produce.

NATIONAL REPORT
OF
THE COMMONWEALTH OF DOMINICA

by

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I. GENERAL INFORMATION

Geography and Economy

Area	754 km²
Length of coastline	152.93 km
Shelf area	716.45 km²
Terrain	Mountainous volcanic island with rain forest cover
Climate	Tropical
Population	81 200 (1988 est.)
Annual growth rate	0.3%
Languages	English (official); French patois is widely spoken
Work force	43 000 (1988) - Agriculture 37%, Services 30%, Industry and Commerce 20%
Unemployment rate	10% (1988)
GDP	US$ 114 million (1988)
GDP growth rate	5.6% (1988)
GDP per capita	US$ 1 650 (1988)
Central Gov't Budget	US$ 40 million (1998)
Currency unit	Eastern Caribbean Dollar US$ 1.00 = EC$ 2.71 (May 2002)
Agriculture	Products: bananas, citrus, coconuts, cocoa, essential oils.
Industry	Types: agricultural processing, soap and other coconut based products, apparel, cigars
Trade	Exports: US$ 55.5 million (1988) - bananas, citrus, fruits, soap, cocoa. Imports: US$ 87.5 million (1998) - machinery and equipment, foodstuff, manufactured articles, cement.

Fisheries Data

Commodity balance (2000)

Fish for direct human consumption	Production	Imports	Exports	Total supply	Per caput supply
	'000 mt live weight				kg/yr
	1.15	0.67	0.00	1.82	22.20

Estimated employment (1983)

Primary sector	An estimated 2 000 part-time and full-time fishermen
Secondary sector	Not Available

Gross value of fisheries output (at ex-vessel prices - 2000)

US$ 2.4 million

Trade (2000)

Value of imports	US$ 1.58 million
Value of exports	Negligible

II. STATUS OF AQUACULTURE PRODUCTION

Species cultured and technologies

Inland aquaculture

Currently, the Asian freshwater giant prawn, *Macrobrachium rosenbergii* is the only species being cultured in Dominica. With regard to the existing level of operations, there are four private farms in operation.

All of the freshwater prawn post-larvae are produced at the Government-owned Prawn Experimental Farm in Belfast. The infrastructure of the station was completed in 1984 and the first stock of post-larvae was obtained from Guadeloupe and introduced into the grow-out ponds in late 1985. Two years later the facility was further expanded to include a clear water hatchery system set-up with funds and technical assistance of Taiwan (Province of China) through the Taiwanese Agriculture Cooperation Mission.

Coastal aquaculture

Due to the topography of the country, with its steep coastline, limited sites are available for coastal aquaculture. At the present moment, the indigenous population of seamoss (*Gracilaria* sp.), which is found throughout the island, is popularly harvested for human consumption as a drink or in a jelly form. However, due to over-exploitation of the natural stocks, the Fisheries Division has included in its National Fishery Sector Plan for the period 1992-93, the initiative of culturing the seaweed utilizing the technology developed in Saint Lucia, i.e. bamboo rafts and/or long-line culture method.

Aquaculture technologies

The Agricultural Mission of Taiwan (Province of China) constructed a marine hatchery at Canefield and began growing tilapia in saltwater but the mission closed the facility in 1998.

The physical structures remain, with tilapia in the concrete ponds, but no aquaculture activities occur on that site today.

With regard to the Asian freshwater giant prawn (*Macrobrachium* sp.), the Fisheries Division feels that the available technology ranks to acceptable world standards, particularly when considering the level of post-larvae survival. However, the refinement of the on-growing technology is presently affected by the lack of facilities and technical experience, particularly in the field of nutrition.

Coastal aquaculture (mariculture) has been attempted on a number of occasions to grow seamoss (*Gracilaria* sp.) in sufficient quantities to supply two local beverage manufacturers. The quantities demanded were never produced so the beverage manufacturers have to import some of the raw materials (dried seamoss) from other neighbouring islands. The local beverage manufacturers are planning to employ persons to increase local production, but the problem of larceny is a major concern.

A project to propagate hard and soft corals using local species for export and reef restoration was granted a license in 1998. The licensee attempted to export a shipment of stony corals which is listed on CITES Appendix II. The shipment was confiscated in the US, so only soft corals can be exported at present. Some propagation of hard corals continues but this is focussed on the restoration of degraded areas within the Cabrits Marine Park.

Aquaculture statistics

Reliable production statistics are not available. Bearing in mind the present number and size of the operations, a combined output estimate of the *Macrobrachium* species can be placed in the range of a couple of thousand kilogrammes. No accurate data is also available for seamoss collected from the wild stocks.

III. POLICY MAKING, PLANNING AND MANAGEMENT

The Fisheries Division (FD) of the Ministry of Agriculture, Lands, Fisheries and Forestry (MALFF) is the government office responsible for aquaculture policy making and for the co-ordination of all planning in this sector of the fisheries industry. The main objectives of the FD concerning aquaculture development are:

- to complement the supply from the marine capture fishery and therefore increase protein intake;
- to reduce expense of foreign exchange by cutting down in fish imports;
- to create employment;
- to promote agriculture diversification by making use of marginal agriculture land and resources;
- to promote conservation of natural resources (wild and indigenous stocks); and
- to increase overall socio-economic status of the people.

The FD is made up of five units including the Aquaculture Unit.

The aquaculture activities of the public sector have declined since 1996 when the experimental hatchery was handed over to the agricultural mission of the Taiwan (Province of China). No official records or information on the activities are available from that facility.

In addition to the ordinary legislation related to land tenure, sanitary regulation, etc., the only specific reference to aquaculture is made in the Fisheries Act No. 11/1987; the specific reference relating to aquaculture provides for the leasing of seabed areas to persons interested in aquaculture development. The Act can be deemed to be complemented by a series of laws issued by other ministries, such as the Ministries of Health and the Environment.

IV. TECHNICAL CAPABILITIES

Education and training

No academic institutions exist in Dominica where education and training in aquaculture related subjects could be obtained. Formal academic education can, however, be obtained at the University of West Indies (UWI) either in the Campus of Cave Hill in Barbados, Mona Campus in Jamaica and in the Campus of St. Augustine in Trinidad and Tobago, although a specific programme in aquaculture is not available. The UWI has an exclusive liaison centre on the island.

There is need for trained aquaculturists if fully commercial ventures are to be developed.
The Government of Dominica although not providing technical assistance and extension service to farmers interested in the aquaculture has supportive of prawn culture. This is the result of a greater interest manifested by the private sector due to the higher market price and demand of prawn compared to the tilapia.

Research

The only facility available to the public sector is closed; there are no active aquaculture research activities at the present time.

Technical assistance and extension

The Fisheries Division provides as much support as possible to the private sector with regard to advice and extension. The support provided to interested investors and existing farmers include (i) land survey for site suitability, (ii) technical assistance for pond construction and water management and (iii) facilitating the supply of prawn post-larvae free of import duties or at subsidized cost.

V. POTENTIAL FOR AQUACULTURE DEVELOPMENT

Physical potential

Although the island of Dominica is of volcanic origin and characterized by a rugged landscape, suitable sites are reasonably available for inland aquaculture development, where small-scale operations (earth ponds) can be established. With regard to surface freshwater, it is abundantly available throughout the island and therefore not a limiting factor.

An overall land survey of the country, for the identification of suitable sites for aquaculture development, has been carried out in the recent past mainly with regard to land morphology and water availability. The Fisheries Division, however, feels that an additional survey is required taking into account other important factors such as land geology (i.e. soil type), land ownership, and availability of infrastructures (roads, electricity and other services). Development of coastal aquaculture, although possibly achievable in certain areas and by

using certain culture techniques (e.g. long-lines), has generally not been attempted because of the exposed coastlines.

Species

In spite of the availability of the country's natural resources, land topography/morphology, available technologies and present market demand, the only aquaculture development existing in today Dominica is semi-commercial for the following types of culture:

- freshwater pond culture of *M. rosenbergii (*prawn) species; and
- mariculture of seamoss (*Gracilaria* spp.) using long-lines and/or floating rafts.

Loans for farmers interested in commercial aquaculture operations can be obtained either from the National Commercial Bank (a semi-government institution) and the Agricultural Industrial Development Bank (AIDB) under the Ministry of Development. The AIDB has established a main credit line of US$ 1 million for the development of the fishery and aquaculture industry, which however has been underutilized. The loans available through the above mentioned banks are offered at an annual interest rate of 11.5 and 17% per year.

VI. FISH HANDLING, PROCESSING AND MARKETING

At present, production from aquaculture operations (as most of the catch from the capture fishery) is sold fresh either in the vicinity of the culture sites or in small outlets in the major inhabited centres. Freshwater prawns are usually graded according to size and mainly sold directly to hotels and restaurants. Previously there was a grading system and government sale prices were as follows:

- Grade A (Large) 13-17 prawns/kg @ US$ 5.8 /kg
- Grade B (Medium) 26-35 prawns/kg @ US$ 5.2/kg
- Grade C (Small) 35-53 prawns/kg @ US$ 4.7/kg

The prices are presently averaging US$ 13.25 per kilogram. Once the private sector started producing the prawn with severely reduced production subsidy costs became higher and consequently the increase in the retail prices of the product.

VII. CONCLUSIONS AND FUTURE DEVELOPMENTS

Within the limits of freshwater and coastal aquaculture development in Dominica, the Government, through the Fisheries Division, remains committed to the promoting the development aquaculture in the country.

NATIONAL REPORT OF GRENADA

by

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I. GENERAL INFORMATION

Geography and Economy

Area	344 km²
Length of coastline	121 km
Shelf area	3 100 km²
Terrain	Volcanic in origin, with interior dominated by mountain peaks, steep ridges, and deep narrow valleys.
Highest peak	Mount St. Catherine - 833 m
Climate	Tropical
Population	100 703 (1999 est.)
Annual growth rate	0.45%
Languages	English (official); some vestigial French patois
Work force	42 250 (22 679 male; 19 571 female) - Agriculture 33%, Industry 17%, Other 50%
Unemployment rate	17% (1996); 10.3% male, 24.8% female
GDP	US$ 243 million at factor cost in constant prices (1999)
GDP growth rate	7.51% (1999)
GDP per capita	US$ 2 413 (1999)
Central Gov't Budget	US$ 89.8 million (1999)
Currency unit	Eastern Caribbean Dollar US$ 1.00 = EC$ 2.71 (May 2002)
Agriculture	10% of GDP (1999). Products: nutmeg, mace, cocoa, bananas, fruits, vegetables.
Industry	22.23% of GDP (1997). Types: Manufacturing (5.4%) (7.03%), hotel/restaurant (7.87%), construction (7.33%)
Trade	Exports: US$ 42 million (1998) - nutmeg, mace, cocoa, bananas, fruits, vegetables, clothing. Imports: US$ 206 million (1998) - food, machinery and transport, manufactured goods, fuel.

Fisheries Data

Commodity balance (2000):

Fish for direct human consumption	Production	Imports	Exports	Total supply	Per caput supply
	'000 mt live weight				kg/yr
	1.70	0.44	0.54	1.60	16.0

Estimated employment (2000)

Primary sector	An estimated 1749 fishermen, 85% full-time, 15% part-time and subsistence
Secondary sector	100 vendors, 20 boat builders

Gross value of fisheries output (at ex-vessel prices - 2000)

US$ 2.64 million

Trade (2000)

Value of imports	US$ 1.5 million
Value of exports	US$ 2.64 million

II. STATUS OF AQUACULTURE PRODUCTION

Species cultured and technologies

Inland aquaculture

Inland aquaculture in Grenada is currently carried out on a limited scale. In 1982 some *Oreochromis niloticus* were released in selected rivers and ponds in the northeast and western regions of the island, but this only resulted in subsistence activities. In the late 80s, a pond culture project on the Asian giant freshwater prawn (*Macrobrachium rosenbergii*) was funded by the Organization of American States (OAS) and operated by the Grenada Science and Technology Council. Although encouraging results were obtained from the pilot project and some interest stimulated among the private sector, there were practically no follow-up activities either from the Government or the private sector. In 1992 a pilot project (funded by the Peoples Republic of China - Taiwan), was established to produce fresh water juvenile prawns (*M. rosenbergii*), to farmers. It consists of a hatchery and grow-out ponds, and five farmers were assisted by Government to construct ponds, while several more showed interest in its farming. Tilapia (*Oreochromis mossambicus*) was also cultured. However, when the technical assistance from Taiwan ceased in 2000/2001, operations at the project were severely affected due to lack of adequate funding, and Government has since commercialized on a lease basis, operations at the facility, where salt water shrimp is produced.

Coastal aquaculture

Attempts in culturing seamoss (*Gracilaria* sp.) were carried out by the Artisanal Fisheries Development Project in the mid-80ss with financial support from the International Fund for agriculture Development (IFAD). Although encouraging results were obtained, no commercial operations were established due to the selection of unsuitable culture sites and theft of the culture rafts.

During the same period, a Caribbean king crab (*Mithrax spinosissimus)* culture research project, financed by a private investor, was underway in the island of Carriacou. The project was eventually abandoned due to financial difficulties of the investor.

Aquaculture technologies

The aquaculture technology available in Grenada is limited to the culture of seamoss. Some experience in the culture of the freshwater prawn is also locally available. However, most of the know-how is limited to one skilled staff of the Fisheries Division. Therefore, in order for the country to develop its limited potential, applied and adaptive research are needed to develop simple technologies suitable for the local environmental and socio-economic conditions.

Aquaculture statistics

Up until 2001, approximately 0.5 metric tons of aquaculture products were produced. Approximately 80% were fresh water prawns (*M. rosenbergii*), and 20% Tilapia (*O. mossambicus*). However, production has since declined. However, with the commercialisation of the aquaculture facility, production is expected to increase in the near future, although not significantly since the facility is limited in land space for pond construction. It seems, however, that the on-going development in many neighbouring countries would stimulate interest in the public sector to promote and assist the development of a local industry.

III. POLICY MAKING, PLANNING AND MANAGEMENT

The Fisheries Division (FD) of the Ministry of Agriculture, Lands, Forestry and Fisheries (MALFF) is the government office responsible for aquaculture policy making, planning and co-ordination of all developmental efforts directed towards the sector. Only one staff member of the Fisheries Resource Unit has some experience in aquaculture having received two years training in aquaculture in Cuba, as well as having participated in three short training courses in seamoss culture in St. Lucia, and freshwater prawn culture in Taiwan and Jamaica.

One of the specific objectives of the Unit is to develop an aquaculture and freshwater resources assessment programme. However, although the above objective has been highlighted from 1992 in the Operational Plans of the Fisheries Division, no funding has been allocated to the programme, due to the limited funds available to the Fisheries Division.

The aquaculture sector is presently not receiving much attention nor emphasis compared to the capture fishery sector, although the Government is seeking and welcomes external support to establish aquaculture projects aimed at developing and promoting the sector as an option to the capture fishery and use of marginal agricultural land.

Apart from legislation related to land tenure, use of inland waters, sanitary regulations, etc., the only specific reference to aquaculture is made in the Fisheries Act No. 15/1986 dealing with leasing of sea areas for mariculture activities (e.g. seamoss culture).

IV. TECHNICAL CAPABILITIES

Education and training

One academic institution (St. Georges University) exists in Grenada where education and training in marine biology or related subjects such as aquaculture can be obtained. Formal education, specific to aquaculture, can also be obtained at the St. Augustine campus of the University of West Indies in Trinidad and Tobago.

Research

Currently, the only public facility available is the aquaculture facility provided by the Government of Taiwan, which produced mainly freshwater prawns and tilapia to a lesser extent. However, the facility is now commercialised and special arrangement must be negotiated with the private owners to use the facility for research purposes.

Technical assistance and extension

Due to the shortage of staff, budget constraints and lack of any research/training facilities, the Fisheries Division has been unable to provide the necessary technical assistance to farmers who expressed keen interest in aquaculture.

V. POTENTIAL FOR AQUACULTURE DEVELOPMENT

Physical potential

Grenada is a volcanic island characterized by a mountain ridge (highest peak: 840 m) that forms a spine throughout the length of the island. The centre of the island is covered by a relatively thick rain forest. With regard to the coastline, various sides of the island have specific and predominant characteristics. The west coast is dominated by steep cliffs alternated with rather small flat rivers outlets usually few centimetres above the mean sea level. Flat alluvial plains on the other hand dominate the northeast coast, while the southeast coast is characterized by a number of large protected bays usually associated with river outlets and alluvial platforms.

The climate of the island is typically tropical with a mild dry season lasting from January to May. The rest of the year the weather remains rather wet with a mean temperature ranging between 30-32^{o}C. Rainfall varies from 1 500 mm/year in the coastal areas to about 4 000-6 000 mm/year in the mountains.

The favourable tropical conditions of the island (high temperature and salinity stability all year round) and the good quality of the inland (freshwater) and coastal (seawater) waters would certainly aid aquaculture development in Grenada. However, the potential developmental degree of the sector is likely to be limited by the availability of land.

According to the findings of a FAO technical mission to Grenada in 1986, approximately 100 hectares of flat lands have been identified as suitable for aquaculture operations, most of that is located along the north-eastern coast. The above-mentioned land, however, belongs to private farmers and therefore a number of socio-economic constraints may additionally hinder the development of the industry.

Species

Although a number of technical and socio-economic factors could favour the development of aquaculture in Grenada, such as the good water quality, availability of freshwater supply by gravity, relatively cheap labour cost and the possibility of incentives for private investors, others seriously limit the development potential of the industry. Among the limiting technical factors are the lack of skilled staff, low concentration of wild fry of high value species (e.g. groupers and marine shrimps), and the limited availability of suitably large coastal areas. The high energy cost, the present situation of the banking system and the lack of capital on the other hand are some of the economic factors which will likely hamper the development of aquaculture particularly at the level of small owners. A limited potential, however, does exists for the following types of culture:

- seamoss *(Gracilaria* spp.) cultivation using long-lines and/or floating rafts; and
- culture of the Asian freshwater prawn *(M. rosenbergii)* and tilapia in earth ponds;

Finance

The Grenada Development Bank (GDB) is the only government financing institution that provides loans to fishermen at an interest rate ranging between 8-9% instead of 11.5% charged by other commercial banks. However, although the same rate conditions would be applied to farmers interested in developing aquaculture projects, so far the bank has yet to receive any loan requests for such projects.

VI. FISH HANDLING, PROCESSING AND MARKETING

The fish catch in Grenada is distinctly for the fresh fish market. There are presently eight market centres and one central facility in St. George equipped with blast freezers, chillers, etc. Seasonal supply continues to affect the consistent availability of fish on the local market. With specific regard to species, which could be cultured locally, handling and processing would not cause serious problems if the production were for the local market. Factors which would certainly facilitate the handling and processing aspects of the industry are: (i) small size of the country and therefore a rapid transportation of the products from one site to another, and (ii) the products would be mainly, if not totally, for the fresh market. However, in order to encourage the development of the industry other marketing and economic aspects need to be seriously analysed and considered prior to investing in any particular project. Some of the aspects, which should receive due consideration, are market acceptability of the product (e.g. tilapia) and production costs.

VII. CONCLUSIONS AND FUTURE DEVELOPMENTS

Aquaculture in Grenada is not a developmental priority if compared to the capture fishery sector. However, it appears that the Government, although financially unable to channel

much effort towards the development of the industry, is willing to support international and regional activities aimed at promoting the sector. To date the aquaculture industry as a whole is still at a very early stage of development. Finally, the country would be willing to collaborate closely and exchange information with neighbouring countries, most of which already have some kind of research/training facility.

Considering the past actions carried out by the Fisheries Division such as the FAO Aquaculture Feasibility Study in Grenada in 1986 (TCP/GRN/6651), and the hatchery funded by Taiwan (Province of China), the short and medium-term priorities aimed at strengthening and supporting the role of the FD in promoting aquaculture development seem to be the following:

- upgrading of the public sector in order to better acquire the capacity to assist the private sector with regard to both technical assistance and extension services;
- detailed identification of suitable areas for land-based and coastal aquaculture operations with regard to their physical and socio-economic suitability; and
- provide technical assistance and training to revitalize and continue the projects on seamoss, king crab and freshwater prawn culture.

NATIONAL REPORT
OF
SAINT KITTS AND NEVIS

by

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I. GENERAL INFORMATION

Geography and Economy

Area	269 km²
Length of coastline	135 km
Shelf area	690 km²
Terrain	Volcanic islands with central mountainous forest
Climate	Tropical maritime
Population	45 900 (2000 est.)
Annual growth rate	0.3 % (2000)
Language	English
Work force	22 583
Unemployment rate	4.8 % (2000 est.)
GDP	US$ 349.4 Million (2000)
GDP growth rate	4%
GDP per capita	US$ 7 471 (2000)
Central Gov't budget	US$ 110 764 000 (2000)
Currency unit	Eastern Caribbean Dollar US$ 1.00 = EC$ 2.71 (May 2002)
Agriculture	Agro-Products: Sugar, Vegetables, fruits, fish, livestock, 4.5% + (fishing: 1.7%)
Industry	Trans./comm.: 18%, Manufacturing: 11.6%, Construction: 14%, Hospitality: 7%, Banking/financial: 13%
Trade	Exports: $ 50.78 million - Sugar, rum, molasses, electronic/electrical components, miscellaneous manufactured goods Imports: $ 172 563 million - Machinery, electrical items, foodstuff, garments, fuel-oils, transportation equipment, agro-chemicals, fertilizer & pesticides, beverages, miscellaneous consumer goods & materials

Fisheries Data

Commodity balance (2000)

Fish for direct human consumption	Production	Imports	Exports	Total supply	Per caput supply
	'000 mt live weight				kg/yr
	0.470	1.376	0.073	1.846	43.9

Estimated employment (2000)

Primary sector	578
Secondary sector	Not Available

Gross value of fisheries output (at ex-vessel prices)

Not Available

Trade (2000)

Value of imports	US$ 2.81 million
Value of exports	US$ 0.245 million

II. STATUS OF AQUACULTURE PRODUCTION

Over the last two decades aquaculture has been thought of as supplemental provider of fresh fish for the country. A number of attempts have been made at developing viable systems within both islands.

In Saint Kitts, a marine shrimp farm was attempted using a natural salt pond. This encountered a number of technical problems. The venture was later abandoned. The farm produced a small amount of the shrimp that was marketed locally.

On Nevis, attempts were made through assistance from the OAS to develop a tilapia project. However, this venture encountered a number of challenges both financial and technical. In spite of the challenges, one of the project's main objectives was achieved. This was the awareness of the local population of the potential for aquaculture. This was evident as a number of persons expressed their interest in starting their own backyard production. One of those persons was the former Premier of Nevis. Today concerns are being raised by the Fisheries Department, as a number of ponds/water catchments that were stocked with tilapia are being harvested indiscriminately by locals. Aquaculture still does not make any contribution to the national statistics of fish production.

Handling and marketing of aquaculture products

Presently, nothing is being cultured. However, different varieties of tilapia can be found both on Saint Kitts and Nevis in water catchments and back yard systems. Experience has demonstrated that aquaculture products can be successfully marketed on Saint Kitts and Nevis. Shrimps were marketed whole and headless with much success.

III. POLICY MAKING, PLANNING AND MANAGEMENT

The future of aquaculture looks hopeful. It is anticipated that with more lands becoming available, as a result of adjustments in the present acreage under sugar cane production, aquaculture could get the long awaited boost. Ironically, in the Department of Agriculture "Landscape after Sugar", little or nothing has been said as to the potential for aquaculture to influence land use. Nevertheless, the Government has stated its intention to develop aquaculture and a number of avenues are being pursued to achieve this goal.

It is suggested that any significant development in aquaculture will come through the private sector with government providing an enabling environment for development. A number of proposals have already been received. On Saint Kitts, one proposal to "grow out" tilapia is currently under way. No brood stocks or nursery will be run. While on Nevis plans are being developed to commence a multi-million dollar aquaculture project. Not much information is available on this proposal.

With regard to legislation, very little is legislated with direct reference to aquaculture. The Fisheries Management Unit has been mandated by the Ministry of Agriculture to develop projects for aquaculture. The process is still in its infancy.

NATIONAL REPORT
OF
SAINT LUCIA

by

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I. GENERAL INFORMATION

Geography and Economy

Area	616 km²
Length of Coastline	130 km
Shelf area	522 km²
Terrain	Mountainous
Climate	Tropical maritime
Population	158 018 (2001)
Annual growth rate	1.47% (2000)
Language	English (official); French patois is common throughout the country.
Work force	Agriculture 36.6%, Industry and Commerce 20.1%, Services 18.1%.
Unemployment rate	18%
GDP	US$ 584.3 million (2002)
GDP growth rate	4.05% (2001)
GDP per Capital	US$ 2 823 (1999)
Central Govn't Budget	EC$ 492 814 068 (2002/2003)
Currency Unit	Eastern Caribbean Dollar US$ 1.00 = EC$ 2.71 (May 2002)
Agriculture	6.3% of GDP (2001). Products: bananas (major), other crops, livestock, fishing, forestry.
Industry	4.9% of GDP (2001). Types: garments, electronic components, beverage, corrugated boxes.
Trade	Exports: US$ 43.8 million (2000) - bananas, other Agricultural products, oil and fats, manufactured goods. Imports: US$ 359 million (2000) - food, fuel, manufactured goods, machinery and transport equipment.

Fisheries Data

Commodity balance (1989)

Fish for direct human consumption	Production	Imports	Exports	Total supply	Per caput supply
	'000 mt live weight				kg/yr
	1.90	0.70	0.0	1.60	10.60

Estimated employment (2001)

Primary Sector	An estimated 2096 fishermen half of which are full-time
Secondary Sector	Not Available

Estimated fish production (2001)

1 967.2 tonnes

Gross value of fisheries Output (at ex-vessel prices - 2001)

S$ 8.6 million

Trade (2001)

Value of imports	EC$ 232 790 706.00
Value of exports	EC$ 33 972 456.00

II. STATUS OF AQUACULTURE AND PRODUCTION

Species cultured and technologies

Inland aquaculture

The Asian freshwater prawn *Macrobrachium rosenbergii*, the Nile Tilapia *(Oreochromis niloticus)*, and the Red Hybrid Tilapia are the three species cultured in Saint Lucia. The culture of both the freshwater prawn and the tilapia are carried out in small earthen ponds ranging between a few hundred square metres to a couple thousand. The ponds are usually fed by a continuous flow of pumped freshwater or gravitational flow from water dams fed by rivers or springs. The overall combined surface area under present production for both species has been estimated around 24 800 square metres. The private sector interest in freshwater aquaculture, particularly with regard to freshwater prawn farming, is steadily increasing as clearly shown by the recent increase in pond areas.

Coastal aquaculture

The only marine species which has received considerable attention and currently being cultured using a simple technology is a local strain of seamoss known as GT (*Gracilaria* sp.). The seamoss was originally carried out on floating bamboo rafts, which have been replaced since 1990 by the long-line method mainly due to its stronger resistance to wave action. The long-lines are made of polypropylene, 0.75-1 cm in diameter by 10-20 m long, suspended by used oil bottles and kept in position with concrete or metal anchors. The seamoss usually grow to the harvestable size within 4-6 weeks and are harvested at about 50 mm from the rope and usually individual plants are about 200 mm long. Production yields of GT grown on rafts is about 2 kg fresh weight per metre of the line in two months. At present, the total

combined area approximately under production has been estimated at one hectare, divided in 20 culture units. The whole sector is currently being operated by 5 full-time and 15 part-time farmers. The majority of the culture plots are presently concentrated in the Southeast and some locations in the Southwest.

Aquaculture technologies

The technologies developed and/or adapted in Saint Lucia for the culture of the Asian Freshwater prawn, tilapia and seamoss appear to be at the right level, bearing in mind the size (i.e. relative small scale) of the aquaculture projects being developed. Some applied research is still required to improve the technologies in use, for example: Gracilaria strain improvement, prawn feed development, prawn stocking and feeding rates. It is generally felt, however, that the culture technologies of the commercially attractive species must be maintained at an easily transferable/digestible level, and also at a level which is financially affordable to the small-scale farmers.

Aquaculture statistics

The production of Tilapia and freshwater prawns from the facilities in operation in 1991 amounted to 67 kg and 266 kg respectively. Both marketable size products, i.e. one pound per fish and 10-15 prawns per pound are sold and consumed locally. The ex-farm price is US$ 1.11 and US$ 5.61 for a pound of live weight fish and prawns, respectively. With regard to seamoss, no reliable annual production estimates are available, and for this reason the Department of Fisheries organized a national workshop in August 2002 to inform and assist farmers to start a common production monitoring system. Although the production data has not been officially registered, seamoss cultivation in Saint Lucia can be considered as commercial in terms of sales and production potential of the country. The ex-farm price is approximately US$7.5 a pound of dried product.

III. POLICY MAKING, PLANNING AND MANAGEMENT

The Department of Fisheries (DOF) of the Ministry of Agriculture, Forestry and Fisheries is the public agency responsible for aquaculture policy-making and for the co-ordination of all planning and development efforts towards the sector. It is responsible for the acquisition of data and information, formulating policies, devising regulations and enforcing them as well as to provide technical assistance to existing farmers and interested investors. The DOF is headed by a Chief Fisheries Officer supported by a number of staff working in the various units. One of the above-mentioned staff, who has formal aquaculture training at the Diploma in Aquaculture Technology level, is presently responsible for aquaculture.

Aquaculture activities are included within a five-year management plan which was developed by the Ministry of Agriculture, Forestry and Fisheries. Aquaculture activities are further elaborated in an annual work programme.

IV. TECHNICAL CAPABILITIES

Education and training

No academic institutions exist in Saint Lucia where in-depth education and training in marine biology or related subjects such as aquaculture can be obtained. Formal education can, however, be obtained at the University of the West Indies: either at the Cave Hill Campus in

Barbados, Mona Campus in Jamaica and at the St. Augustine Campus in Trinidad and Tobago, although a specific programme in aquaculture is not available. Some practical training at the farmers' level can be obtained locally in prawn culture at the government Beausejour Prawn Facility in Vieux-Fort, and in Tilapia rearing at the small government fish Hatchery located in the northern part of the island (Union Aquaculture Facility). The Vieux-Fort facility, originally constructed with funds donated by the Chinese Government (Taiwan), as part of an agriculture co-operation programme, has a hatchery and office/house building and four earth ponds totalling a surface area of approximately 0.5 hectares. The hatchery has been designed for a monthly output of one million post-larvae. The head of the Aquaculture Unit oversees the hatchery. Other staff include a Fisheries Assistant with certificate level training and two support workers with on the job training. The Fisheries Assistant assists in the breeding of the post-larvae.

Research

Basic applied aquaculture research on tilapia and prawns can be carried out at the existing Government facilities. However, the unavailability of laboratory apparatus and supplies and limited manpower, reduces the possibility of research outputs focused on the solutions of specific feed development.

NATIONAL REPORT
OF
SAINT VINCENT AND THE GRENADINES

by

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I. GENERAL INFORMATION

Geography and Economy

Area	388 km²
Length of coastline	150 km
Shelf area	7 800 km²
Terrain	Mountainous volcanic island with rain forest cover on Saint Vincent, but drier and flatter in the Grenadines
Climate	Tropical
Population	110 022 (2001)
Annual growth rate	1.0% (2001)
Language	English (official)
Work force	58 000 (2001)
Unemployment rate	28% (1998)
GDP	US$ 289 million (2001)
GDP growth rate	2.84% (2001)
GDP per capita	US$ 2 655.00 (2001)
Central Gov't budget	Recurrent Revenue US$ 96.2 Million (2000) Recurrent Expenditure US$ 95.5 Million (2000)
Currency unit	Eastern Caribbean Dollar US$ 1.00 = EC$ 2.71 (May 2002)
Agriculture	10.5% of GDP (2001)
Trade	Exports US$ 44.42 million (2001) Imports US$ 185.77 million (2001)

Fisheries Data

Commodity balance (1999)

Fish for direct human consumption	Production	Imports	Exports	Total supply	Per caput supply
	'000 mt live weight				kg/yr
	1.71	0.19	0.10	0.80	12.50

Estimated employment (1999)

Primary sector	An estimated 2 500 part-time and full-time fishermen and occasional fishermen
Secondary sector	An estimated 2 000 working in marketing, fish vending, gutting/cleaning, boat building etc.

Gross value of fisheries output (at ex-vessel prices – 1999)

US$ 2.58 million

Trade (1999)

Value of imports	US$ 1 million
Value of exports	US$ 0.74 million

II. STATUS OF AQUACULTURE

In 1983 small-scale experiments on aquaculture of *Oreochromis niloticus* (from Dominica) as well as *Macrobrachium* sp. and *Atya* sp. were carried out by the Fisheries Division of the Ministry of Agriculture at the Botanical Gardens. These experiments showed positive results and generated some interest among several sectors of the population, e.g. some primary schools and private individuals.

That same year a project from the Taiwan (Province of China) was established for the introduction of an agricultural development, with an aquaculture component which had the objectives of (i) promoting tilapia and freshwater prawn culture, and (ii) transferring the technology to local technicians. Unfortunately, this component of the project progressively faded because of lack of a local counterpart and was eventually phased out.

The site at Pembroke which was used (in the past) for the aquaculture demonstration site proved not to be appropriate, difference in water levels between the ponds and water supply was such that pumps had to be used to fill and empty the ponds. This increased the cost of production so that the aquaculture program was not economically viable. In addition, the soil composition at that site did not have a high water retention capability and if the site should be designated as an option in the future it is recommended that it would be necessary to line the ponds with clay soil to make them impermeable to water.

In March 2002, Mr. Lu Fong Gan, an Aquaculture Technician from the Republic of China (ROC/POC) visited Saint Vincent and the Grenadines (SVG), based on a request made to the Premier of the ROC by the Prime Minister of SVG during his visit to Saint Vincent in September 2001. The government of SVG requested the assistance of the government of the ROC/POC to evaluate the potential for the development of an aquaculture industry in the

state. During discussions held between the Technical Mission and the Fisheries Division, the scope of the evaluation was outlined. The outline included an assessment of the fishery industry potential based on on-shore culture, sea cage culture and seaweed culture.

A team comprises of representatives from the ROC/POC and the Fisheries Division, SVG visited several sites on main land Saint Vincent, and the Grenadines islands of Union Island, Bequia and Canouan. A pre-evaluation for the development of an aquaculture industry in SVG was prepared and submitted by Mr Lu Fong Gan. The following are the findings:

Fresh water aquaculture

The difficulty of onshore aquaculture in Saint Vincent:

- The absence of land appropriate for the setting up of ponds and the lack of a market for the product

Because the country is small, areas suitable to locate fresh water aquaculture are limited. In addition the size of the population is a deterrent to development of a freshwater food-fish industry that would achieve the necessary economies of scale to be profitable. However, if the focus of implementing a fresh water aquaculture activity is the provision of employment and the satisfaction of the local and tourist markets then the project can be pursued with reservation.

- The average difference between the river beds and banks is too great

During the evaluation process the Fisheries Division indicated several rivers where fresh water on shore aquaculture may have seemed viable, however with one exception, the difference in height between the river beds and their banks was so great that filling and draining problems would result. This problem could be resolved by either damming the river to raise the water level to that of the ponds or using a pump to fill and drain the ponds. Unfortunately, both resolutions would result in increasing the high cost of implementation.

Grant Sable is the only river with a potential for creating a pond through natural water flow but the available land area is only five acres. However, the project cannot be replicated anywhere else in the country as these optimum conditions do not exist elsewhere. Replication would be the key to economic viability.

- The soil texture is too sandy to retain water

Because the soil has a high component of sand it is loose and allows water to seep through. This problem can be solved by putting a layer of clay, or by lining the pond with plastic or by cementing the pond. This of course increases the investment cost.

The aforementioned difficulties can render attempts to develop on-shore aquaculture, even at a subsistence level, financially infeasible

Sea cage aquaculture

The leeward coast of main-island, Saint Vincent, is calm with some areas having depths of approximately 10 to 30m. These conditions would seem to be suitable for sea cage aquaculture. If the objective is to establish an industrial level sea cage culture in Saint Vincent, problems of natural disasters, inadequate feed supply and the cost of providing and

maintaining other infrastructure and facilities necessary for the successful operation of this industry must be solved. If the necessary facility construction and maintenance hardware have to be imported, then the investment in setting up and maintaining this type of industry would not be cost effective.

There is one feed producing factory in Saint Vincent but its production is limited to the production of feed for livestock. At present it does not have the capacity to produce aquatic feed, especially the technology for producing the floating food required by sea cage culture fish. In addition organizing a sea cage culture industry on the basis of a small economy of scale and intermittent consumers would make economic viability very difficult if not impossible.

III. CONCLUSIONS AND RECOMMENDATIONS

Saint Vincent is constrained by the limitation of its topography, as it does not have areas that can be developed into viable fishponds. It would therefore be difficult to institute an on shore aquaculture industry under these conditions.

The country is surrounded by sea especially the Leeward side where the water is suitable for sea cage culture, however, the country is prone to natural disasters, for example, hurricanes. Sources of constant feed supply need to be identified and knowledge of the market to determine which variety should be exploited needs to be documented. This would require that a more advanced evaluation be conducted.

Since there are many reefs surrounding Saint Vincent it would seem that there is a ready supply of decorative tropical fish for which there is also a ready market. It is possible that research into the reproduction of these species can be conducted to start an exotic fish breeding and exporting industry. This type of fish requires low investment, low maintenance and has a high end-value.

It may also be possible to expand an existing high value resource for example lobster by using sea cages to catch and fatten them for sale to an already existing market.

NATIONAL REPORT
OF
THE REPUBLIC OF TRINIDAD AND TOBAGO

by

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I. GENERAL INFORMATION

Geography and Economy

Area	5 128 km²
Length of coastline	391 km
Shelf Area	80 000 km² (EEZ)
Terrain	Plains and low mountains
Climate	Tropical
Population	1163 724 (July 2002 est.)
Annual growth rate	-0.52% (2002 est.)
Language	English
Work force	563 400 (1999) - Construction and utilities 12.4%, manufacturing, mining, quarrying 14%, agriculture 9.5%, services 64.1% (1997 est.)
Unemployment rate	10.7% (2001)
GDP	US$ 10.6 billion (2001 est.)
GDP growth rate	3.5% (2001)
GDP per capita	US$ 9 000 (2001)
Inflation rate	5.5% (2001)
Central Government Budget	US$ 1.41 billion (2001 est.) revenues, US$ 1.2 billion (2001 est.) current expenditures including capital expenditure of US$ 930 million
Currency unit	Trinidad and Tobago Dollar (TTD) US$ 1.00 = TT$ 6.2314 (2001)
Agriculture	1.6% of GDP (2001). Products: cocoa, sugarcane, rice, citrus, coffee, poultry, fish, vegetables.
Industry	43.2% of GDP (2001). Types: petroleum, petrochemicals, tourism, processed food and beverages, cement, cotton textiles, printing and paper, assembly-type, chemicals and non-metallic minerals
Trade	Exports: US$ 3.2 billion (f.o.b. 2000) - crude oil, petroleum products, ammonia, fertilisers, methanol, iron/steel, cocoa, coffee, citrus, flowers, fish.

Imports	US$ 3 billion (f.o.b. 2000 est.) - industrial machinery, electrical machinery, transportation equipment, manufactured goods, food, live animals.
Import-partners	USA 39.8%, Venezuela 11.9%, EU 11%, CARICOM 4.8% (1999)
Economic aid-recipient	US$ 24 million (1999 est.)
Fiscal year	1 October - September 30

Fisheries Data

Estimated employment

13 000 persons (1998)

Gross value of fisheries output (at ex-vessel prices - 2000)

US$ 100 million

Trade

Value of imports	US$ 3.94 million
Value of exports (2000)	US$ 10 million - 4 000 mt

II. STATUS OF AQUACULTURE PRODUCTION

Species cultured and technologies

Inland aquaculture

Aquaculture had its genesis in Trinidad and Tobago in the 1950s when petroleum companies introduced the freshwater cichlid, tilapia (*Oreochromis mossambicus*) indigenous to the African continent, into their cooling-water dams to control breeding of mosquitoes. Subsequent to this, tilapia was perceived as an answer to the protein deficiency problem facing the colonies of the British Empire, since it could provide a cheap food source for low-income groups. The Bamboo Grove Fish Farm was established to research the culture of tilapia and produce fingerlings for farmers.

The initial focus of the Ministry at the time was to promote small-scale and subsistence farming using small family ponds in rural communities where marine fish was not readily available. Farmers were encouraged to use dams, irrigation channels and ponds to rear fish such as the red hybrid and silver variety and the indigenous catfish known as the cascadura (*Hoplosternum littorale*). Fish farming was an integrated activity with other types of farming such as animal husbandry, rice farming and other crop farming in order to maximize total food production within their holding.

Due to the poor marketability of the black tilapia, and following a recommendation of an Aquaculture Review Commission established by the Ministry of Food Production and Marine Exploitation (MFPMR) in 1986, the Institute of Marine Affairs (IMA) started an aquaculture unit with red hybrid and Nile tilapia (*Oreochromis niloticus)*. In 1985, the IMA and Professor Kenny of University of the West Indies also introduced the Asian freshwater prawn, *Macrobrachium rosenbergii* to Trinidad. In 1988, La Vega Limited imported *Cherax*

quadricarinatus, and the Australian red claw crawfish. Among the indigenous species, the river conch, *Pomacea urceus*, was also successfully cultured by the IMA in the late 1980s.

In 1989, Caroni (1975) entered into commercial aquaculture. The pilot phase consisted of a multi-purpose hatchery and 9.5 hectares of earthen ponds. The company initially produced Malaysian prawns (1990-1995), and then focus shifted to the production of red hybrid tilapia. Cascadura was produced during the period 1992-1993. At the Government operated Bamboo Grove Fish Farm, a prawn hatchery was established in 1991 with technical assistance from Taiwan (Province of China). However, this project was never developed to realize its potential and it was discontinued when the Chinese left one year later. Also, in the mid-1980s, two farms were established: a tilapia farming venture on the eastern side of the Caroni swamp and a pilot project for shrimp at Brickfield. Neither ventures succeeded and were eventually closed down.

The Sugar Cane Feed is another demonstration facility of the MALMR, which was established to formulate feeds for the livestock industry utilizing sugarcane by-products. In 1988, an aquaculture project was established with the culture of the red and silver hybrid tilapia, and the cascadura, using 0.4 hectare pond area. The project was expanded by a further 0.5 hectare in 1990. The SFC advocated an integrated farming approach to agriculture and aquaculture. In 1988, a 3-hectare farm was established in Plum Mitan to culture cascadu on a semi-intensive basis. In parallel a commercial fish hatchery was established in Gran Couva to provide fingerlings for the fish farm. These projects initially went well but disease and larceny problems developed which impacted negatively on operations. The hatchery subsequently entered into ornamental fish production and eventually ceased operations due to an irregular supply of water.

In the early 1990s, the red hybrid was the major freshwater fish species cultured throughout the country on a small-scale. Other freshwater species being cultured to a small extent were the Nile and black tilapias and the armoured catfish, *Hoplosternum littorale.* The IMA has conducted a number of hatching trials of the freshwater prawn and has supplied post-larvae to several small-scale fish farmers. After the poor success experienced with the culture of the red hybrids by most aqua farmers, the Wallerfield Fish Hatchery attempted to re-introduce the Nile tilapia, *Oreochromis niloticus*, as a new species in 1997, with the hope that claims of its growth potential would stimulate interest in purchasing fingerlings. The hatchery was capable of producing 1 million *O. niloticus* fingerlings yearly. But in the absence of external farms and available land for grow out; production was curtailed until the industry can absorb this output.

The ornamental fish industry has a longer history and there are about six large-scale producers who also export. There are approximately thirty-nine small to medium-size breeders who concentrate on the rearing of several exotics and indigenous species. The major species produced are: Angels, Barbs, Goldfish, Danios, Swordtail hellaries, Mollies, Platies, African cichlids, Bettas, Kois, Tetras, Rainbow fish, Gouramies, Oscars, White clouds, Tetas, Guppies and Pui-Pui. The latter three species are indigenous to Trinidad and are usually harvested from rivers in rural areas. Stocking studies are currently be undertaken by the IMA to restore wild stocks of teta, which is currently overexploited.

Coastal aquaculture

Presently no commercial coastal aquaculture operations exist in Trinidad and Tobago. Attempts have been made to culture various species of penaeid shrimps (*Penaeus monodon*

and *Penaeus vannamei*), however, to date none of the former farms and pilot projects are in operation. Presently, there is little or no interest in coastal aquaculture activities. Until the early 1990's, there was a strong market demand for the mangrove oyster (*Crassostrea rhizophorae*). The above-mentioned oyster was once very abundant in the Caroni and Nariva Swamps. However, due to over-harvesting, the numbers are much reduced and now collected mainly from the Claxton Bay region. Additionally, the vending of oyster cocktails, which was a major source of oyster sales, was significantly affected when a ban was imposed on vending in 1994 due to sanitary concerns. This enterprise was never able to recover even though in 1996, the Oyster Vendors Association attempted to save the industry by proposing a culture project in the Caroni swamp. The project was to be funded by a Florida based agency but for reasons, which are unclear, the project was never started. In 1995, mariculture trials were conducted using seamoss, *Gracilaria* sp. and the carangids, *Trachinotus* sp.

Aquaculture technologies

Several reasons have been cited for the failure of aquaculture in Trinidad and Tobago. Among those reasons are the following: the transfer of inappropriate production technologies to farmers, the subsistence technology that is used in small backyard production units, and the use of extensive culture systems that are not commercially viable and or will not ensure the sustainability of an industry. Also, failure in the use of sex-reversal technology to produce all male fingerlings for stocking of production ponds has made it difficult for farmers to manage production units ultimately resulting in poor yields at harvest time. The recent thrust of the Fisheries Division has been sensitising the national community about aquaculture, and encouraging commercial scale production units of ½-acre to 1-acre minimum size and minimum production capacity of 5 acres or 2 hectares. Incentives are being given to farmers, effective 1999, which meet these minimum criteria.

Aquaculture statistics

The total number of registered fish farmers in December 1991 was 1 020 while the total area of ponds (ranging in size from 0.05 to 5.0 hectares) amounted to approximately 120 hectares compared to the 23 hectares in production in 1985. Most of the 1028 farmers practised small extensive backyard fish farming and they were located in the countries of Caroni, St Patrick and Victoria. No mechanism had been put in place by the Fisheries Division to collect data on these Freshwater Fisheries. However, in 1999, a telephone survey was conducted to identify the number of practising food fish farmers in the nation.

Of the fifty-three existing farmers identified in that survey, forty-three were determined to be cascadura subsistence and small-scale farmers who depended largely on capture fisheries for brood stock and even market supply. Four of these projects practised polyculture with Tilapia. The Sugarcane Feed Centre, the Bamboo Grove Fish Farm and Caroni (1975) Ltd. were also counted among the fifty-three. However, Caroni Aquaculture Division closed down all production operations by late 1998 and the Bamboo Grove Fish Farm was divested in 1999. The lessee has only recently (2002) initiated small-scale production at this facility.

Generally, it was discovered that Tilapia production was not being practised on a wide scale. The Fisheries Division established one, 0.2 hectare, pond in each of two rural communities as demonstration projects. This initiative attempted to encourage both a co-operative approach to production, as well as to seed other production units. In each case, only male *O. niloticus* fingerlings were stocked. Two more community-based projects were established between 2000-2001 providing additional five, 0.2 hectare, production ponds and a capacity of 23 tonnes of fish yearly. These demonstration projects helped to provide valuable hands-on

training to community members but once the Division withdrew financial support for a project no further investment in the project was found.

No reliable production statistics are available to date, however, the Aquaculture Unit of the Fisheries Division, reported that in 1991 approximately 2.5 metric tonnes of fresh fish were sold, mainly red-hybrid tilapia. The combined production figure for the cultured freshwater fish species is likely to be an underestimate as very little of the total production reaches the local markets. Tilapia, as well as the highly regarded cascadura, usually serves the farmer and his immediate family. The former species are rarely sold, while the cascadura, when sold, is taken to the produce market and retailed by the farmer to his/her agent at TT$ 44/kg. The SFC produces about 2 tonnes of fish yearly but since research and not production is the emphasis this quantity is not guaranteed.

The Central Statistical Office only commenced the collection of production data for the cultured food fish industry in 1998, and the information is limited to that supplied by Caroni (1975) Ltd. Over the period 1990 to 1996, Caroni (1975) Ltd was the largest producer of cultured food fish in the country and accounted for an estimated 98% of the Malaysian prawns produced, 80% of the cascadura produced and 70% of the tilapia produced. It is reported that in 1991, Caroni (1975) Ltd produced 5.2 metric tonnes from 5.5 hectares. Table II, below, provides data for the period 1990 to 1996. By 1999, no projects were established which cultured freshwater prawns.

YEAR	SPECIES (Quantity in Kg & Value in US$)					
	Tilapia	Value	Cascadura	Value	Prawn	Value
1990	1250	1,600	2000	12,000	-	-
1991	1250	1,600	1250	8,100	5200	20,000
1992	2500	1,600	4000	16,900	2000	4,000
1993	2800	4,000	2500	9,600	2500	8,800
1994	16000	23,460	1250	4,100	2500	9,600
1995	16000	2,300	1200	4,000	3000	12,900
1996	18000	29,000	1200	4,000	500	1,600

In 1999, Wallerfield Fish Hatchery produced approximately 200,000 fingerlings and 10 tonnes of fish. In 2000 approximately 50 000 fingerlings and 15 tonnes of fish were produced. In 2001 and 2002 there was no production. The Nariva Aquafarms is a twenty-acre farm, which initiated its production operation in 1999. From 1999 to 2001, half tonne of cascadura was produced each year. In 2000, half tonne of red hybrid tilapia was produced in earthen ponds. In 2001, two tonnes of fish were produced. In 2001, approximately 3.6 tonnes of fish were harvested from two community projects. In 2001, the two projects yielded almost 2.4 tonnes fish.

In the ornamental fish trade, expanding export markets have been identified in North America and Europe. In 1999, 10 ornamental fish exporters sold a total of 1 375 000 fish generating on income of approximately US$ 130 000. These figures are believed to be under-estimated. It must be noted, however, that not all of these fishes were produced locally by aquaculture, and that some are captured from local rivers while others are imported from South America using Trinidad as a transhipment point.

III. POLICY MAKING, PLANNING AND MANAGEMENT

The Fisheries Division (FD) of the Ministry of Agriculture, Land and Marine Resources (MALMR) is the official agency responsible for the management and development of the fishery sector, including aquaculture. The major role of Fisheries Division is the development, organisation and regulatory support to the industry through policymaking and strategy implementation. Extension, training and information services are also provided via the assistance of the Fisheries Officer and the scientific assistant.

The Government of Trinidad and Tobago, in its macro-economic policy framework (MTPF 2001-2003) enunciated its overarching strategy for Aquaculture as 'A *Strategy for generating additional employment in the sector include-increasing access of farmers, fisher folk and aquaculturalists to agricultural credit'*. The MTPF also states that *'In respect of marine fisheries and aquaculture, Government, as part of its efforts to promote sustainable management of natural resources, will seek to provide institutional and infrastructural support to fisher folk and aquaculturalists; and establish links with national and international agencies for the necessary financial and technical support'*. The role of the State is also articulated in the Sector Policy for the Ministry of Agriculture, Land and Marine Resources (2001-2005) as follows: *"The State will facilitate private sector activity by producing public goods and services in support of private sector activity and improved livelihood for citizens. The MALMR considers the aspect of enforcement of regulations and provision of certification, including but not limited to public health and food safety as essential. The Ministry will accommodate the needs of stakeholders for speedy and transparent decisions and actions in the conduct of its regulatory and certification responsibilities"*. The facilitative role of the State includes its functions with respect to development and enforcement of regulations and standards for quality assurance, also intervene in markets, for limited periods, to assure supply of some 'strategic' goods not provided by the private sector'.

In 1997, a task force consisting of six representatives from the UWI, IMA, SFC and Fisheries Division was appointed to formulate an aquaculture policy for the benefit of the emerging industry. Dr Indar Ramnarine headed the task force and a draft aquaculture policy document was produced. This document has undergone two to three revisions, but it is still to be finalised before being sent forward for cabinet consideration.

IV. TECHNICAL CAPABILITIES

Education and training

The only institution in Trinidad and Tobago, which carries out formal education at the graduate level in the field of biology and related subjects, is the St. Augustine Campus of the University of the West Indies (UWI). The Department of Zoology has no specific programme in aquaculture, however, courses on fishery/aquaculture/estuarine sciences are available as part of the zoology degree. The UWI, however, expressed interest on a possible tough M.Sc. course in fisheries and aquaculture, provided that it is fully conducted in only one of its campuses. It is generally felt that there would be sufficient interest for such a course, which could be conducted on alternate years.

Hands-on training can be received at the Institute of Marine Affairs and at the small Aquaculture Unit of the Sugarcane Feeds Centre. The Fisheries Division has for the last two

years (2000-2002) been offering an intensive six-day training course in Food Fish Farming. In the last fiscal period, the Introduction to Ornamentals and Integrated Farming was introduced for the benefit of the emerging industry.

Research

The Institute of Marine Affairs (IMA) is an autonomous government institute established with the following objectives to:

- promote the better understanding of all aspects of the marine environment;
- disseminate in the Caribbean knowledge of the various disciplines relevant to marine affairs; and
- increase the capabilities of the Government in the formulation of policies in marine affairs. Aquaculture research is one of the programmes of the Institute.

The Pilot Aquaculture Project was initiated at the IMA in 1985 and was intended to conduct field and laboratory trials with a view to identifying potentially suitable culture species for Trinidad and Tobago. In former years, production and culture trials were conducted on the cascadura (*H. littorale),* the red hybrid tilapia and the freshwater giant prawn *(M. rosenbergii).* Some work was also being carried out with the Nile tilapia *(O. niloticus),* the freshwater black conch (*Pomacea urcea)* and seamoss (*Gracilaria* spp.). IMA's applied research concentrated on the following topics:

- polyculture of freshwater prawns and cascadura
- production of red hybrid tilapia and cascadura fry and fingerling
- production and cage culture of the grey snapper (*Lutjanus griseus*) and pompano (*Trachinotus* sp.), and
- seamoss raft culture.

The output of this research is the documentation of several manuals by Paul Gabbadon and Gregory DeSouza for the benefit of potential and existing aqua farmers.

The Institute is equipped with office space, a library, an analytical laboratory for water analysis, a wet laboratory, hatchery, nursery and nine small earth ponds (total surface area approximately 0.5 hectares). Presently, the research of the Aquaculture Division is directed to the ornamental industry with regard to fish pathology, culture techniques and re-introduction of wild stocks into their natural environment. There is greater emphasis on environmental studies and some of the professional staff have moved into providing technical consultancy on environmental issues.

The Sugarcane Feeds Centre (SFC) is conducting culture and production trials on the river conch for very little is known on the feeding requirements and the reproductive behaviour of this local delicacy.

The Life Sciences Department of the University of the West Indies, St Augustine Campus, has been carrying out some basic studies on freshwater and brackish water species of commercial interest. The campus is not equipped with research aquaculture facilities, however the Bamboo Grove Fish Farm (BGFF) was divested to Dr I. Ramnarine who is a senior lecturer at the Department of Life Sciences, UWI. Dr I. Ramnarine together with the university students are therefore able to continue developing and implementing applied fishery research projects utilizing the facilities at BGFF.

Technical assistance and extension

The Sugar Feed Centre and Fisheries Division continue to provide technical assistance and extension services to farmers. However, this service is not in demand as much as the need for training. The above centres usually provide, free of charge, the following assistance:

- assessment of the land and water resources of an applicant
- preparation of feasibility studies
- advice on the biological aspects of the species being considered and/or cultured,
- advice on pond design and construction, and (v) advice on farm management practices.

The objectives of the Aquaculture Extension Programme are:

- to demonstrate certain fish culture practices so that the farmers can be acquainted with the scientific method of fish farming;
- to act as liaison between the research units and the farmers, so as to ensure that new and improved techniques are transferred to the farmers in a language readily understood; and
- to support farmers in all aspects of their aquaculture project.

The Sugarcane Feeds Centre, with its small hatchery and few culture ponds, has adopted an open-door policy where all interested parties can observe and receive advice on the management of small-scale cascadura and tilapia operations. The Institute of Marine Affairs also provides technical assistance and extension services to fish farmers in the form of hands-on technical workshops, seminars and technical manuals.

In 2001, National Flour Mills (NFM) hosted a seminar on '*Tilapia Feeds and Nutrition'* conducted by the American Soybean Association. The follow-up to this was another seminar in May 2002 on 'Achieving Optimum Efficiency in Aquaculture Production'. The NFM entered the aquaculture industry in 2000 as a commercial producer of starter and grow-out extruded fish feeds. This business initiative was undertaken in order to supply the Jamaican market where demand was not being met by supply. This organisation has decided to promote aquaculture production in Trinidad and Tobago and consequently, it is expected that seminars of this nature will continue in the future.

V. POTENTIAL FOR AQUACULTURE DEVELOPMENT

Physical potential

Trinidad and Tobago are the southern-most islands of the Lesser Antilles chain in the Caribbean. Trinidad, the largest island of the chain, is separated from Venezuela by the 11 kilometre-wide strait of the Gulf of Paria. Three relatively low mountain ranges cross Trinidad from east to west. Their highest elevation reaches 940 metres in the heavily forested Northern Range. Between the northern and central ranges the land is flat and well watered; between the central and southern ranges it is rolling, and the water supply often falls short in the dry season. Tropical forest covers half of the island. Swamps are found along part of the east and west coasts. The island's low latitude places it outside the usually path of hurricanes. The island of Tobago lies 30 kilometres northeast of Trinidad and is characterized by long

stretches of sandy beaches and a ridge of volcanic origin which lies along the centre of the island.

The suitability of Trinidad and Tobago for aquaculture was discussed in the 1998 FAO document '*A strategic assessment of the potential for freshwater fish farming in the Caribbean island states'*. Six major criteria were used for the evaluation exercise:

- Market size and proximity: based on population density at urban centres and estimated travel time along roads to reach urban markets;
- Water loss from ponds by evaporation and seepage: annual water loss is estimated from precipitation over the pond and its embankments, evaporation are from the pond surface and seepage is assumed to be a constant;
- Soil and terrain suitability for ponds;
- Potential for agriculture by-products: inputs for fish farming as fertilizers or feeds on the basis of crop potential;
- Farm gate sales: depends on population density local to the farm site but does not take into account purchasing power or disposable income; and
- Farming system criteria combined: combining the criteria weighted by their relative importance.

Trinidad and Tobago scored high on the basis of the importance placed on annual water loss; soil conditions were also determined to be favourable. Generally, good quality water in adequate supply is found on the eastern side of Trinidad in the Oropouche, Nariva and Ortoire basin and along the north coast between Chupara and Grand Riviere. With regard to freshwater swampland, extensive unpolluted areas are available at Nariva in the east and Los Blarquizales in the southwest.

Most of the more extensive areas of brackish water swamp are under pollution risk, but the southern half of the Caroni Swamp and the Fullarton Swamp still have reasonably good quality water. Sheltered marine areas suitable for mariculture are available in the Gulf of Paria but pollution and other commercial activities is a serious problem. Other bays on the North coast, such as Teteron Bay, Chacachacare Bay, Maracas Bay, Las Cuevas Bay, Cyril Bay, Man-of-War Bay and Bloody Bay can be effectively used. If mariculture is to be done in ponds or tanks next to the marine environment, then there are other potential sites on the South and East Coasts. In Tobago, good quality freshwater is available in limited quantities. Excellent conditions are available for mariculture in Buccoo and Bon Accord and in the deeper West Coast bays.

Species

The aquaculture industry as a whole is still at an early stage of development and the potential for expansion exists. However, factors such as market demand, availability of technology and resources must all be taken into account in order to determine whether the culture of any particular species is economically attractive and justifiable. A brief survey of local species indicated that Trinidad and Tobago have many organisms with value for culturing.

These organisms as well as a number of non-endemic species would fill the various needs in the country, i.e. as basic or luxury food items, recreational fishing and aquarium export trade. Some species could be successfully and profitably cultured within one or two growing seasons (e.g. cascadura, mullet and oysters), while other require more research before their

future economic returns can be assessed (e.g. queen conch, crabs, marine plants, marine shrimps).

Beside tilapia, cascadura and the giant freshwater prawn, the potential exists for the following types of culture.

- Culture of brackish water shrimp in coastal ponds;
- Culture of indigenous ornamental fish species (e.g. *Corydoras aeneus, Hypostomus robinii*)
- Mariculture of tilapia and other indigenous marine species in cages;
- Culture of indigenous freshwater species in ponds; a
- Culture of bivalves in coastal areas *(C. rhizophorae, Perna* sp.).

Finance

The Aquaculture Task Force reported that one of the major impediments to the development of the industry is the stringent requirements in accessing available capital. The Task Force was of the view that the Agricultural Development Bank (ADB) should provide the best available loan conditions for aquaculture projects. Under the Agricultural Incentive Programme, there is an integrated package of fiscal incentives to stimulate greater interest for investors in the industry. These include duty-free concessions on aquaculture equipment and some supplies, corporate tax reductions to fish processors, and rebates for pond construction, rehabilitation of ponds, construction of wells, pumps, vehicles, and minor equipment. A waver of charges on water used is being discussed. No taxes are paid on agricultural holdings of with less than 100 acres in production.

VI. FISH HANDLING, PROCESSING AND MARKETING

Aquaculture production is mainly subsistence in nature with a very small portion of the catch being marketed-fresh to local consumers. Presently none of the existing fish processing plants handle aquaculture products, mainly due to the small annual outputs. However, should production from aquaculture substantially increase, there are adequate fish processing plants to absorb the raw material for processing into value-added products.

Marketing information and facilities have been identified as major constraints to the development of the aquaculture industry in Trinidad and Tobago. Presently, there is little or no current market information available to the industry. Production decisions are made in the absence of adequate market information and as such, producers are probably not able to maximize their potential and exploit market demands. The Aquaculture Task Force recommended that the National Agricultural Marketing Development Co-operation, with the assistance of the Export Development Corporation (folded in 1993) and various trade missions, develop a comprehensive marketing information gathering system, which would provide important information on a regular basis to the industry.

With regard to marketing facilities it has been recognised that adequate storage facilities are not available as well as the need for an efficient and low cost supply of packaging materials. There is also need for greater co-ordination among agencies involved in the inspection of fisheries and aquaculture exports. The strengthening of the organisation and support services to the industry is recognised as a priority to enhance the development of the sector.

VII. CONCLUSIONS AND FUTURE DEVELOPMENTS

There is need for a proper marketing study to be conducted, which would identify the potential markets for Trinidad and Tobago fish and fishery freshwater products including market characteristics, product requirements, competitive producers, market prices and so on. The only marketing study to date was conducted by IMA into consumer preferences for tilapia on the basis of freshness, features and colour, in the early 1990s. There exists a cultural bias in the country for fresh marine fish and consumers are generally unwilling to consider alternatives of like tastes unless they are prepared, processed and packed for convenience. Aquaculture products are therefore niche products at present; acceptance being mainly in the rural communities. There is need to organise public awareness and education programmes aimed at promoting fresh water fish consumption.

Although aquaculture activities have been in existence for over fifty years in Trinidad and Tobago, the fishery has yet to develop commercially. It is believed that this can be achieved via the establishment of an Aquaculture Management Authority (AMU), to oversee the development and implementation of a National Aquaculture programme. This institution would facilitate cooperation and collaboration among all stakeholders, including government institutions, non-government organizations NGOs, private investors and fish farmers. A determination of the domestic protein requirements measured against local production and quantities lost to the local market through exports can be used as a basis for setting production targets and a production plan must be formulated. The AMU would also be responsible for marketing fish and fishery products as well as training and monitoring the progress of projects.

There are about three investors who have proposed lucrative commercial-scale inland fishery projects to the Government of 40.5 hectares (100 acres) upward but implementation is hindered because of the long delays in being provided with a lease agreement. This is in part due to political issues not to mention that land is at a premium and the competition with other economic interests is intense. Lands have not been identified in the MALMR for Aquaculture in like manner to lands reserved for agriculture. To facilitate this process there is need for a detailed technical and economic feasibility study to investigate opportunities and provide specific options for profitable investment.

In summary, the Government of Trinidad and Tobago and the private sector seem seriously committed to the promotion and development of the aquaculture industry. However, the implementation of policy and other measures are not being pursued with the necessary vigour and determination to continue to motivate the private sector. As a result, the private investors are undertaking bold initiatives to encourage market interest and to lobby the Government. One such initiative is the establishment of the Aquaculture Society of Trinidad and Tobago, which replaces the Fisheries Society, which became dormant in 1994.

Other issues to be addressed to facilitate this fragile industry include:

- High production costs as a result of costly feeds and costly seed stock;
- Insufficient institutional capacity and human resource capability;
- Inadequacy and lack of proper access to information and research;
- High cost of water.

PART III

REPORTS FROM THE RESOURCE PERSONS

MARKETING OPPORTUNITIES FOR AQUACULTURE PRODUCTS IN THE LESSER ANTILLES

by

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INTRODUCTION

Sustainable development of aquaculture is only possible when there is a market for the commodities produced. A precondition for aquaculture to take of is that consumers, locally or in export markets, should be interested in its products. In the next sections the trade of fishery products by the SIDS of the Lesser Antilles and Bahamas, the markets for aquaculture products in the USA and EU, current trends and prospects for fish consumption and issues of importance to commercially oriented aquaculturists will be discussed subsequently.

Trade in fisheries products

The trade in fisheries products by the SIDS of the Lesser Antilles and the Bahamas shows large variation between the various countries. Export and import data of fisheries products in the year 2000 are detailed in Table 1 below.

Table 1: Exports and imports of fishery products by the SIDS of the Lesser Antilles and Bahamas in the year 2000 (Source: FAO FishStat Plus).

Country	Exports in Metric Tonnes (2000)	Imports in Metric Tonnes (2000)
Trinidad & Tobago	4 361	4 028
St Vincent & Grenadines	251	421
Bahamas	3 440	1 634
Grenada	542	438
St Lucia	7	1 249
St Kitts & Nevis	73	1 376
Barbados	297	3 798
Dominica	0	666
Antigua & Barbuda	644	470
Total	**9 615**	**14 080**

Taking in consideration the balance of trade in fishery products, only three of the nine above listed countries showed a positive sign, being Bahamas, Trinidad and Tobago, and Grenada. The other countries spent more on fisheries products imports than they earned with exports in 2000 (Figure 1). The positive balance of the Bahamas is largely a result of the high value of the spiny lobster exports. When specifying the imported fishery products by product class,

tunas (prepared or preserved), fish various (dried, salted or in brine) and sardines (prepared or preserved) appear to be the main imports. The lack of detail in the data available makes it impossible to distinguish between the sources of origin of the fisheries products (capture fisheries or aquaculture). It is safe to say that most of the currently being imported products originate from capture fisheries, however, some of these products could be derived from aquaculture as well. Considering the current aquaculture production of the SIDS of the Lesser Antilles is largely limited to tilapia and shrimp it might be useful to look at the import trends of similar products. Figure 2 details the imports of some of the fisheries products by class in 1990 and 2000; products that might be partly derived from aquaculture. The figure shows that imports of frozen shrimp more than doubled, and those of frozen fish fillets increased from insignificant to over 1600 mt and fresh fish fillets to over 500 mt over a 10 year period.

As the population of the SIDS of the Lesser Antilles is relatively small, a large part of the demand for fisheries (incl. aquaculture) products should come from tourism if aquaculture is to be economically viable. Aquaculturists should take advantages of the needs for fresh, safe and high quality fish by the tourism industry. Steady supplies are demanded by caterers and restaurants/hotels, which can only be guaranteed by the aquaculture sector or imports.

Exports of fisheries products from the SIDS of the Lesser Antilles and Bahamas are largely going to the USA. Main export products are frozen lobster (Bahamas), fresh yellow fin tuna (Trinidad and Tobago, Grenada, Barbados) and frozen albacore tuna (St. Vincent and the Grenadines).

Trade policies that affect fisheries products trade between the SIDS of the Lesser Antilles and USA and Canada are among others: The Caribbean Basin Initiative (CBI), which is a broad programme to promote economic development through private sector initiative in Central America and the Caribbean. It especially promotes investment in non-traditional sectors such as aquaculture. Under the Caribbean Basin Economic Recovery Act duty free entry of fresh and frozen seafood is being provided for. However, canned tuna is excluded from this duty free entry status. Under the CARIBCAN fisheries products from the SIDS of the Lesser Antilles have duty free access to the Canadian market, provided that they originate from the Islands.

European Union trade policies that impact the trade of fishery products between the SIDS of the Lesser Antilles and the EU are largely based on the Lomé Agreement (1975), the Cotonou Agreement (2000) and various EU directives. Since the early 1990's the EU has emphasised that fishery and aquaculture products entering the European market should be of high quality. This was written down in various directives. An important directive for fish farmers from the SIDS of the Lesser Antilles is Directive 91/493/EEC that lays down the health conditions for the production and the placing on the market of fishery products. In short, Directive 91/493/EEC stipulates that all fishery and aquaculture products (fresh, as well as chilled, frozen, canned, smoked, dried or salted) entering the EU market must come from a an establishment where fishery and/or aquaculture products are prepared, processed, chilled, frozen, packaged or stored which is approved by the competent national authorities. For the implementation of these EU Directives the EC is developing harmonised import conditions for the third countries exporting fishery and aquaculture products to the EU. The specific conditions for imports of specific products and product forms are being documented, which is a long process. Therefore, a transition period has been defined, during which so called "third" countries are allowed to export fishery and aquaculture products to the EU. Not-harmonized countries are not allowed to export fishery and aquaculture products to the EU. Provisionally

harmonized countries among the SIDS of the Lesser Antilles and Bahamas are at the time of the workshop: Antigua and Barbuda, Bahamas and Grenada. This means that the other countries are not harmonized and thus not allowed to export fishery products to the EU. If harmonized the General system of Preferences (GSP) becomes important as it allows for duty-free access without any quantitative restrictions to products originating in the Least Developed Countries (LDCs). This includes fisheries and aquaculture products as well.

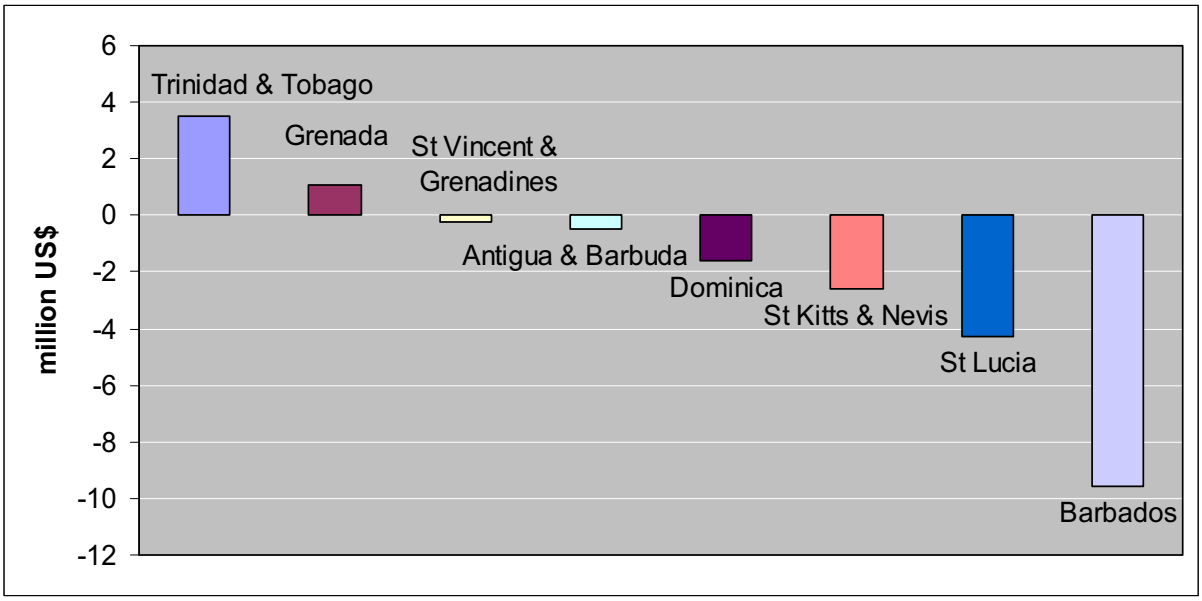

Figure 1: Trade balance of fishery products of selected countries in million US$ in 2000.

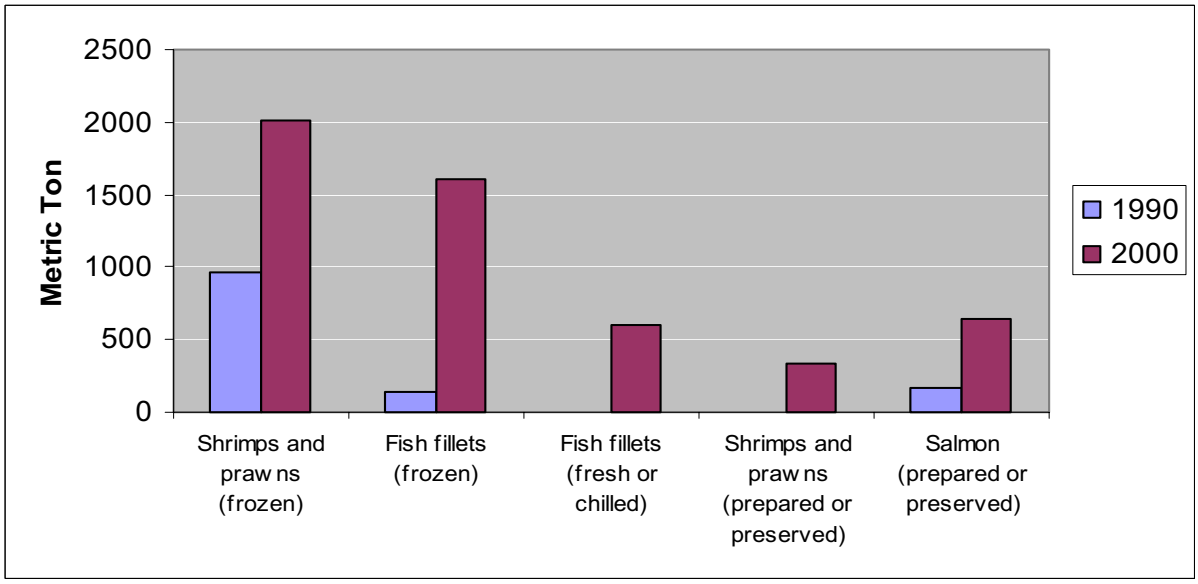

Figure 2: Growth in imports of certain fishery product classes in the SIDS of the Lesser Antilles and Bahamas between 1990 and 2000.

Consumption

The consumption of fishery products varies largely between and within countries. Figure 3 presents the fish consumption in a number of EU countries and the USA, relevant as (potential) export markets for fisheries/aquaculture products from the region. Portugal has the

largest consumption of fish per capita in the EU, 61 kg/year, followed by Spain with 41 kg, Finland 34 kg and France with 31 kg/capita/year. Austrians, Germans and Dutch only consume between 11 and 16 kg per person per year. Average consumption in the USA is around 21 kg/capita/year.

Although no fishery products consumption data were available from the SIDS of the Lesser Antilles, supply data were. In the SIDS of the Lesser Antilles the per capita supply of fishery products is generally higher than 15 kg (except in Trinidad and Tobago) (Figure 4). This does not mean that there is sufficient fish available, but is just a calculation of the production + imports – exports of fishery products divided by the population size. Consumption by tourists is not considered in this figure. When including the consumption by tourists the total supply per capita would be much smaller. Since 1990 the per caput fish supply increased in St. Lucia, St. Kitts and Nevis, Barbados, Dominica, Trinidad and Tobago and Antigua and Barbuda. However it decreased in Grenada and the Bahamas over the same period. Recent fish consumption forecasting studies expect an increasing trend for the coming 50 years. However, up until 2010 the expected increase in consumption per year per caput is just over 1 kg in Latin America. For instance in Asia, Europe and North America the increase will be around 2 kg over the same period. Relating the fish consumption trends to the increase in regional global population the differences are larger. Africa, Asia and Latin America will need a much larger supply of fish than they have now available. As production from capture fisheries is not growing sufficiently most of the increase in supply will have to come from aquaculture.

The trend in fish consumption in the USA and EU is towards an increase in fresh and value added products (e.g. sashimi, ready to eat fish soups, paella and fish salads), while a slight decrease can be seen in the consumption of whole frozen fish and canned products. As far as the market for shrimp products concerns, the following trends are visible:

- Variation in products increased. Individual Quick Frozen Techniques (IQF) has contributed to this trend. Also the availability of especially battered products and the use of shrimp in ready to cook products (soups, paella) are increasing.
- Demand increased again after 2001 (now 15% higher in US).
- Wholesale prices in US are 19% down compared to last year.
- EU imports increased as well (especially in France).
- Competition is high from Asia (Thailand, Vietnam) and Africa (Madagascar, Mozambique) in EU market.
- Chloramphenicols remain a problem.

The tilapia market is characterized by the following:

- Production also in Jamaica and Costa Rica.
- Fresh fillets reach the EU market within 24 hours.
- EU imports of tilapia are mainly coming from Zimbabwe, Israel and Jamaica.
- In EU competition from Nile/Lake Victoria Perch and Tilapia.
- Demand increased rapidly during the last decade in US.
- In EU main consumption is by ethnic groups in UK, Germany and France.
- Fillets available in supermarkets at low prices.
- Consumer acceptance is rising (low calories).
- Consumers in the EU prefer bigger sizes than the USA and fresh over frozen.

Regarding the consumption of aquaculture and fisheries commodities it should be noted that aquaculture products have a considerable advantage over products derived from capture fisheries. Main advantages of aquaculture products are: 1) Homogeneous size of products, 2) Homogeneous meat/flesh colour, 3) Year-round availability, 4) Less odour (preferred by some consumers), 5) Taste can be adapted to local preferences, 6) Traceability and control, 7) Less damaged products as result from handling/bringing on board, and 8) Prices are generally low and predictable.

Following the above issues on trade, marketing and consumption commercially oriented aquaculturists should take into consideration some strategically important issues:

1. Produce a specie that has demand locally or in the US or EU, in other words a specie that is commonly known.
2. Keep records of all inputs and outputs of the production process.
3. Collect trade and price data (domestic & export) from internet & other sources.
4. Prepare a business plan including a clear marketing plan, financial analysis and if necessary a lending analysis.
5. Contact possible trade partners (CARICOM, US and EU)
6. Keep up-to-date on prices, markets and regulations.
7. Use written contractual agreements.

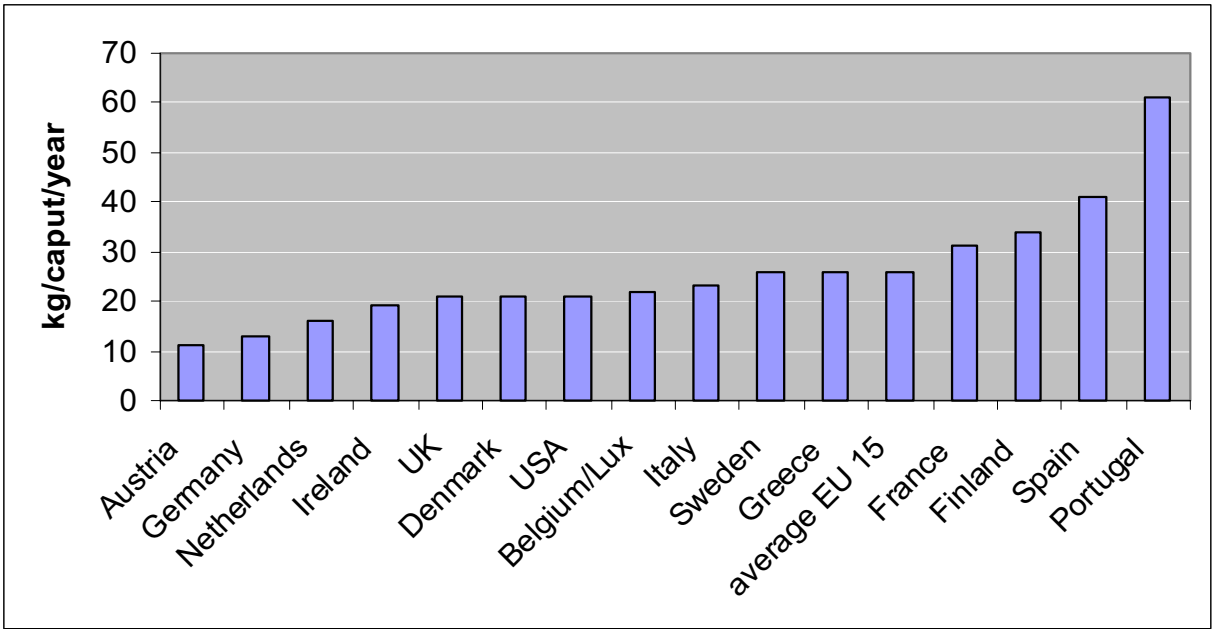

Figure 3: Average fish consumption (kg/caput/year) in EU and USA (period 1994-1998).

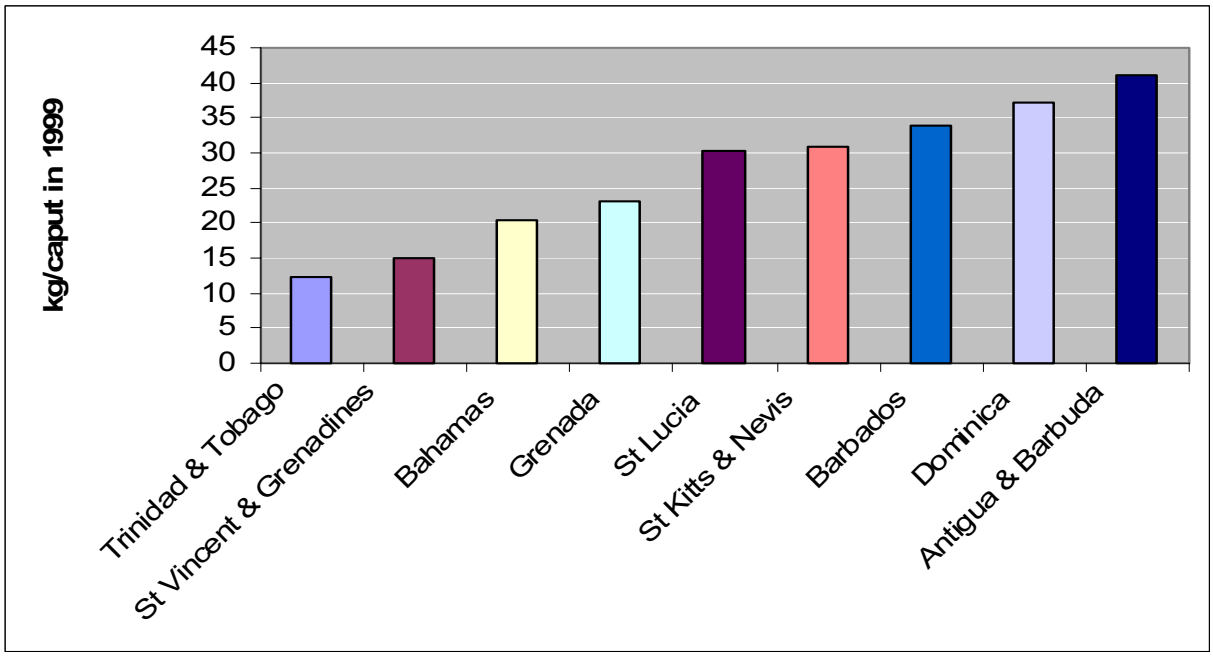

Figure 4: Supply of fish and fishery products in the SIDS of the Lesser Antilles and Bahamas in kg/caput live weight equivalent.

AQUACULTURE DEVELOPMENT OF RED DRUM (*SCIAENOPS OCELLATUS*) IN MARTINIQUE AND THE FRENCH WEST INDIES

by

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SUMMARY

The aquaculture of red drum (*Sciaenops ocellatus*) has been the subject of research and development work in Martinique since 1985. It was during the initial eight-year period that research findings showed the suitability of the species for domestication and mariculture.

However, whilst biological and technical knowledge is a compulsory prerequisite, it is not the only requirement for development. Operations throughout the production chain need to be synchronised, right through to product selling and company profitability. This explains the lengthy development process.

Since 2000, research reorganisation at IFREMER, the separation of larval rearing from growing-out, and the political and financial support of Martinique Region, have given a fresh impetus to our work, and development is now really taking off.

However, Martinique should not be the only island to benefit from this example ; other Caribbean countries must also be given the opportunity to put the small-scale aquaculture model into practice.

INTRODUCTION

IFREMER has had a mariculture research department since its establishment in 1968. Interest quickly focused on the initial species considered for development at that time (fish, crustaceans and molluscs) and a small number was selected for farming.

The Robert station was established in the early seventies and began work on filter-feeding bivalves (oyster culture trials), giant freshwater prawns (*Macrobrachium rosenbergii*) and some fish species. The European sea bass (*Dicentrarchus labrax*) was the key species, due to the fact that its growth in the tropics is greatly accelerated by water temperature.

However, this stock was wiped out by a virus (*Nodavirus*), which led to trials on other species from 1985.

In 1985, the Association for Aquaculture Development in Martinique (ADAM) introduced red drum (*Sciaenops ocellatus*) from the American coasts (Gulf of Mexico and Southern Atlantic). In the early seventies a restocking programme to support natural stocks was successfully developed. Between 1990 and 1995, intensive aquaculture techniques were adapted with considerable help from the local IFREMER laboratory.

The potential for mariculture in Martinique is very good. There are many suitable sites, some in the Caribbean Sea, protected from the prevailing winds, others on the Atlantic coast, the southern half of which is protected from the swell by an off-shore barrier reef, demarcating a wide area suitable for development (Figure 1).

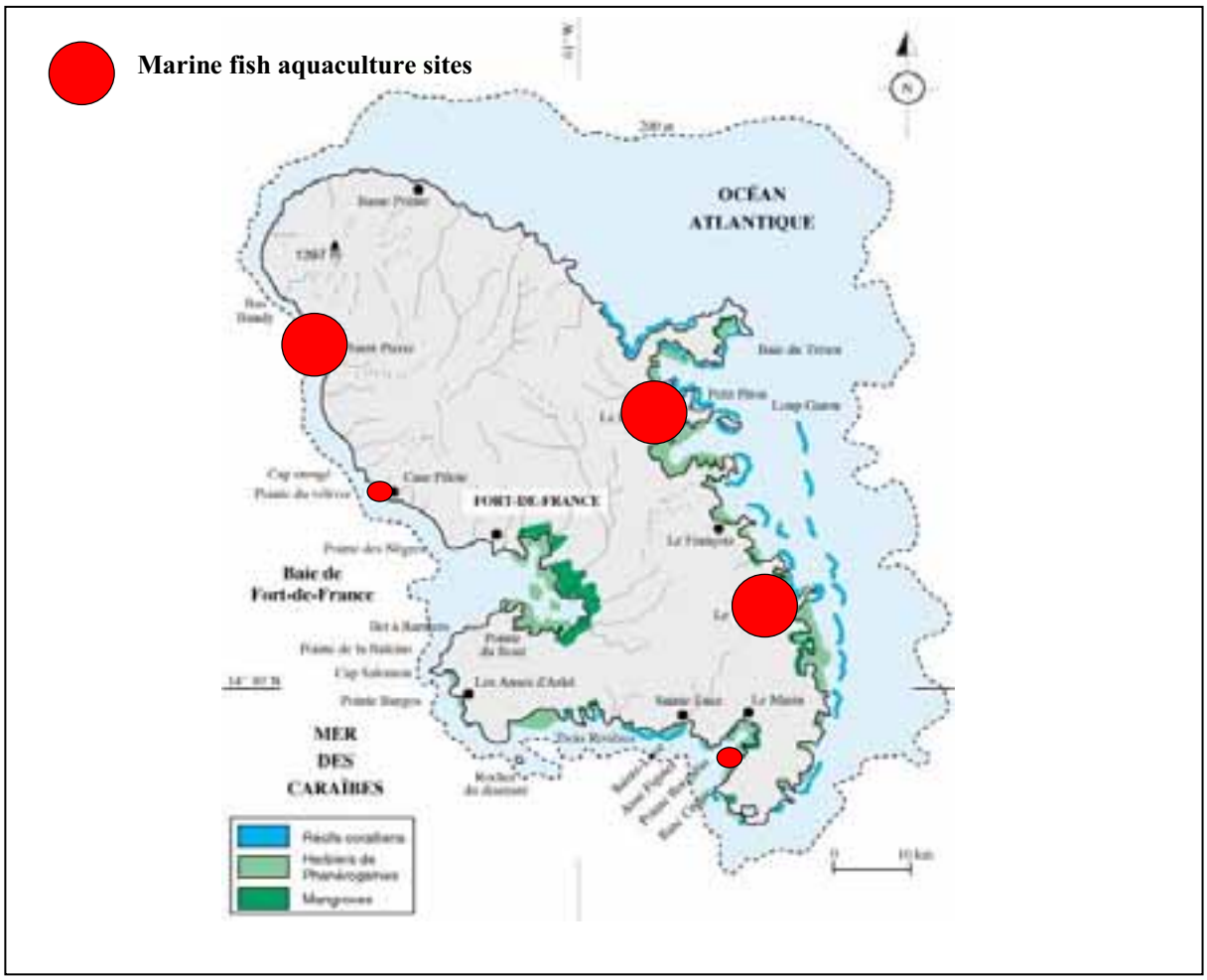

Figure 1. Suitable coastal areas for mariculture development in Martinique.

In 1995, a development framework was set up, based on a regional hatchery providing juveniles to aquaculture farms. This programme was not put into operation for several reasons:

- under-estimation of the technical skills required for hatchery development;
- inadequate training for aquaculturists; and
- inadequate management skills.

This meant that fingerling output was unpredictable, thereby hindering the development of the species.

In late 2000, the programme was reviewed in terms of the use of aquaculture potential, the role of the various players and how to make the most of the available opportunities. The effect of this was that, in 2002, fish were beginning to be marketed, there were requests to set up new hatcheries and professional skills were being organised.

Before the Introduction of Red Drum

The first species to be used for mariculture was the European sea bass (*D. labrax*), one of the few species whose rearing techniques are considered to have been fully developed. Since this species' growth is highly temperature-dependent, it was hoped that it would respond well to the transfer from the Mediterranean to the environment of Martinique. This was indeed so until an unknown virus wiped out the AQUAMAR farm's stock.

This virus and the lack of knowledge at the time on how to reduce the mortality rate forced the company to close down. This affected potential local investors who turned their backs on aquaculture.

It is worth noting that the same strategies are currently being implemented in Cuba, where a European industrial farm is rearing European sea bass and gilt-head bream (*Sparus auratus*). The pathological obstacles have been overcome, but other biological and technical problems have emerged, such as early ripening which hinders rapid growth, resulting in products of less than expected value.

Diversification trials

Phase two involved trials in Martinique's two experimental stations, IFREMER and ADAM (Association for the Development of Aquaculture in Martinique). Several local species were tested as well as the introduced species, red drum.

Red drum proved to be a much higher-performance species in terms of growth and hardiness, and in the initial stages of domestication. In 1993, it was felt that sufficient knowledge had been gained to justify its development (Goyard and Falguière, 1993). ADAM established a pilot-farm for growing-out and, in 1996, designed and set up a hatchery in order to meet the needs of the first aquaculturists.

In 1997, an industrial company was set up in Martinique providing a new outlet for local fish farming, with Martinique adopting a two-pronged approach: a small-scale sector supplying the local market, and an "industrial" sector, which had to be competitive on the Metropolitan French market, as well as on the international market generally (Houel *et al*, 1996). Meeting requirements in terms of fingerlings depended on the production capacity of the ADAM hatchery, which benefited from IFREMER's research findings.

This set-up proved inadequate to enable the red drum sector to take off. Fry production was irregular, not to say non-existent, and all the technical operations were risky (absence of materials in Martinique and the need to import them from Metropolitan France, lack of cash, lack of know-how and lack of operational synchronisation). Red drum production remained small and was too sporadic to give the product a stable position on the local market. None of the companies were economically viable and requests to establish new companies were few and far between.

At that time, IFREMER and ARDA (Association for Aquaculture Research & Development) developed an assistance programme for Reunion Island. First, eggs were sent, followed then by larvae for hatching, thus enabling a fish stock to be established. The local hatchery in Mayotte provided the material both for the initial experiments and for an industrial development which began production in 2000 (300 tonnes in 2002).

Reactivating the Production Chain

It is clear that until 2001 there were too few players involved in the sector to enable both rearing and marketing to be carried out. Taken separately, each segment of the sector requires know-how, but the sector can operate only if these segments are well synchronised, which is all too rarely the case.

Therefore, in an effort to simplify operations, IFREMER proposed putting their experience, acquired with ARDA's help, into practice: the Institute has a sizeable breeding stock from several genetic sources and is able to schedule spawning several times a year at precise dates and to supply users directly with larvae for hatching. The taking over of these operations by the Institute allowed the sector to concentrate on the other activities. A test carried out in late 2001 produced almost 120 000 juveniles, a sufficient quantity given the current number of aquaculturists.

In 2002, the test was carried out once more. Six new growing-out enterprises had been established and three larval rearing workshops were in operation. Projections for 2003 point to the creation of four new grow-out enterprises and one new larval rearing facility.

Aquaculture products are highly appreciated on the local market and there have been no marketing problems to date, as the products are backed up by advertising campaigns promoted by the producers.

Technical Know-How

Rearing techniques may be divided into four complementary operations:

- good growth and survival in intensive rearing up to marketing size
- monitoring of juvenile production
- controlled breeding in order to obtain programmed spawning
- sustainable management of breeding stock.

Growth and Survival

Fry growth and survival rates are shown in the table below (Houel et Paquotte, 1996).

Weight obtained (g)	Rearing time (d)	Survival (%)	Stocking density (kg/m^3)
350	158	85	30
800	245	79	30

The growth curve in Figure 2 refers to the first year of rearing (Buchet *et al*, 1999).

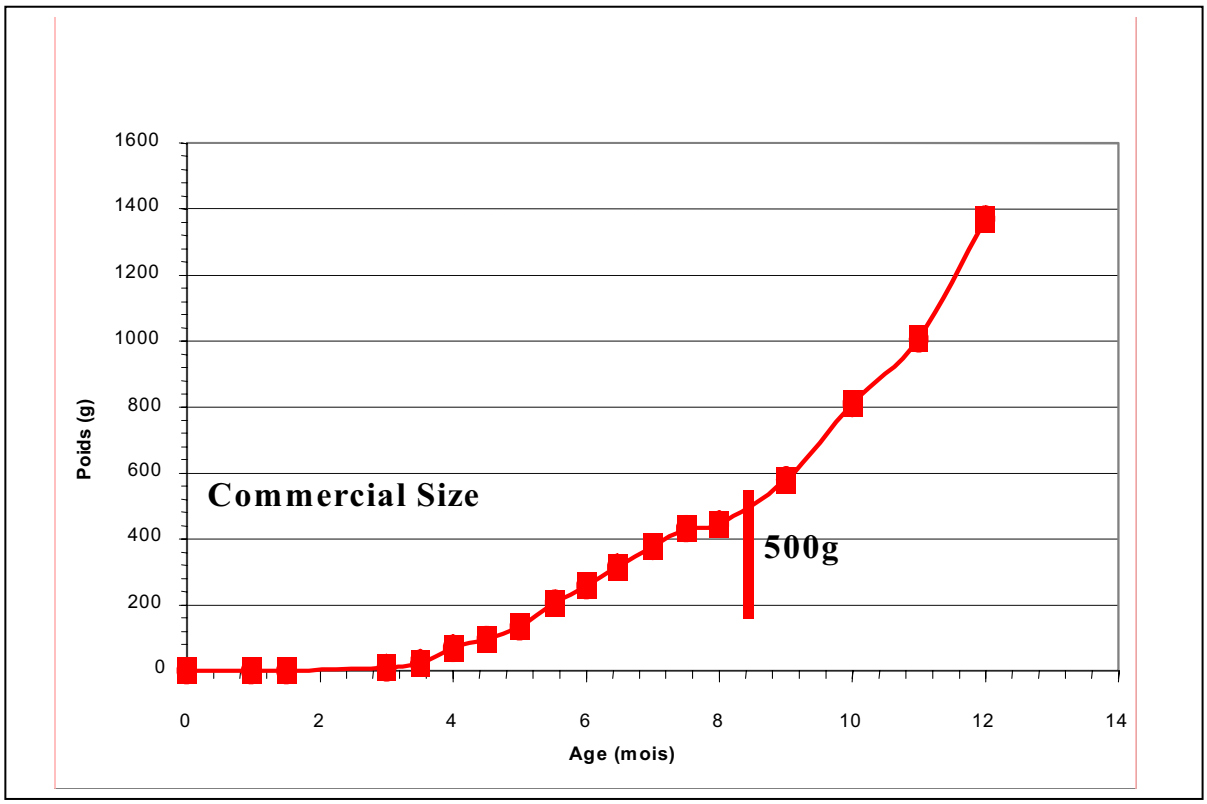

Figure 2. First year rearing growth curve of red drum in Martinique (IFREMER, 2001).

The fish are given industrial feeds, formulated for sea bass (*D. labrax*), but recently modified for red drum. The conversion index is 1.8.

The smallest marketed size (350g) is what is termed "food size". This is the size distributed to restaurants and to some private consumers. The 800 g fish are not as common, but this is the size in greatest demand for family meals and parties. This is also the size preferred by fish farmers as fish of this size are not commonly found in West Indian seafood markets. It also reduces fingerling costs in terms of one kilo of marketed fish - still a very costly item. On the other hand, fish farmers are obliged to retain the fish for longer, which ties up space in the cages and reduces the frequency of fish deliveries to market.

Juvenile Production

The juvenile production technique was developed in the early eighties (Arnold *et al*, 1979, Chamberlain *et al*, 1987). However, this technique had to be modified to suit Martinique's environmental conditions and available technical facilities (Goyard *et al* , 1993). It is updated regularly (Dudognon et Parry, 2002). A summary of the technique is given in Table 1 below.

Table 1. Characteristics of red drum larvae rearing.

Larvae rearing density:	50 to 100/litre	
Feeding:	From Day-2 to Day-12	= rotifers
	From Day10 to Day-18	= artemia
	Weaning from Day-15	
Larvae survival:	10 to 40 % for a juvenile of 2g	
Duration of larval rearing:	50 to 70 days	
Mortality mainly due to:	Cannibalism	

Generally speaking, juvenile production is carried out by hatcheries which monitor the degree of egg ripeness in the breeding stock by means of ovary biopsies. One tank contains both males and females ; the eggs are laid and then fertilised. They float to the surface and can then be easily collected and placed in an incubator.

Martinique's existing facilities can deal with hundreds of thousands of eggs and have the capacity to rear 100 000 to 200 000 juveniles. The final days of rearing are particularly demanding in terms of facilities (200 to 400 kg of fry). These quantities are sufficient for the current level of mariculture, but generate high fry production costs.

Controlling the Breeding Process

Red drum has only one natural breeding season. Depending on the geographical area, the species spawns between August and October, with egg ripening dependent upon environmental conditions, mainly shorter day length and lower water temperature (Arnold *et al*, 1979). The effect of water temperature has been shown to be negligible under local conditions.

The equipment available in the IFREMER station's controlled photoperiod rooms has allowed us to adapt the techniques (Goyard *et al*, 1993). In 1995, the IFREMER station had two separate conditioning rooms (Buchet *et al*, 1999), each comprising one 16 m3 trough with a water recycling device (Figure 3). The current process (Figure 4) is based on constant lighting for 16 hours/day, falling by 5 ½ hours in two months, with a low exposure time of 10½ hours for two further months, during which the ripening process comes to an end and the eggs are laid. At the end of the season, the photoperiod is increased and the fish become sexually dormant for the remainder of the year (Gardes *et al*, 2000).

The IFREMER station was fitted with a third conditioning room in 2001 and can now have three spawning seasons per year.

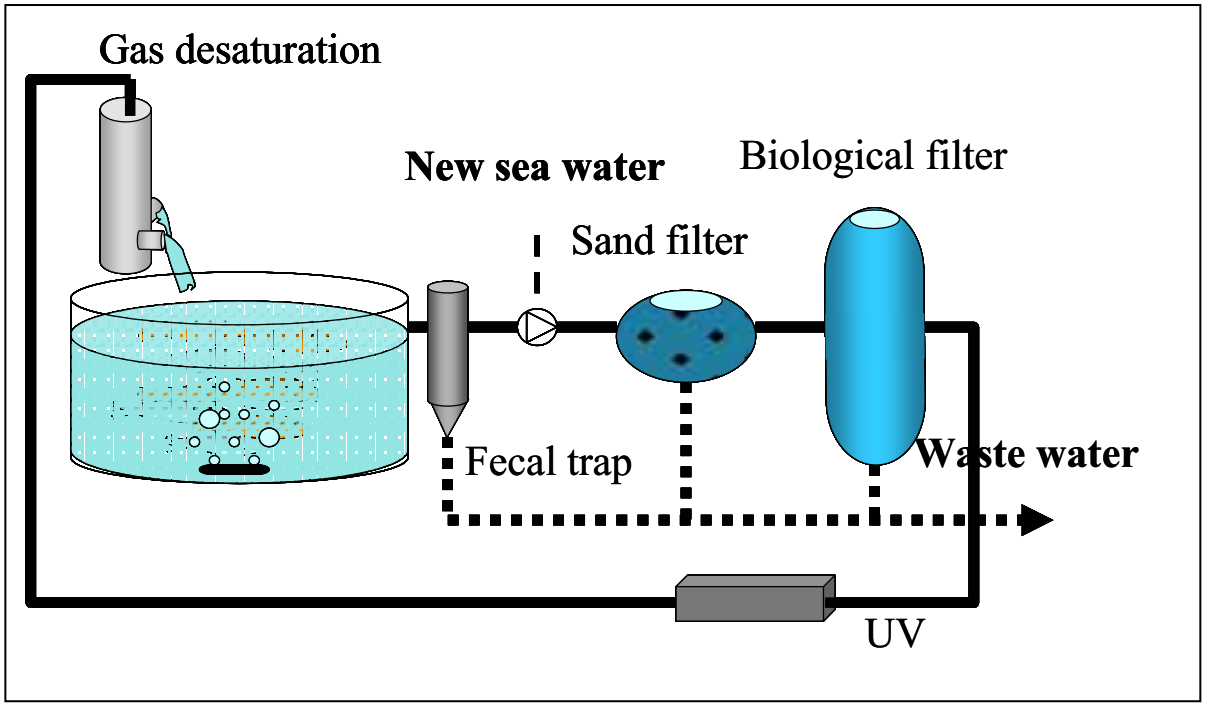

Figure 3. Broodstock conditioning tank under light control.

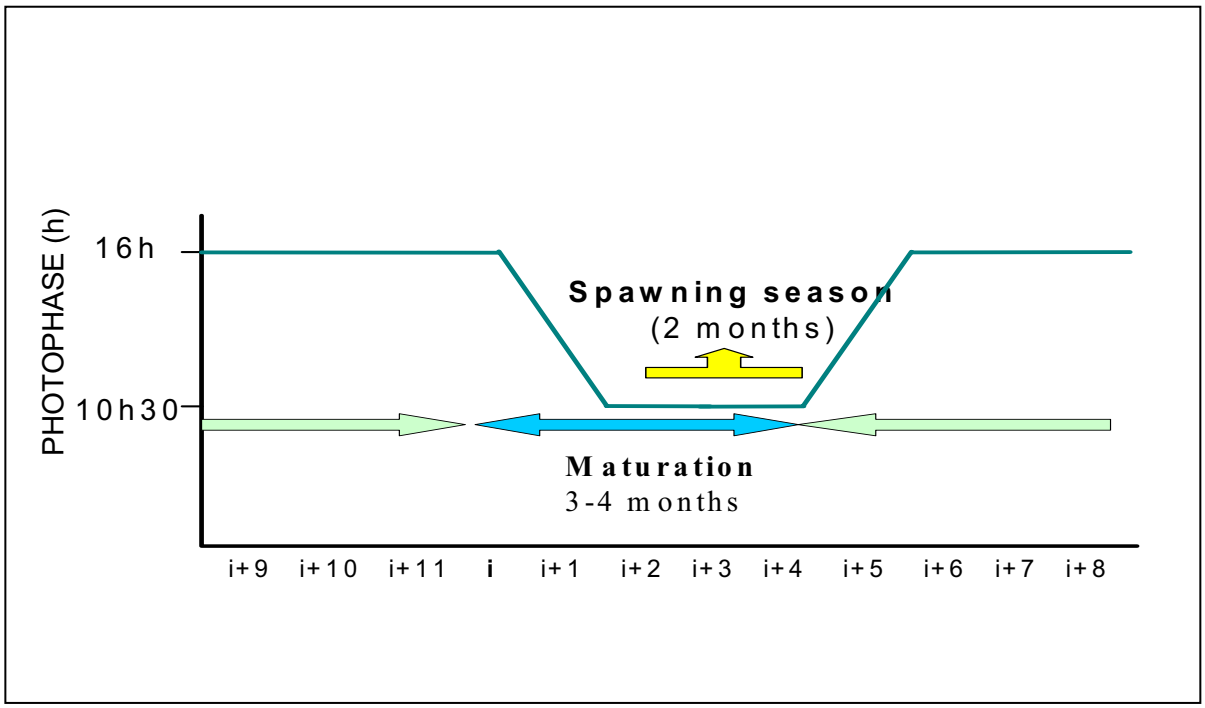

Figure 4. Conditioning cycle of broodstock.

Sustainable management of breeding stock

Since red drum's initial introduction in 1985, followed by further regular introductions in 1987, 1990, 1996, 1998 and 1999, we have not observed breeding in the Martiniquan environment either by fish maturing naturally in cages or by fish that have escaped from the fish farms.

Aquaculture depends, therefore, on having a captive breeding stock and ensuring its sustainability:

- by preventing in-breeding through fish selection;
- by using broodstock derived from different genetic stock.

Spawners are identified individually and fitted with a magnetic tag. Work was carried out in 2001 and 2002 at the IFREMER station with a view to selecting the breeding stock individually and isolating them in pairs (Usache *et al*, 2002). This is the first step towards the establishment of genetic research programmes.

Care must also be taken to prevent the introduction of pathogens. Due to a better understanding of nodavirus and the development of a sensitive screening system, (Lancelot, 2002), the station's red drum larvae have, since 2002, undergone an ELISA test prior to dispatch to the fish farmers.

Development Phases

Mariculture development can be divided into three successive phases (Figure 5).

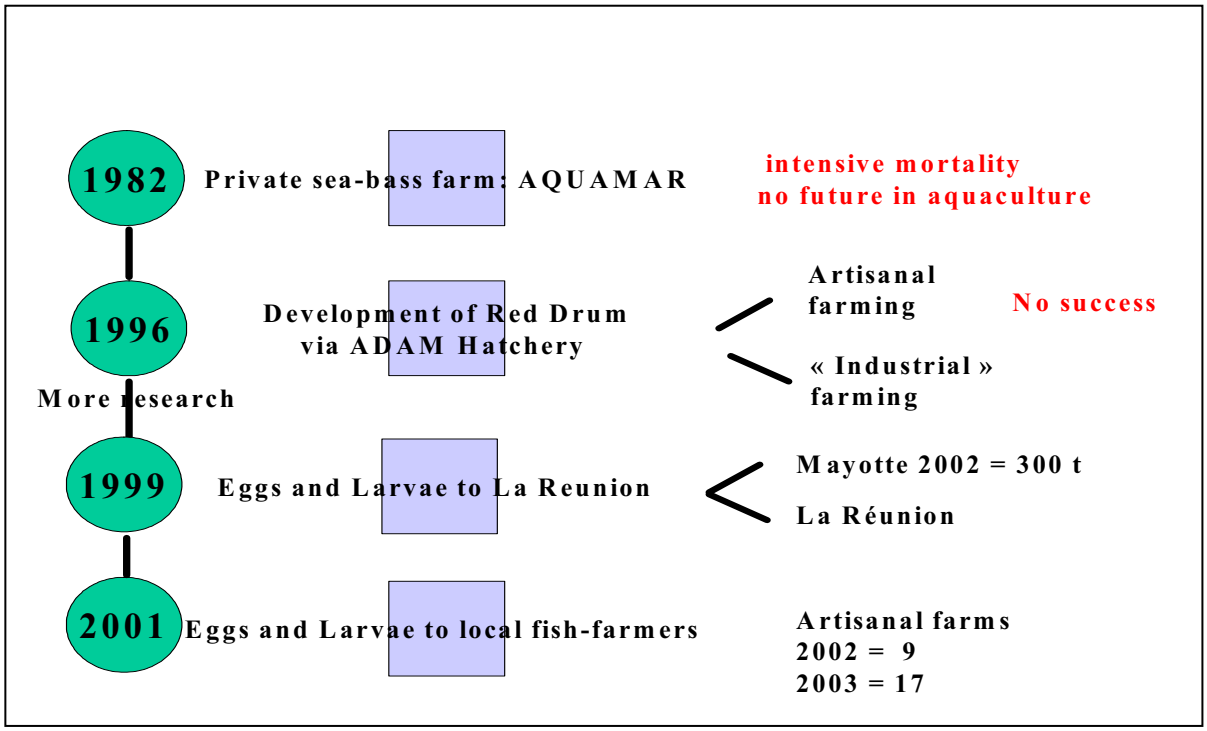

Figure 5. History of fish farming development.

IFREMER's Role

IFREMER's role includes conducting and promoting basic and applied research, as well as taking technical steps to promote the economic development of aquaculture. Consequently, the organisation of the mariculture laboratory was reviewed with a view to using the existing breeding stock to improve knowledge (thematic research), increase the production of eggs and, even more importantly, increase the production of larvae for hatching.

To this end, the fish stock was divided into three separate lots in an effort to achieve spawning three times a year, with the dates decided after discussion with the producers. The composition of the lots was reviewed so as to increase the number of hen fish per pond in 2003, thereby ensuring that the rearing workshops' larvae requirements are met. (Figure 6).

An aquaculturist helped to convert a larval rearing workshop for a small-scale enterprise. The workshop consists of a concreted area between two disused tanks. One tank has been prepared for rearing live prey and the larvae are kept in 800 litre tubs on the concreted area, protected from the light by a canopy. The existing seawater network (pumps, filters and distribution system) was carefully examined. The workshop has already conducted four rearing operations and can now supply the enterprise with juveniles (Figure 7).

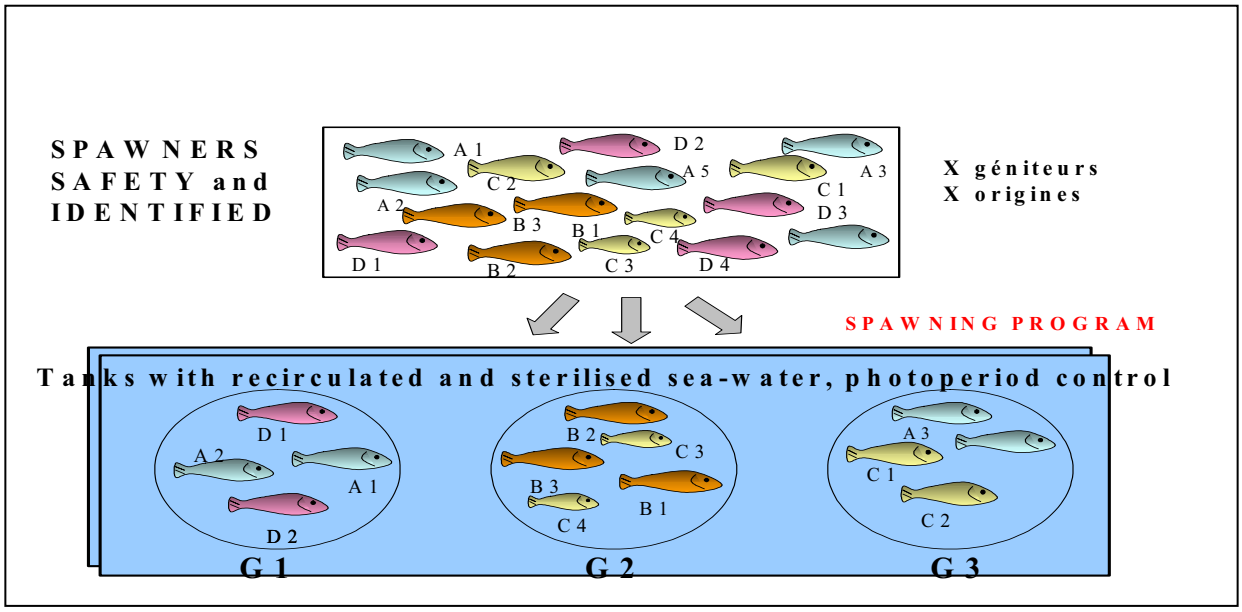

Figure 6. Management of spawning stock.

Figure 7. Artisanal hatchery: Aquanord Caraibes.

Given the risk of viral pathogens as found in red drum farms in the Indo-Pacific, special attention has been paid to health conditions. The breeding stock are kept in closed systems with UV sterilisation of the recycled water, and ELISA tests are carried out on the larvae prior to dispatch to outside workshops (Figure 8).

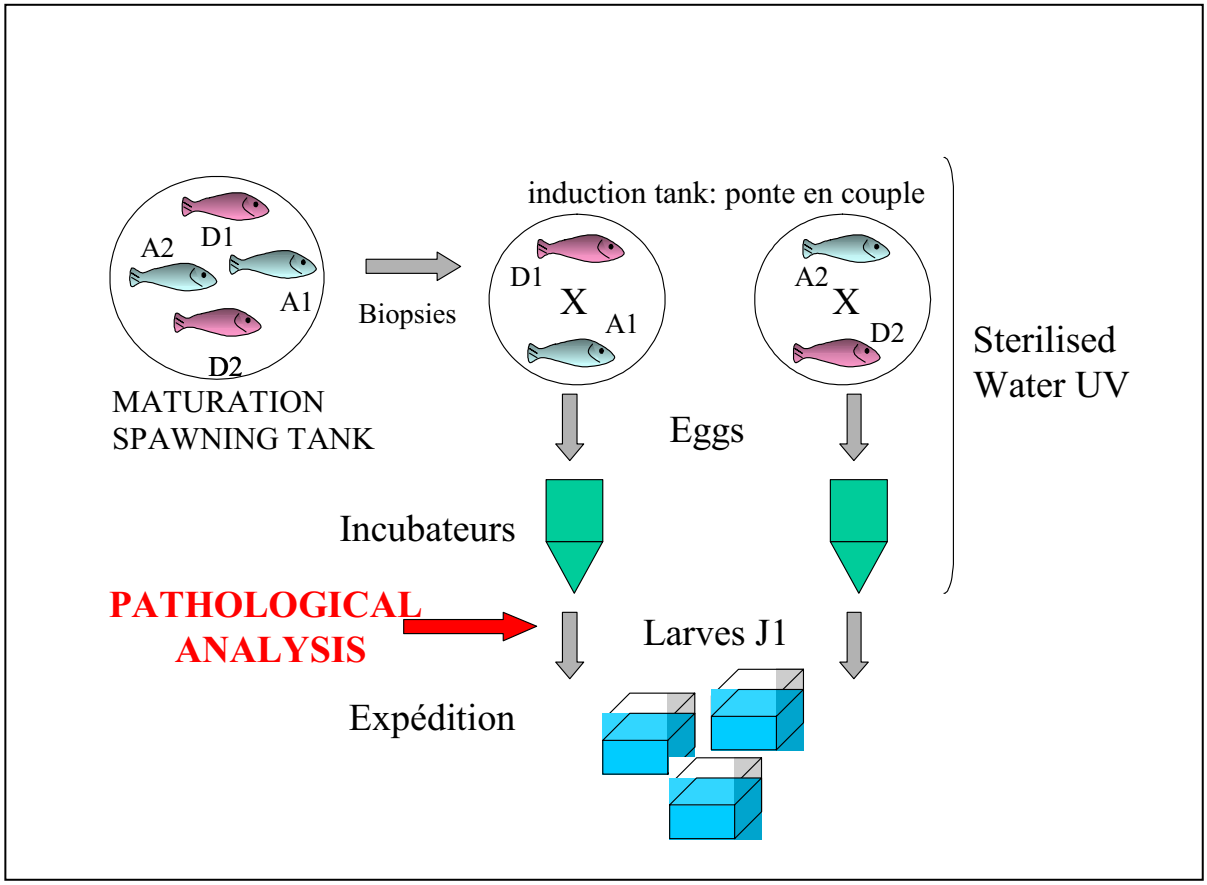

Figure 8. Planning of the spawning process.

Research programmes have attached top priority to breeding physiology. The aim is to control fertilisation between isolated pairs to enable selection of the breeding stock (this reduces the risk of in-breeding in the ponds and helps in the preparation of genetic programmes).

All the operations are to be covered by a protocol, currently being prepared by the producers, Martinique Region and IFREMER. It will apply for a period of 3 years to secure the sector's start-up.

Regional Cooperation

Red drum mariculture is now operational in Martinique. It is a small-scale aquaculture operation largely geared to small family-run enterprises. Initial economic viability calculations suggest a production threshold of about 15 tonnes/year/enterprise under Martinique's socio-economic conditions.

The Martiniquan model deserves to be extended to other Caribbean countries. This model relies on one larval production unit which supplies the enterprises. Product distribution is

easy, transport conditions are well-known and the air transport between the islands is well-developed. The first implementation of this model is starting in Guadeloupe. There, local development may be restricted to larval rearing workshops and grow-out - simple operations of relatively short duration (two months for larval rearing and 5 months for grow-out). A first co-operation trial is planned between Martinique and Cuba.

The prerequisite for technical trials must be a technical/economic feasibility study. Living standards differ from one island to another and there will be wide disparities between the price of materials, labour costs and marketing prices.

A cooperation programme should not only cover the technical aspects of fish farming, but deal with all matters regarding feasibility (administrative constraints, the presence of suitable sites, coastal development options, training for fish farmers and technical and financial assistance

Acknowledgements

Special mention must be made of Martinique Region for its special and sustainable efforts to promote mariculture. IFREMER's research programme in support of the aquaculture sector is co-funded by the Region.

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