



# 5<sup>th</sup> SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture

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Background paper 2

## HoF14 IP12: Assessment of the Aquaculture needs, priorities and future direction in the Pacific Islands Region

Integrated Aquatic Solutions (IAS)

## Executive summary

This Regional Aquaculture Assessment was conducted in response to the stated need of the PICTs to address numerous challenges that continue to deny the Pacific region the long-term benefits that can be derived from the development of sustainable aquaculture. These challenges are limiting the extent of the contribution of the aquaculture sector to employment, food security, livelihoods, environmental protection and economic growth. It is the Pacific aquaculture sector itself that is under assessment, not SPC's delivery of support to members for aquaculture.

The main finding in the Assessment is that the Pacific aquaculture sector has great socio-economic value and economic potential within the PICTs region but remains largely under-developed. There are many reasons for this, and they are not limited only to matters of technical capacity. There is much that can yet be done to improve individual PICTs support for sustainable aquaculture. Regional cooperation offers further opportunities to strengthen the industry.

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis, based upon available information and extensive stakeholder engagement, shows that the strengths and opportunities now existing in aquaculture in the Pacific outweigh the weaknesses and threats. Further, the weaknesses are internal and can be overcome by PICT government intervention and specific actions to create a more enabling governance environment for aquaculture. Regional cooperation offers opportunities to mitigate many of the current threats. One example is the possibility for sub-regional cooperative agreements for the maintenance of quality brood stock and trans-boundary dissemination of seed for selected priority species. Another example is review of legislation to address a general lack of clarity among members about aquaculture governance arrangements, such as to provide clear and timely bureaucratic pathways for establishment of new aquaculture enterprises.

The Assessment highlights the key aquaculture priorities of the PICTs, to the extent reported in interviews with stakeholders and stated in available documents. Lack of capacity remains a fundamental concern, not only in academic understanding of biology but also in on-farm trade skills. There is a need to assess the success of aquaculture projects in a more appropriate way, and to concentrate on methods and species that are known to work. The Pacific aquaculture sector is very data-deficient, affecting planning and investment in the sector. The slow uptake of technological advances in both communications and at farm level needs to be addressed.

Among the immediate needs of PICTs are improvements in capability and capacity, post-harvest quality control, marketing and biosecurity, as well as addressing feed supply and costs.

Identified priority needs include:

1. Capacity Building in technical and policy areas of aquaculture, including regulatory and MCS frameworks
2. Better assessment of feasibility of aquaculture projects and programmes.
3. Concentrate on methods and species known (proven) to work, plus unlock opportunities for “extractive” (unfed), “restorative” (improves the environment) and “climate-smart” (resilient and/or sequesters carbon) forms of aquaculture.
4. Better data collection, storage, analysis & dissemination.
5. Improved equity, and inclusivity for Vulnerable Disadvantaged Groups (Youth, Gender, etc).
6. Regional cooperation needed to overcome common problems and reach critical mass

7. Technology (“T4”) should be more widely adopted.

Whilst COVID has had an effect on every country in the Pacific, and has impacted aquaculture, it would appear that once the pandemic subsides normality will return relatively quickly. The lessons from COVID need to be learned, and the voice of the aquaculture sector must be heard in national planning for future pandemic responses, however there is no immediate action specifically required for aquaculture.

One feature of this Assessment is that views of the aquaculture private sector were actively sought, in addition to those of PICT governments and administrations. Due to COVID restrictions it was not possible to adequately consult with communities engaged in aquaculture about their own special needs, however their needs will to some extent overlap with those of the private sector, whose priority needs include:

1. An improved “enabling environment” for aquaculture enterprise establishment and operations.
2. Improved access to sources of investment, and financial services like insurance.
3. Improved financial literacy, leadership and business skills

The development and implementation of a Regional Aquaculture Strategy will strengthen the capacity of PICTs and the private sector to harmonise their development and investment plans, enhancing their ability to cooperate and trade regionally and with the rest of the world.

Objectives for the Strategy suggested by the Assessment (further elaborated in its Appendix II) provide a broad indication of what a Pacific Regional Aquaculture Strategy could tentatively look like:

- Mainstream aquaculture into the economic and social development agendas of PICTs
- Increase aquaculture production of edible and non-edible aquatic products for income and food security in the commercial, community and small holder subsectors
- Improve capacity and capacity in the aquaculture sector
- Improve biosecurity in the region
- Assess the resilience of aquaculture to climate change and other natural disasters in the region and develop outline plans for mitigating measures.
- Improve market access and supply chains
- Enhance quality of post-harvest product
- Establish regional cooperative institutional frameworks
- Mainstream cross cutting issues such as health, environment and gender in the whole aquaculture value chain throughout the region

## Résumé

L'évaluation régionale de l'aquaculture a été menée à bien pour répondre à la nécessité mise en évidence par les États et Territoires insulaires océaniques de s'attaquer aux nombreux défis qui empêchent toujours la région de tirer profit sur le long terme du développement d'une aquaculture durable. Ces défis limitent la contribution du secteur en matière d'emploi, de sécurité alimentaire, de moyens de subsistance, de protection de l'environnement et de croissance économique. L'évaluation porte sur le secteur aquacole proprement dit, et non sur le soutien apporté aux membres par la CPS en la matière.

La principale conclusion de cette évaluation est que le secteur océanique de l'aquaculture revêt une grande importance sur le plan socioéconomique, qu'il recèle un grand potentiel économique dans le Pacifique insulaire, mais qu'il reste largement sous-développé. Les raisons sont multiples et ne se limitent pas à des questions de capacité technique. Il reste beaucoup de choses à faire pour améliorer le soutien apporté par les États et Territoires insulaires océaniques à l'aquaculture durable. La coopération régionale offre de nouvelles possibilités de renforcer le secteur.

Une analyse SWOT (forces, faiblesses, opportunités et menaces), fondée sur les informations disponibles et une large mobilisation des parties prenantes, démontre que les forces et opportunités qui existent actuellement dans l'aquaculture en Océanie l'emportent désormais sur les faiblesses et menaces. Par ailleurs, les faiblesses sont internes et peuvent être surmontées grâce à l'intervention et aux actions des pouvoirs publics des pays océaniques visant spécifiquement à mettre en place des structures de gouvernance plus propices à l'aquaculture. La coopération régionale permet d'atténuer nombre des menaces actuelles. La possibilité de conclure des accords de coopération sous-régionaux pour le maintien de la qualité du stock reproducteur et la distribution transfrontière de juvéniles pour des espèces prioritaires déterminées en est un exemple. La démarche consistant à revoir les législations pour pallier le manque général de clarté parmi les membres quant aux modalités de gouvernance de l'aquaculture, dans le but notamment de mettre en place des procédures claires et rapides pour la création de nouvelles entreprises aquacoles, en est un autre exemple.

L'évaluation met en lumière les principales priorités des États et Territoires insulaires océaniques en matière d'aquaculture. Ces priorités ont pu être mises en évidence lors des entretiens menés avec les parties prenantes et à la lecture des documents disponibles. Le manque de capacités reste une préoccupation fondamentale, non seulement pour ce qui est de la connaissance théorique de la biologie, mais aussi en ce qui concerne les compétences commerciales au sein des exploitations. Il est nécessaire d'évaluer les résultats des projets aquacoles de manière plus appropriée et de se concentrer sur les méthodes et les espèces dont on sait qu'elles fonctionnent. On dispose de très peu de données sur l'aquaculture en Océanie, ce qui a une incidence sur la planification et les investissements dans le secteur. Il convient de remédier à l'adoption trop lente des avancées technologiques, requises tant pour ce qui est de la communication qu'au sein des exploitations.

Parmi les besoins immédiats des États et Territoires insulaires océaniques, on peut citer l'amélioration des capacités et des moyens, le contrôle de la qualité après la récolte, le marketing et la biosécurité, ainsi que la nécessité de se pencher sur la fourniture et le coût de la nourriture animale.

Les besoins prioritaires définis sont notamment les suivants :

1. renforcer les capacités dans les domaines technique et stratégique de l'aquaculture, y compris en ce qui concerne les cadres réglementaires et de suivi, contrôle et surveillance (SCS) ;
2. mieux évaluer la faisabilité des projets et des programmes aquacoles ;
3. centrer les efforts sur les méthodes et les espèces dont on sait (il est établi) qu'elles fonctionnent et exploiter le potentiel que recèlent les formes d'aquaculture « extractive » (espèces qui ne sont pas nourries), « réparatrice » (qui améliore l'environnement) et « climato-responsable » (résiliente et/ou

- qui piège le carbone) ;
4. mieux collecter stocker, analyser et diffuser les données ;
  5. veiller à offrir aux groupes défavorisés et vulnérables (jeunesse, genre, etc.) plus d'équité et d'inclusivité ;
  6. s'appuyer sur la coopération régionale pour surmonter les problèmes communs et atteindre une masse critique ; et
  7. encourager une adoption plus massive des technologies (« T4 »).

Si la pandémie de COVID-19 a eu des répercussions dans chaque État et Territoire du Pacifique, ainsi qu'une incidence sur l'aquaculture, il semblerait qu'une fois la pandémie passée, la situation reviendrait relativement vite à la normale. Il convient de tirer les leçons de la pandémie de COVID-19 et d'écouter les voix du secteur de l'aquaculture pour ce qui est de la planification nationale des réponses à de futures pandémies. Néanmoins, pour l'heure, aucune action immédiate spécifique n'est requise pour le secteur.

Particularité de cette évaluation : l'avis du secteur aquacole privé a été activement sollicité, en plus de celui des autorités des États et Territoires insulaires océaniques. En raison des restrictions liées à la pandémie de COVID-19, il n'a pas été possible de consulter suffisamment les communautés impliquées dans l'aquaculture au sujet de leurs besoins particuliers, mais ces derniers se recouperont dans une certaine mesure avec ceux du secteur privé. Les besoins prioritaires du secteur privé incluent :

1. un « environnement plus propice » à l'établissement et au bon fonctionnement des entreprises aquacoles ;
2. un accès amélioré aux sources d'investissement et aux services financiers, tels que les assurances ; et
3. des compétences renforcées en matière de gestion financière, d'encadrement et d'entrepreneuriat.

L'élaboration et la mise en œuvre d'une stratégie régionale pour l'aquaculture permettront de renforcer la capacité des États et Territoires insulaires océaniques et du secteur privé à harmoniser leurs plans de développement et d'investissement et, partant, d'améliorer leur capacité à coopérer et à échanger à l'échelle régionale et avec le reste du monde.

L'évaluation a permis de mettre en évidence une série d'objectifs (développés à l'annexe II), qui dessinent les contours possibles d'une stratégie régionale océanique de développement de l'aquaculture :

- Intégrer l'aquaculture aux programmes de développement économique et social des États et Territoires insulaires océaniques ;
- augmenter la production aquacole de produits aquatiques comestibles et non comestibles aux fins de la sécurité économique et alimentaire dans les sous-secteurs (production commerciale, production locale, petits exploitants) ;
- renforcer les capacités et les moyens dans le secteur aquacole ;
- améliorer la biosécurité dans la région ;
- évaluer la résilience de l'aquaculture face au changement climatique et aux autres catastrophes naturelles dans la région, et mettre au point des plans contenant des mesures d'atténuation ;
- améliorer l'accès aux marchés et les chaînes d'approvisionnement ;
- améliorer la qualité des produits après récolte ;
- établir des cadres institutionnels de coopération à l'échelle régionale ; et
- prendre systématiquement en compte les questions transversales, telles que la santé, l'environnement et le genre, dans toute la chaîne de valeur de l'aquaculture à l'échelle océanique.



## **SPC FAME**

Assessment of the aquaculture needs, priorities and future direction in the Pacific Islands region

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Appendix V Terms of reference**Erreur ! Signet non défini.**



## 1. DEFINITIONS

**Aquaculture:** The farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated.

**Aquatic plant** – means any kind of plant, algae or other plant organism farmed in fresh water or the sea or on the seashore;

**Brackish Water Culture:** The cultivation of aquatic organisms where the end product is raised in brackish water; earlier stages of the life cycle of these species may be spent in fresh or marine waters. Brackish waters are characterized by large seasonal fluctuations in salinity.

**Depuration:** The act of purifying, clarifying or cleansing water associated with marine, brackish and freshwater organisms. Depuration of seafood is the process by which marine or freshwater animals are placed into a clean water environment for a period of time to allow purging of biological contaminants (such as *Escherichia coli*) and physical impurities (such as sand and silt).

**El Niño & La Nina:** El Niño is a climate pattern that describes the unusual warming of surface waters in the eastern tropical Pacific Ocean. La Nina is a pattern that describes the unusual cooling of the region's surface waters.

**Extensive Aquaculture:** Organisms cultured at low densities, dependent on natural productivity for food but possibly assisted by fertilization of the substrate. Characterized by small-scale fish farming in individual ponds that are commonly rain-fed or supplied with running water. Requires low management input and is usually focused on subsistence.

**Fish:** For the purposes of this document fish means any aquatic plant or animal whether piscine or not, and any mollusc, crustacean, coral, sponge, holothurian or other echinoderm, and includes their eggs, larvae and all juvenile stages.

**Freshwater Culture:** The cultivation of aquatic organisms where the end product is raised in freshwater; earlier stages of the life cycle of these species may be spent in brackish or marine waters.

**Intensive aquaculture:** Organisms cultured at high densities and dependent on artificial feed for their nutritional requirements, these are commercial operations.

**Mariculture:** The cultivation of aquatic organisms where the end product is raised in seawater; earlier stages in the life cycle of these aquatic organisms may be spent in brackish water or freshwater.

**Semi-intensive Aquaculture:** Organisms cultured at higher densities than are found in extensive culture; dependent on both increased productivity, using fertilizers and waste resources, and supplemental artificial feed. Characterized by production in earthen ponds with increased management inputs (e.g., manipulating water flow to provide oxygen and maintain water quality) and the supplementing of natural foods with artificial feeds; usually focused on crops of higher value, possibly to target local market demand.

**Stock enhancement:** means the release of cultured juveniles into wild population(s) to augment the natural supply of juveniles and optimize harvests by overcoming recruitment limitation.

## 2. ABBREVIATIONS AND ACRONYMS

ACP	Africa, Caribbean and Pacific
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AusAID	Australian Government Aid
BMP	Best Management Practices
CFAP	Coastal Fisheries Aquaculture Programme
CI	Conservation international (an NGO)
CITES	Convention on International Trade in Endangered Species
CNMI	Commonwealth of the Northern Marianas Islands
COFI	Committee on Fisheries, a subsidiary body of the FAO Council
COP	Code of Practice
CTSA	Centre for Tropical and Sub Tropical Aquaculture
EIA	Environmental Impacts Assessment
ESIA	Environmental and Social Impacts Assessment
EU	European Union
FAME	Fisheries, Aquaculture & Marine Ecosystems - SPC
FAO	Food & Agricultural Organization (of the UN)
FFA	Forum Fisheries Agency
FSM	Federated States of Micronesia
Genome	An organism's genetic material
GHP	Good Hygiene Practices
GIFT	Genetically Improved Farmed Tilapia
GLP	Good Laboratory Practices
GM	Genetically Modified
GMP	Good Manufacturing Practice
HACCP	Hazard and Critical Control Point
HoF	Heads of Fisheries (Meeting)
IFAD	International Fund for Agricultural Development
ILO	International Labour Organisation
IOE	World Organisation for Animal Health
JICA	Japan International Cooperation Agency
MASA	Micronesian Association for Sustainable Aquaculture
MCS&E	Monitoring, Control, Surveillance & Enforcement
MFAT	Ministry of Foreign Affairs – New Zealand
MPA	Marine Protected Area
NBS	Nature Based Solutions
NFA	National Fisheries Authority (PNG)
NGO	Non-Governmental Organisation
OFCF	Overseas Fisheries Cooperation Foundation
PICT's	Pacific Islands Countries and Territories
PLs	Post larvae
PNA	Parties to the Nauru Agreement
PNG	Papua New Guinea

PRC	Peoples Republic of China
R & D	Research & Development
RAS	Recirculating Aquaculture Systems
RMI	Republic of the Marshall Islands
RTMCFA	Regional Technical Meeting on Coastal Fisheries and Aquaculture
SDG	Sustainable Development Goal
SOP	Standard Operating Procedure
SPC	Pacific Community
SPREP	Pacific Regional Environment Programme
SPF	Specific Pathogen Free
SWOT	Strengths, Weaknesses, Opportunities, Threats
T4	The 4 <sup>th</sup> Industrial Revolution. Technology
TA	Technical assistance
TNC	The Nature Conservancy (an NGO)
TOR	Terms of Reference
UN	United Nations
UoG	University of Guam
UNEP	United Nations Environmental Programme
UNFSS	United Nations Forum on Sustainability Standards
UPNG	University of Papua New Guinea
USAID	United States Agency for International Development
USP	University of the South Pacific (in Fiji)
WB	World Bank
WHO	World Health Organisation

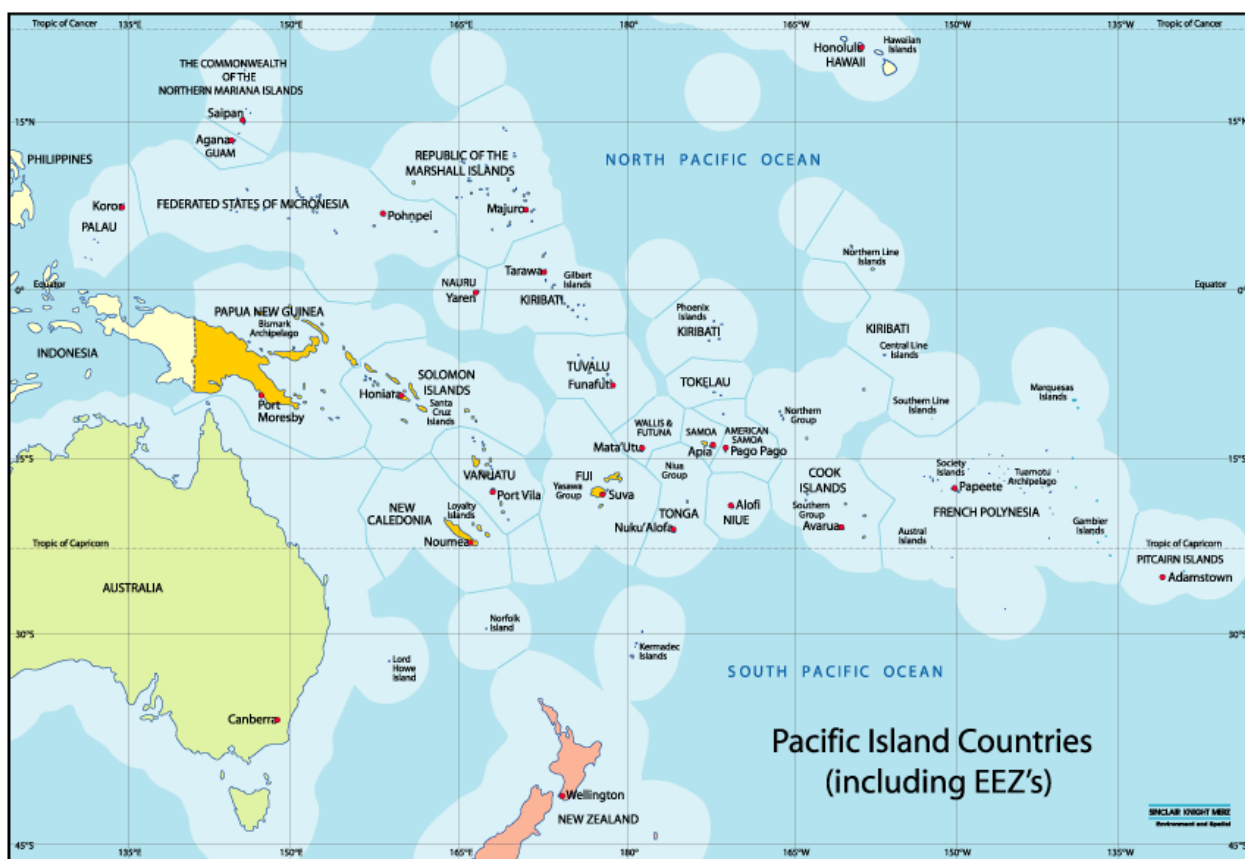
### 3. ACKNOWLEDGEMENTS

The IAS consultant team of Mr. Stephen Lindsay, Mr. Robert Lindley, Ms Michelle Lam and Mr Hugo Lassauce and would like to thank the more than 60 people consulted through video and phone interviews during the preparation of this review study. These informants have provided much of the material that has provided the information forming the basis for recommendations on the future strategy in the region.

Special thanks are also due to the SPC FAME Aquaculture Section staff who provided valuable support and guidance throughout the study.

### 4. MAP

Map of Pacific PICTs



(Map from SPC)

## **5. EXECUTIVE SUMMARY**

This document was conceived out of the commonly expressed need of the PICTs to address the numerous challenges that continue to deny the Pacific region the long term benefits that can be derived from the development of sustainable aquaculture. These challenges are limiting the extent of the contribution of the aquaculture sector to employment, food security, livelihoods, environmental protection and economic growth.

Aquaculture has great socio-economic value<sup>1</sup> and economic potential within the PICTs region but remains largely under-developed. There are many reasons for this and they are not just technological in origin, since much could be done to improve individual PICTs support for aquaculture, and regional cooperation offers further opportunities to strengthen the industry.

A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis (See Section 8) has been produced using available information and extensive stakeholder engagement. The conclusion derived from the analysis is that the strengths and opportunities now existing in aquaculture in the Pacific outweigh the weaknesses and threats; in that the weaknesses are internal and can be overcome by PICT government intervention and specific actions, and that regional cooperation can mitigate many of the current threats. It should therefore be possible to take advantage of the opportunities available.

This report also highlights the key aquaculture priorities of the PICTs as far as was reported in interviews with stakeholders and in recent reports by the SPC and other regional development partners. Capacity<sup>2</sup> remains a fundamental concern, as is the need to assess the success of aquaculture projects in a more appropriate way and concentrate on methods and species that are known to work. Data collection is also noted to be poor, affecting planning and investment in the sector whilst regional cooperation on many matters is a priority requiring immediate action. Finally the slow uptake of technological advances in both communications and at farm level needs to be addressed.

Among the immediate needs of PICTs are improvements in capability and capacity, post harvest quality control, marketing and biosecurity, as well as addressing feed supply and costs.

Whilst COVID has had an effect on every country in the Pacific, and has impacted aquaculture, it would appear that once the pandemic subsides normality will return relatively quickly. The lessons need to be learned but there is no immediate action specifically for aquaculture required.

The implementation of a regional strategy will strengthen the capacity of PICTs and the private sector to harmonise their development and investment plans, enhancing their ability to cooperate and trade regionally and with the rest of the world. Suggested objectives are

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<sup>1</sup> Including amongst others, food security, livelihoods, and better nutrition

<sup>2</sup> Educated people are in abundance but only have the government sector and academia to turn to, or else emigration. These educated people thus do not have a chance to develop the practical skills which are required for aquaculture.

presented in a table with the results of achieving these objectives listed.

A brief section shows how the consultative process for developing a regional strategy for aquaculture could be implemented. Primary and secondary stakeholders are identified, and also the process within the PICTs and regionally to achieve an agreed strategy.

The process of developing the regional strategy begins with a comprehensive range of consultations, particularly with the primary stakeholders (those that are directly affected by aquaculture), and a series of steps are given to achieve acceptance by PICTs, including regional meetings and the validation process. As suggested in the TORs (Appendix V), the priority objectives are presented with possible responses providing a model to show what a regional strategy might look like (Appendix II).

The Appendices cover: a review of current aquaculture in the PICTs, potential priority objectives and responses, the people contributing to the study, documents consulted and the Terms of Reference

## 6. INTRODUCTION

Aquaculture is expanding very quickly worldwide, and now aquaculture production exceeds that from marine capture fisheries.<sup>3</sup> Most of this increase in production is in Asia, in fish such as milkfish and in seaweeds, though there are regions outside Asia, such as Egypt, for Tilapia, Ecuador, for shrimp, and Europe and the Mediterranean, for salmon, bream and sea bass, where large amounts of aquaculture products are produced for local and export markets, with production continually rising. This has been achieved through diversification, intensification, technological innovation, multi-trophic integration, industrialization and advances in genetics, nutrition, husbandry and fish health management.

The past decade has seen major progressive strides, and in general, the industry has become more conscious of the impacts of aquaculture on aquatic ecosystems and the need for regulatory frameworks that promote environmental responsibility, commodity sustainability and the protection and management of biosecurity. The failure to have done this is a constraint to investment, as is the slow rate of progress to address bottlenecks caused by tenure systems on land and in coastal areas.

While global demand for fish is increasing, the supply from capture fisheries has stagnated over the last decade, with some regions showing signs of reduction. Even with improved management practices and benign climate change no major increases can be expected from the world's capture fisheries in the immediate future. Thus, it is internationally accepted that the global and regional demands for fish will have to be fulfilled through aquaculture.

Due to increasing demand, declining domestic fishery production and insufficient production from aquaculture, a growing share of protein consumed in the Pacific Islands Countries and Territories (PICTs) consists of imports. It is for this reason that aquaculture as an important food production sector is recognised in the region and the need to advance commercial aquaculture and to transform small-scale, and community based aquaculture into vibrant fish producing sectors.

In the Pacific region aquaculture has also grown over the last 30 years, but at a considerably lower pace as in neighbouring regions, especially Asia. Nevertheless the Pacific region have developed a number of successful aquaculture commodities. In French Polynesia for instance, black pearl (*Pinctada margaritifera*) has been the largest export for many years, and the value of its production exceeds the value of all other aquaculture in the PICTs. Similarly a relatively small shrimp industry (based on *Penaeus stylirostris*) in New Caledonia is also a highly valuable export industry. Both of these are high value and are cultured at relatively low volumes. Seaweed, predominately the red alga *Kappaphycus alvarezii*, on the other hand has also become important for some coastal communities in the Pacific, but is a low value bulky product which suffers from transport difficulties and costs. Onshore there have been advances in Nile tilapia (*Oreochromis niloticus*) and freshwater prawn (*Macrobrachium rosenbergii*) culture for income and food security, particularly in Melanesia, and the introduced freshwater rainbow trout

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<sup>3</sup> FAO. 2020. The State of World Fisheries and Aquaculture 2020. Sustainability in action. Rome.

(*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) are well established in the highlands of Papua New Guinea (PNG). Most of the other successfully aquacultured products are for the aquarium trade (e.g. giant clams and hard corals), or on a very small scale.

Research continues and new species and methods are constantly being examined, and tested for viability throughout the PICT's.

There are also a series of threats and opportunities (see SWOT analysis below) that have been identified to aquaculture in the PICT's region, both by this study through interview and in and previous published studies and literature. some of which require an urgent response over the next few years.

## **7. BACKGROUND TO THE STUDY**

The Pacific Community (SPC) Fisheries, Aquaculture and Marine Ecosystems (FAME) Division commissioned this report so as to identify possible future directions of Aquaculture in the PICT region, ultimately so as to be able to produce in the next few years an overarching regional policy document to be agreed by the PICTs, that will identify a common approach to the sustainable development of aquaculture. (see Appendix V for TORs).

The methodology for this report included: conduct an extensive review of the literature on the activities of PICT countries in aquaculture; identify any technical advances where they are relevant to Pacific region aquaculture, and; determine trends that will be important to aquaculture in the region in the next few years. In addition extensive contact was made with PICT government staff and commercial aquaculturalists to assess the present situation in aquaculture, their needs and comments on the future direction of aquaculture in the region. In total 20 PICT countries were surveyed, covering 21 government aquaculture agencies and institutions, 9 commercial operators and 5 from outside the industry, totalling 68 stakeholders. (See Appendix IV for the list of people consulted and Appendix III for the list of documents consulted).

This document therefore coalesces together the specific needs and requirements of the PICTs administrations and the commercial sector garnered from interviews and e-mail exchanges, and the numerous other externalities including biosecurity, climate change, overarching documents, agreements and treaties that affect aquaculture in the region, together with likely advances in aquaculture technologies (Aquaculture "T4") which will affect the future direction of aquaculture in the region. This information has been used to prepare a path to producing a regional strategy for consideration, together with an example of what it might look like, to guide the future directions of aquaculture, and activities in the region.

## **8. SWOT ANALYSIS. PACIFIC AQUACULTURE**

Given the developmental and economic diversity of PICTs it is challenging to undertake an analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) of aquaculture for the region. However, using recent reports, and information provided by interviewees in the donor, commercial and government sectors during this assessment, it has been possible to draw up a detailed SWOT analysis.



It should be observed that some of the strengths, weaknesses, opportunities and threats do not necessarily prevail everywhere in the region; noting particularly the large landmass countries compared to the atolls and small high islands.

This SWOT analysis will have to be refined during the consultation process for the preparation of the regional strategy, since consultation since the beginning of COVID has concentrated on government departments, donors and large scale commercial producers, and not covered the smaller producers. The SWOT analysis will be different for high islands and atolls, and for those with a large land area and those without.

The conclusion drawn from this SWOT analysis is that the strengths and opportunities for aquaculture overall in PICTs outweigh the weaknesses and the threats, given that the weaknesses are internal and can be overcome by governments assisted by donors and regional organisations, particularly if a regional approach is adopted to solve them.

Many of the threats can also be mitigated against through improved regional cooperation and planning.

Strengths (Internal)	Weaknesses (Internal)
<ul style="list-style-type: none"> <li>• Land and coastal topography in many PICTs provide good areas for coastal cage culture and land based saltwater, brackish and freshwater aquaculture.</li> <li>• Conducive climatic conditions for farming a variety of species - Tilapia species, sea bass, siganid's (rabbit fish), baitfish, groupers, snappers and other marine fish species. Also invertebrates such as oysters for pearls and food, giant clam, corals, marine and freshwater prawns, mud crabs, sea cucumber and seaweeds.</li> <li>• A rich choice of potential aquaculture candidate species, both invertebrate and vertebrate.</li> <li>• Strong market for fish throughout the Region.</li> <li>• Aquaculture products can reduce the reliance on imported protein and carbohydrates leading to better health outcomes and less imports.</li> <li>• A reasonably long history of aquaculture in some PICTs.</li> <li>• Political &amp; public support for aquaculture development in most PICTs and strong support from regional and global bodies.</li> <li>• A good history of co-operation between PICTs on many issues (not only aquaculture).</li> <li>• Donor partner support for aquaculture.</li> <li>• Fiscal incentives and financial support for aquaculture in some PICTs.</li> <li>• Extensive network of government research centres in PICTs.</li> <li>• An emerging technical skills base.</li> </ul>	<ul style="list-style-type: none"> <li>• Shortage of certain core skills, which is widespread in both the private and government sectors, and not limited to Aquaculture (Quarantine, CITES, law, policy making etc).</li> <li>• Lack of familiarity with the technology and basics of running a business such as raising quotes from overseas suppliers, maintenance and installation of equipment etc. This training is not part of most aquaculture techs repertoire.</li> <li>• Regulatory frameworks that do not encourage, provide-for, or explicitly contemplate commercial aquaculture development in some PICTs.</li> <li>• Limited number of adequately trained research, extension and development staff.</li> <li>• Inadequate training in the commercial sector.</li> <li>• Poor skills and capacity in the small scale sector.</li> <li>• Data on aquaculture in the region is generally very poor, affecting decision making.</li> <li>• Inadequate scientific and technical cooperation among PICTs, which result in a lack of knowledge sharing.</li> <li>• Incomplete regional cooperative regulatory framework.</li> <li>• Insufficient support or understanding for aquaculture in some Government departments, inhibiting sustainable development.</li> <li>• Emphasis on offshore fisheries in many PICTs fisheries ministries/departments at the expense of aquaculture (and inshore fisheries).</li> <li>• Slow commercialisation of small scale and community based aquaculture.</li> <li>• Lack of understanding of aquaculture sector by financial institutions, leading to reluctance to</li> </ul>

<ul style="list-style-type: none"> <li>• Existence of fish and invertebrate hatcheries in most PICTs.</li> <li>• Institutions such as University of the South Pacific (USP), University of Papua New Guinea (UPNG), University of Guam (UoG) already exist and support the sector.</li> </ul>	<p>provide finance to the sector.</p> <ul style="list-style-type: none"> <li>• Weak research support structures for small scale and community-based aquaculture in most PICTs.</li> <li>• Land and coastal areas ownership issues restricting aquaculture development.</li> <li>• Weak extension services for small scale and community based aquaculture.</li> <li>• Poorly resourced state hatcheries.</li> <li>• No clear guidelines for use of coastal and freshwater (e.g.: Zoning) in many PICT's.</li> <li>• Inadequate development strategies for commercial aquaculture.</li> <li>• Staff of Fisheries and Aquaculture Departments not "commercial" nor "strategic" thinkers, limited training and capacity.</li> <li>• There are very few "aquaculture visionaries" in government.</li> <li>• Poorly conceived government research &amp; development projects.</li> <li>• Government and donors have complex procurement systems which delay activities.</li> <li>• Despite rich choice of potential aquaculture species, relatively few match established global markets for successfully domesticated and internationally traded aquaculture commodities</li> <li>• Concentration on "introduction and transfers" where there are other important biosecurity concerns that are not looked at.</li> <li>• Biosecurity concerns sometimes unfounded and hinder aquaculture.</li> <li>• Insufficient and inefficient hatcheries for development and transformation of small scale &amp; community based aquaculture.</li> <li>• Poor or non-existent local feed supply due to too few regional feed producers.</li> <li>• Seed supply for small scale, community based aquaculture almost totally dependant on government and aid donor support.</li> <li>• Scarcity (absence) of appropriate aquaculture insurance schemes particularly for those areas in cyclone/typhoon prone areas.</li> <li>• Expense of aquaculture insurance compared to agriculture</li> <li>• Lack of regional training courses in aquaculture at tertiary institutions in the region.</li> <li>• Weak cooperation and collaboration between public and private sectors.</li> <li>• Possibility of environmental pollution by high intensity aquaculture systems.</li> <li>• Within one country interstate or island rivalry reducing internal cooperation on aquaculture.</li> <li>• A hiatus in private sector investment in</li> </ul>
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	<p>aquaculture and associated enterprises.</p> <ul style="list-style-type: none"> <li>• Conflict with other sectors regarding use of coastal marine, land and (fresh) water environments.</li> <li>• Most small scale aquaculture in the Pacific is uneconomic if measured in \$\$ terms.</li> </ul>
Opportunities (External)	Threats (External)
<ul style="list-style-type: none"> <li>• “Healthy eating” includes many aquaculture products.</li> <li>• Access to international funding sources can possibly be further developed. (Blue economy, Blue bonds, BINGOs, philanthropic foundations etc).</li> <li>• Aquacultured protein seen as more efficient than on-land meat production.</li> <li>• Decline in capture fisheries regionally and globally making aquaculture more economically viable.</li> <li>• Fish seen as a healthy alternative to land based sources of animal red meat.</li> <li>• High food conversion ratio for aquaculture compared to beef, pork or chicken production</li> <li>• Growing demand for fish and fish products regionally and globally.</li> <li>• Land based agriculture offers opportunities for innovative local feed inputs for aquaculture.</li> <li>• Linkages with capture fisheries (ranching, stock enhancement, re-seeding of invertebrates).</li> <li>• Ongoing development of innovative production technologies.</li> <li>• Possibility of linkages with large aquaculture enterprises in Asia.</li> <li>• Regional and international markets expanding.</li> <li>• New international trends towards emphasis on “extractive” aquaculture (filter-feeders, seaweeds) favours Pacific region</li> <li>• Rising regional and global aquatic products prices.</li> <li>• Some aquaculture systems resilience against climate change.</li> <li>• Some PICTs have strong tourist industries which consume and purchase the products of aquaculture.</li> <li>• Ability to integrate aquaculture with solar and wind energy production.</li> <li>• Development of T4, technology to improve farming systems, security and data collection.</li> <li>• Improved technology assisting knowledge transfer.</li> <li>• Adoption of Recirculating Aquaculture</li> </ul>	<ul style="list-style-type: none"> <li>• High and variable input costs including equipment.</li> <li>• High transportation costs and irregular links leading to expensive imported feed and disruptions to value chains.</li> <li>• Extended periods of high energy prices.</li> <li>• Brain drain of aquaculture research and development (R&amp;D) human resources.</li> <li>• Climate change including sea level rise, rising temperature and increased serious weather events (Cyclones, drought, heavy rainfall etc).</li> <li>• Other natural disasters such as volcanoes, earthquakes and tidal waves affecting coastal and land based operations.</li> <li>• Competition with cheap fish and fish products imports.</li> <li>• Competition from by-catch and reject fish from canning and loining operations undercutting prices for the products of aquaculture</li> <li>• (For aquarium fish &amp; corals) Captive breeding &amp; rearing of the same species in purchasing countries.</li> <li>• Cheaper RAS culture of valuable export species in purchasing nations.</li> <li>• Diminishing competitive advantage of the region compared to Asia.</li> <li>• Disease threats from escapes from high intensity aquaculture systems.</li> <li>• “Do not care” attitude by airlines to the requirements live exports (notably the aquarium trade).</li> <li>• Accidental introduction of exotic species (ballast water, contaminated feeds).</li> <li>• New cheaper protein sources against which it will be difficult to compete (plant-based seafood analogs, cell-cultured seafood &amp; meats).</li> <li>• Pollution &amp; environmental degradation.</li> <li>• Adoption of restrictive rules regarding ethical treatment and against cruelty to animals (aquacultured) that increase costs.</li> </ul>

<p>Systems (RAS) where land is in short supply and/or high value.</p> <ul style="list-style-type: none"> <li>• Upsurge in investor interest in aquaculture.</li> </ul>	
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## 9. KEY AQUACULTURE PRIORITIES IN THE PICTS

The Terms of Reference (TOR) (See Appendix V) call for the key aquaculture priorities to be identified from the document search and the information gained by discussions with government and the commercial sector in the PICTs.

In a questionnaire sent out by the SPC FAME Coastal Fisheries, Aquaculture Programme (CFAP) in 2021, PICTs were asked to list their aquaculture technical issues, challenges and priority needs. The report on the survey<sup>4</sup> showed a broad range of needs, issues and technical challenges. The results of this survey have been noted, along with the responses of those interviewed during this study.

The FAME business plan<sup>5</sup> gives its objectives for aquaculture as;

- Enhance regional and national policy, planning, Monitoring, Control, Surveillance and Enforcement (MCS&E) and legislation in the aquaculture sector;
- Provide technical and analytic support for aquaculture to support production and economic sustainability; and
- Enhance the management of aquatic bio-security risks.

FAME is currently drafting a new business plan for 2022-2027. In the new draft business plan, aquaculture cuts across most of the objectives and Key Result Areas

The FAME 2014 report on the study of Aquaculture potential in the Pacific<sup>6</sup> gives;

- Support aquaculture input supply: Seed is a key constraint in most hatcheries which are often government run and have often underperformed. Strategies for seed production in hatcheries need to be better defined and better equipped. On the other hand feed is also a major constraint and there is an absence of locally produced feed that is affordable in price.
- The need for locally produced versus imported feed needs to be determined.
- Support good governance in terms of policies, legislations, development and management plans. Absence of good governance is said to slow development in aquaculture.
- Provide appropriate socioeconomic assessments.
- Strengthen aquaculture statistics and data bases.

<sup>4</sup> [https://www.spc.int/DigitalLibrary/Doc/FAME/Meetings/RTMCF/4/RTMCF4\\_IP03\\_EN.pdf](https://www.spc.int/DigitalLibrary/Doc/FAME/Meetings/RTMCF/4/RTMCF4_IP03_EN.pdf)

<sup>5</sup> SPC FAME. 2021. Division of Fisheries, Aquaculture and Marine Ecosystems - Business Plan 2016-2021. Version 3.2 Jan 2021. SPC FAME

<sup>6</sup> Amos M, Garcia R, Pickering T & Robert Jimmy. 2014. Study on the Potential of Aquaculture in the Pacific. ACP-EU Technical Centre for Agricultural and Rural Co-operation (CTA) Secretariat of the Pacific Community (SPC), Noumea August, 2014

- Strengthen aquatic biosecurity: Pacific does not have a tradition of aquaculture whereby local species have been domesticated. Suitable species for aquaculture have to be introduced from elsewhere. To protect the biodiversity of the region, there is a strong need for responsible practices and regional capacity in biosecurity is very limited.
- Provide responsible access to genetically improved<sup>7</sup> fish varieties for aquaculture.
- Further research on indigenous species with aquaculture potential.
- Focus efforts upon promoting the high-priority species (do not develop too many species at once).
- Build capacity of aquaculture staff and practitioners, including training exchanges such as inter- African – Caribbean and Pacific (ACP collaboration) and European (EU)-ACP collaboration, while accepting that high staff turn-over is a fact of life in Pacific administrations.
- Improve aquaculture infrastructure, especially to meet national responsibilities in brood stock management, to provide bio-secure facilities for quarantine, and to support fledgling private sector with aquaculture inputs (seed, feed).
- Strengthen capacity of aquaculture associations or organizations to support their sector: there is a need to provide critical mass of competent personnel.
- Private sector development and up-scaling of production from research phase to commercial phase.
- Provide opportunities to access finance for aquaculture projects.
- Improve net-working and collaboration, technology and skills and research transfer, and technical advice, because the Pacific does not have a good network for aquaculture within the region, let alone with Africa or Caribbean.
- Strengthen markets for aquaculture products in the domestic market to meet demand for fish locally and for import substitution. Often, local or national market is relatively small meaning that the economies of scale is difficult to achieve on the back of domestic markets and breaking into international markets in most cases difficult to achieve.

So there is some unanimity as to what are priorities for PICTs in Aquaculture<sup>8</sup>. The difference in priorities between the governmental bodies and what the commercial aquaculture sector considers important is quite marked, with the commercial sector looking for better skills, improved and consistent laws, regulations and better support from government for enterprise. The government and donors are mainly looking to technical assistance and support on aquaculture methods, application of these skills and on further training with the aim to be reef restoration, food security, or community development projects. The latter two should definitely become “commercial”, and ensuring that they are should be a priority.

Combining all this information from previous studies and reports, and incorporating the

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<sup>7</sup> These are not Genetically Modified (GM) organisms. They are improved by selective breeding.

<sup>8</sup> SPC FAME . 2021. Pacific Island country and territory coastal fisheries and aquaculture technical issues, challenges and priority needs. Information Paper 6 4th SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture 12–15 October 2021 – Virtual meeting. This gives the feedback from PICTs in 2021

obligations of the PICT's Sustainable Development Goals, the FAO International Year of Artisanal Fisheries and Aquaculture 2022 Global Action Plan<sup>9</sup>, and other recent binding and non-binding commitments in aquaculture the priority technical needs include:

## **9.1 Capability, Capacity and Improved Aquaculture Knowledge and Skills.**

Both governments and the commercial sector interviewed for this study considered both the capacity, and the knowledge and skills shortages to be critical. Commercial operators also require non aquaculture skills; electricians, carpenters, plumbers and similar as well as the aquaculture orientated ones. In government agencies the shortage of technical skills is severe in some cases, with a high turnover of staff, and which often lack the funds to do extension work, further inhibited by lack of trained extension workers needed.

In short, there are insufficient trained farm managers, research scientists, tradesmen and trained aquaculture operatives; and business and money management skills are lacking throughout the production segment, particularly in rural and remoter areas and islands throughout the region.

The requirements for improving capacity, through training to provide better knowledge and skills can be divided into three:

**1. That of the fish farmers.** They require the basic knowledge on aquaculture and fish husbandry, economic and business skills, and marketing skills which are all required to carry out their business or activity. Even small scale “backyard” or “Mom and Pop” enterprises require knowledge of how to run a business and manage money. In the social context of many communities the failure to manage money is a serious threat to sustainability of enterprises in small scale aquaculture, even if the owners are technically capable, which many are not. This impacts on the small scale farmers, or community enterprises, who do not receive sufficient training to maximise the value of their investments in time, space and money. The onus for providing the training for small scale farmers and community groups mainly falls on government extension services (some NGOs also have competency), but often there are insufficient extension workers and they are not sufficiently well funded; and in many cases insufficiently trained in the first place.

Interestingly in interviews, the commercial sector also identified problems with technical skills of this sort, but only because they could not hire skilled people, partly because there is so little real commercial aquaculture being undertaken that people do not have the opportunity to learn the skills required. They tended to hire their own staff and train them up to the required standard.

**2. That of government.** Government also needs technical people to undertake research, run/manage hatcheries, and provide advise as extension workers. This need has been identified in several recent documents<sup>10</sup>, reviews and in interviews for this study. Additionally, governments need skills in assessing the economic and social importance of aquaculture, different ways to assess viability of aquaculture proposals, to assess the suitability of sites and

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9 FAO. 2022 International year of artisanal fisheries and aquaculture 2022 Global Action Plan. FAO, Rome 2021

<sup>10</sup> SPC FAME . 2021. *Pacific Island country and territory coastal fisheries and aquaculture technical issues, challenges and priority needs*. Information Paper 6 4th SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture 12–15 October 2021 – Virtual meeting

communities for aquaculture, and identify opportunities.

Importantly, and something that has been highlighted several times by the commercial sector during interviews for this study, is that many Governments in their various divisions and departments have no concept of the importance of aquaculture and how to support it; and therefore require education so as to appreciate what the commercial sector requires to thrive. Aquaculture requires action on, among other things, land and water use, finance, tenure and zoning; import and export; transport; quarantine and biosecurity; drafting legislation, policies and regulations; and implementing international treaties and obligations. It is these areas where the commercial sector particularly mentioned a shortage of skills, though of course government aquaculture departments or sections are usually cognisant of the shortcomings of other branches of government. This needs to be recognised and a holistic approach to planning, policy and implementation applied.

Some of the reason for the above is that income for governments in many PICTs is generated by the offshore fisheries, and it is the offshore fisheries which is prioritised though there is no prioritisation of aquaculture needs in any negotiation of fishing vessel access, such as at the very least, the use of fishmeal or fish oil from processing, which could be used in the local feed industry. Additionally, inland aquaculture, being promoted in several PICTs is more akin to farming in the agricultural sense, than fisheries development, which means that the responsibility for the activity sits uneasily in fisheries departments.

Sometimes local or national governments put un-necessary and time consuming barriers in the way of the commercial operators and indeed of the whole industry, although normally by accident rather than design, which ultimately benefits no-one.

Governments also seem to be very slow to enact legislation or regulations which are necessary to the advancement of aquaculture, but that is not necessarily a capacity issue.

Government is generally not “aquaculture smart”, but it must become so, if it is to achieve greater success in aquaculture.

**3. That of regional organisations and NGOs.** Regional organisations, aid donors (bilateral and/or multi-lateral) and NGOs active in the sector also need skills uplift particularly in assessing the suitability of projects based on realistic assessments of technical, biological, social and economic viability.

Additionally, there is a need to improve the dissemination and breadth of knowledge required on aquaculture, both internally in countries and internationally, and improving this is an activity that the donor community and regional organisations may well have a greater part to play in the future. Improving communications technology should be able to help.

## **9.2 Assessment of Feasibility of Projects**

The feasibility of projects and enterprises has to be better assessed, whether a proposal is financially or socially viable, by looking at whether the total value generated is more than the cost of developing the activities being proposed or undertaken in the country or region<sup>11</sup>.

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<sup>11</sup> See: Bueno PB. 2014. Lessons from past and current Aquaculture initiatives in selected pacific island countries. FAO Sub-Regional office for the Pacific Islands TCP/RAS/3301

Only in the purely commercial sector is assessment of an aquaculture proposal undertaken on purely economic terms, and the decision to go ahead or not is based on the bottom line of the cash flow chart. From then on the enterprise relies on profits (or at least break even) to keep the business going. This also applies to businesses dealing in aquarium fish and corals cultured for export. Any loss is therefore not that of the government, and the commercial investors make their own decisions regarding success or failure; though in some cases a “public private” relationship with government exists where surplus production of seed from private or government hatcheries is shared/sold with the community, as happens with giant clams and some fish. Although the commercial sector may trumpet its social inclusion in communities or with vulnerable groups, this is not generally completely altruistic.

Normally government sponsored programmes and projects are assessed first on biological and technical criteria (Can we do it ?), and there is an appraisal of social issues (Should we do it to support the target group ?). The target group might be gender based, communities, vulnerable groups, or indeed food security for individuals or communities. Sometimes the target groups need is the prime criterion for a decision to go ahead.

Seldom is the total cost of a socially orientated programme and its requirement for long term subsidy by government measured prior to implementation. This often leads to a dependence on government, which can sometimes be an unpredictable partner.

The problem is that there has to be more emphasis on the economics of aquaculture, including, where appropriate, the value of social benefits<sup>12</sup> as well as monetary returns, prior to implementation of a project: otherwise scarce development funds will be used and donors, governments and NGOs committed to long term support to keep programmes running, which were never going to stand alone, and often have not even achieved their social objectives.

A social consideration identified during this study’s stakeholder discussions which has not been much appreciated is becoming apparent in some PICTs. This is that many young people do not wish to remain at home with their parents and siblings in rural areas: they wish to go to the towns where there are income earning opportunities far greater than being a rural farmer or aquaculturalist and a much better social scene and other diversions away from the social strictures of traditional life. Additionally, the youth living in the rural areas<sup>13</sup> aspire to a different world from their parents, often having been exposed to what goes on elsewhere through social media and television; and also being better educated than their parents, with several years of schooling being the norm, rather than the exception. They see small scale fish farming to be an activity they do not wish to do, it being hard work, full time and in all weather conditions. In some places this is very evident with no-one available to take over a fish farm when the head of household gets too old to run the farm, leading to a reduction in absolute numbers of fish farmers, or at least a significant reduction in productivity. How to address this remains a moot point,<sup>14</sup> though introducing aquaculture into the school curriculum may go some way to encouraging young people to enter the industry.

More emphasis must be placed on environmental considerations, beyond those based solely on

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<sup>12</sup> Note that this is recognised and a subsidy to rural entrepreneurs is acceptable in some PICTs.

<sup>13</sup> Gardiner, D., & Goedhuys, M. 2020. Youth Aspirations and the Future of Work: A Review of the Literature and Evidence, ILO Working Paper 8 (Geneva, ILO)

<sup>14</sup> One approach to counter this is to set a national goal for farm work to be a decent living and then find out what elements need to be explicitly incorporated into policies and practices to achieve that goal.



the needs of the commodity being cultivated. Some areas are unsuitable for cage culture due to periodic climatic events (typhoons, cyclones, El Nino events), others due to pollution, siltation and strong currents. Whilst site selection can be assisted by GIS and T4, it still needs to be done, so that new areas can be assessed for suitability.

The United Nations Forum on Sustainable Standards<sup>15</sup> is currently addressing Voluntary Sustainability Standards (VSS), which are special rules that guarantee that products sold don't hurt the environment and the people that make them, focusing on economic sectors like forestry, farming, mining or fishing, though it is not yet clear what effect this will have on the primary producers in aquaculture.

There are few critical evaluators in the decision making process who are qualified or permitted to filter out projects and programmes which are not likely to work, biologically, environmentally and/or technically, and then assess the economic viability (including the value of the social benefits) that accrue from the intervention. Even then, many of the decisions as whether to proceed or not are influenced more by political and geopolitical aims and objectives than financial and biological criteria. The "gap" between economic and political viability must therefore be measured in terms of "social capital", which may be a valid rationale to proceed.

It has to be realised that there are three forms of aquaculture that it seems will rarely be economically viable in purely monetary terms for a long time<sup>16</sup> or ever, without continued support from either donors, NGOs or governments within the PICTs<sup>17</sup>

- **Aquaculture for food security** and local incomes. (Mostly freshwater tilapia, some freshwater prawn, some milkfish (*Chanos chanos*) and other species in communities). This type of aquaculture, if to be any more than a purely subsistence "Mom & Pop" or "backyard" activity, requires constant inputs which the farmers are unlikely to be able to afford on their own. This includes seed stock. Tilapia farming requires a constant resupply of fresh seed (fingerlings) from genetically improved broodstock to maintain the positive genetic qualities of the fish being farmed. For other species, such as milkfish and siganids (rabbitfish), hatchery produced fry is required. Additionally, if this type of small scale farming activity is to produce product for any significant local sales then the quality and quantity of feed required to produce a marketable product is generally too expensive for a backyard operation.

Recent attempts at clustering small scale farmers, particularly in tilapia farming, have shown great promise and are probably easier to implement than getting disparate groups of people to work together towards a community goal; though clustering would be difficult in many coastal areas, particularly with the ownership problems of the intertidal (littoral) zone. Clustering can be divisive in some communities unless there is a high degree of cooperation and cohesiveness amongst the farmers.

In some PICT areas, tilapia farming has expanded and does provide food security and some income to the most progressive farmers, as was demonstrated in the Covid period

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<sup>15</sup> <https://unfss.org/>

<sup>16</sup> That is not to say that they should not be pursued, merely that they should not be considered as commercial enterprises, nor measured in the same economic terms. Social benefits may be very valuable, but these are difficult to measure, and the data usually does not exist to make fair value estimates of social benefits.

<sup>17</sup> The term 'viable' is most commonly employed in a monetary sense, this term is indeed confusing when trying to account for nonmonetary 'values', despite the fact that many 'values' perceived by beneficiaries are non-monetary.

of 2020/2021 and early 2022 in Vanuatu, PNG and Fiji. Even in these cases at least free fry is usually provided to the farmers on start-up, and in some cases feed as well.

There is a case for multi trophic aquaculture, or polyculture, to be adopted, so as to reduce risks and also make full use of the capital investment made by farmers.

- **Community based aquaculture** has not generally been as successful as expected in the past within the PICT's and the reasons for this are many and complex, though poor organisational capacity among community members, land disputes, pre-existing personal disputes and lack of capable and respected community leaders play significant roles. Weak research-extension linkages, poor cooperation among operational agencies, and low technical, management and skills in the communities also contribute. If community characteristics are such that these weaknesses are absent or can be overcome, then there can be success. These community characteristics need to be identified and objectively assessed up-front, however. The amount of time and effort needed to overcome a shortfall in any of them must not be underestimated.

Community based aquaculture projects require seed of strains of tilapia, clams, milkfish, sea cucumber and others. This seed is mostly coming from a central (usually government owned) hatchery. It's not free to produce but is usually given out free to communities, either directly by government or through an arrangement with a private hatchery. In some cases feed is provided as well.

There are also obvious options here for multi-trophic aquaculture, though capacity in communities is still generally deficient, on basic economics and business skills, management of aquaculture itself and in general marine resource management, such as MPAs.

Essentially community based aquaculture requires more effort and funding than has been given provided in the past, and a longer term view must be taken<sup>18</sup>. Hard decisions may have to be made by governments as to how much these initiatives and programmes will be supported long term, through maintaining hatcheries to provide seed, an extension service concentrating on the activity, facilitating adoption of appropriate management structures by communities and guidance about compliance with national laws applicable to small-businesses, continuing to provide other supplies such as ropes, marker buoys, and feeds, and provide any urgent disaster recovery interventions that might otherwise be beyond the means of the community business to implement by itself. However if the programmes are considered worthwhile then they should continue.

- **Reseeding and restoration of reefs.** This type of activity is to repair damaged or overexploited reefs, maintain biodiversity, and heighten awareness. There may also be an application in countering climate change by seeding thermo tolerant corals. *Trochus* (*Trochus niloticus*) and giant clam (*Tridacna sp.* and *Hippopus sp.*) are currently the most used species, however more recently several sea cucumber species have been identified as well as herbivorous fish which may also be appropriate. In general across the PICT region there is no monetary return to the hatchery owner (or the government if it is buying inputs) though it can be a trigger to achieve international commitments made

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<sup>18</sup> Jimmy R, Pickering T & B Tioti 2019 Improving community-based aquaculture in Fiji, Kiribati, Samoa and Vanuatu final report published by ACIAR GPO Box 1571 Canberra ACT 2601 Australia

toward marine environments by governments if it leads to formal protected-area status being declared at local level. Most giant clam, green snail (*Turbo marmoratus*) and trochus re-seeding actions<sup>19</sup> have not had the long term positive effects expected or hoped for, though they may have raised community awareness as to environmental issues of overexploitation of coastal resources, and this alone may be a suitable catalyst to make them considered worthwhile to governments and donors. For some nations, the very action of trying to do something about degraded reefs is enough to justify this sort of activity when linked to general reef ecosystem management initiatives.

It is appropriate to use a completely different measure of success for small scale PICT aquaculture to assess whether the activity is worthwhile, taking into consideration the considerable social, food security and environmental benefits of many of the activities undertaken. This could be used to better justify long term support to the sector.<sup>20</sup> It seems that unconsciously many PICT governments have adopted this approach and seem happy to maintain support to programmes that superficially appear to be economic failures. Development and adoption of tools to objectively assess and attach weighting to these non-monetary benefits will assist greatly in making these judgement calls.

There is a sentiment in some PICTs that there should be some method of cost recovery for government hatcheries; but a direct cost recovery by charging for seed is not generally feasible at this time since most “social” and environmental programmes cannot pay for seed, and many projects aimed at food security cannot charge for seed as the recipients are unable<sup>21</sup> or are generally not prepared to pay. It is likely that the situation cannot be changed quickly; though governments could aim for cooperation with a private sector hatchery which can sell to the government what seed it wishes to distribute for free, and the same private hatchery can sell to farmers what seed they wish to buy. Private public partnerships towards these endeavours should be further explored throughout the region.

### 9.3 Concentrating on Culture Methods and Species that are Known to Work.

Rather than just continued “research” and then failed attempts at commercialisation, food security or community use, it should be possible to filter out some of the research being done. Much of the research in PICTs is repeating research that has been done in other countries or territories, or indeed has been done previously in the past in-country. If the species is biologically suitable, the technology is known and available, the economics of production are positive, and the area is environmentally suitable, then a move out into the field could be made without repeating all the small scale pilot research again and again in different countries and territories. If it doesn’t work then research should move on to something that will work.<sup>22</sup>

It may be possible to intensify existing methods of culture and improve production, particularly in

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<sup>19</sup> The original introductions were seen as very successful in some PICTs though the re-seeding initiatives have tended not to be seen in the same light.

<sup>20</sup> See [https://www.betterevaluation.org/en/evaluation-options/value\\_for\\_money](https://www.betterevaluation.org/en/evaluation-options/value_for_money)

<sup>21</sup> In Malawi 80% of subsistence tilapia producers cannot pay for seed or feed. Imani Enterprises Ltd. (Undated). Commercialising the aquaculture sector in Malawi. Policy briefing for the Ministry of Commerce and Ministry of Agriculture, Malawi.

<sup>22</sup> As reported by an interviewee to this study “We have 30 years experience in aquaculture research, 1 year actual research repeated 30 times”

countries with pressure on land usage, coastal area access or freshwater resources, and improve resilience to disasters by using RAS systems and vertically integrating aquaculture, but currently this requires more investment than is generally available.

It is also revealing to note what happens to cages and facilities used in coastal areas during natural disasters such as cyclones and earthquakes (and more recently a volcanic eruption). With no insurance available to cage farmers in cyclone zones this is a risky business, as was evidenced in Vanuatu in 2015 with Cyclone Pam destroying the single cage farm in the country which has not been replaced, the destruction of the cages in CNMI in Typhoon Yutu in 2018 which have not been replaced, and the damage to seaweed farms in Western Solomons when in 2007 an earthquake raised shallow coastal flats above the low tide level, drying out and destroying the crop. The wisdom of initiating projects and programmes in places exposed to repeated natural disasters has to be taken into consideration whilst assessing whether a project is suitable.

As identified above there is a need throughout the region for a screening process within the administrations or the donor agencies to ensure that inappropriate aquaculture research programmes do not get funding, and more importantly that risky aquaculture activities are not promoted just because a research organisation has managed to get a grant to show that they can be achieved in a laboratory or on a very small scale short term field trial.

## **9.4 Improved Data Collection and Dissemination of Information**

Up to date data on aquaculture production and the dynamics of numbers of farmers and their location in the various PICTs is difficult to access, occasionally even for those in fisheries departments and divisions. Data provided by the World Bank or FAO is of uncertain origin and can contradict each other.

It appeared in some cases that data may have been miss represented as production figures were exactly the same as the previous year, or being reported as continuing even after a complete cessation of activities. This is obviously very unsatisfactory.<sup>23</sup>

Another complication is that whilst some projects are publicised widely at the beginning of activities, there is no further follow up. What happened to that programme ? Was it successful ? Did people adopt it ? What were the result ? Why did it not work ? Unanswered questions ! None of this helps when trying to assess aquaculture progress.

The consequential inability to monitor or manage the industry puts very real barriers in the way of development. Feed and seed supply requirements, disease control and training needs assessment depend on the present situation and the projected future growth or decline of the industry. Governments, donors and regional organisations need these data sets for planning purposes. Investors must know what is going on before allocating funds to aquaculture and the banks will continue to be reluctant to lend to the sector without reliable production figures and profitability forecasts.

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<sup>23</sup> During this study it was impossible to find up-to-date data on most PICTs aquaculture production by species; particularly since Covid. French Polynesia and New Caledonia have detailed import/export figures, but not so detailed for local production and consumption. Some countries produce annual reports with some details, and the US Territories have generalised statistics that in some cases give clues as to what is happening.

Data collection is seen as a rather tedious business in many government departments, but the problem can be alleviated somewhat by the introduction of linked technology through the internet and on-site inputting of data, though this is not a replacement for on-the-ground data collection by extension officers. It does however remove the need to manually enter data into multiple systems. The same data that is entered and stored in different places is also prone to data inaccuracies and loss. When duplicate data entry processes are eliminated through automation, labour and time are saved, and systems become more accurate.

A recurring theme in fisheries departments and divisions is the shortage of Standard Operating Procedures and (SOPs), Codes of Practices (COPs) and technical manuals for aquaculture, particularly if there are several languages being spoken in the country and the manuals are (usually) in English. The use of modern technology and applications such as Facebook®, Whatsapp® and Viber® should be able to assist in dissemination of information. SPC has made great efforts to centralise information on aquaculture and other institutions like USP and UPNG have similarly built up a large library of research papers and manuals which are of great use. Whilst the use of the internet should help farmers access these valuable resources now that internet coverage is far greater than even comparatively recently, few small scale farmers have equipment larger than a smart phone, and many not even that, and due to a widespread tradition of oral knowledge transfer, they are certainly not habituated to getting their technical information from scientific papers and reports. Perhaps the medium needs to be changed to a more audio visual system ensuring that all farmers can be accommodated. Farmers could be also encouraged to meet and discuss at regular intervals, and attend scheduled field days in their area, particularly in areas where clusters of farmers are established.

## **9.5 Regional Cooperation.**

There is a general realization that far more regional cooperation would be beneficial to the sector. Already the Micronesia Association for Sustainable Aquaculture (MSSA) has been created, and it may be possible to establish at least two similar organisations to cover the south western (Melanesian) and south eastern (Polynesian) Pacific, though the MASA has not been properly functional for some years and may not prove to be an ideal model. This possibility should be re-examined for appropriateness.

Lead aquaculture organisations are needed during these turbulent periods of rapidly evolving technological, climatic and social change which all affect aquaculture. At the moment the SPC provides this leadership but has insufficient staff and finances to ensure these services can be provided and sustained/further develop in the future (many, like financial services and advice, would need to be out-sourced and merely coordinated by SPC). An overarching body may have to be created, perhaps under the auspices of SPC, chairing the steering committee, or an regional independent body similar to those created for the offshore fisheries (such as Forum Fisheries Agency (FFA) or Parties to the Nauru Agreement (PNA)) as a coordinating body. The future of aquaculture in the Pacific requires either this kind of formal regional structure, or a far more “loose” cooperative approach regional wide which has not been evident so far among PICTs. As usual one of the major problems is funding, though there is no reason that any organisation set up could not be funded by the proceeds of tuna revenues.

Apart from the possibilities for coordinated research in one central place in each of Micronesia, Melanesia and Polynesia, more regional cooperation would offer the possibility of aligning, inter alia, legislation on trade, export controls, quarantine, biodiversity and policy throughout the region.

It is not beyond the bounds of imagination to envisage countries becoming the regional hub for production of seed of a particular aquacultured species, or a regional centre for training of staff in specific hatchery techniques. Under these arrangements, it should even be easier to move Specific Pathogen Free (SPF) seed and fry throughout the region and indeed sell into areas such as Asia who do not have the disease free reputation of the Pacific Islands, subject to attainment of sufficient aquatic biosecurity capacity at national level to gain the confidence of potential trading partners<sup>24</sup>.

Biosecurity is an example that is currently a national and regional responsibility, with legislation and regulations need to be brought up to date in all countries, and agreed regionally to cover not only introductions and transfers, but also feed security, waste water and genetically modified organisms. SPC has been at the forefront of this work in recent times providing support, advice and assistance to PICTs, but it needs further work. When this is achieved the path is open to SPF seed and broodstock passing relatively freely between PICTs countries allowing significant access to these commodities resulting in enhancing the sustainable development of aquaculture throughout the PICTS.

## **9.6 Technological Innovation**

Moving towards “Aquaculture T4”<sup>25</sup>, the adoption of new technologies to enhance production, reduce costs and control biosecurity, whilst acknowledging that this requires extensive business training, financial support and upgrading of the skills of the operators. It may be too early in many PICTs, especially remote islands and areas, however with a push to larger investment and greater and more efficient production goals, emerging technologies offer routes to efficiency and cost reduction.

“T4” for management of fish production facilities (managing auto feeding, monitoring fish health, integrated solar or wind power) is more applicable to larger scale commercial aquaculture than to aquaculture aimed at food security or small scale community operations<sup>26</sup>. Some uses of T4 also facilitate management and operation of smaller operations (purchasing, banking, security) and aid greatly in the collection of data and the distribution of information generally (price information, special interest Whatsapp® groups, COPs and SOPs, Government services, new regulations, disease alerts). A number of these applications, such as Viber®, Whatsapp® and Facebook® cost nothing in distribution but may require constant and consistent updating and sometimes a moderator, so may be more appropriate to government agencies or co-operatives<sup>27</sup>, but in Asia and Africa phone messaging has transformed information flow among like minded aquaculturalists, and eased their way to commercialisation of small scale farming.<sup>28</sup> The ability to use remote banking to pay bills and receive payments for product is also extremely useful, as nobody has to carry cash, and nobody has to waste time to visit remote banks.

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<sup>24</sup> This is already being done from Saipan into Asia

<sup>25</sup> Use of technologies in the “4<sup>th</sup> Industrial Revolution, “T4”; as they affect Aquaculture, so as to reduce costs, increase efficiency, increase production and help the environment.

<sup>26</sup> Automated feeding regimes for small scale aquaculture do assist in reducing feed costs, at a relatively small capital cost.

<sup>27</sup> An example from Ghana is the weekly price report from the Chamber of Aquaculture. <https://chamberofaquaculture.com/weeklyreport.html>

<sup>28</sup> In Vanuatu the use of the Aquanetix system has been promoted, though it is probably too complex.

Improved communications has also led to an explosive increase in the use of modern technology to keep in touch across the region, which has become both evident and useful during the COVID period. Remote meetings enable project managers from donor agencies and regional organisations to remain up to date with developments without having to repeatedly visit member states, thus reducing travel costs considerably and releasing funds for real development activities. Whilst not a complete replacement for all meetings and not appropriate for such as technical hands-on training in hatchery techniques this holds many possibilities.

Despite recent development in communications currently even accessing email on government servers seems to be an issue, probably a privacy one. There is also a need for professional development within government fisheries departments, on things like ethics and confidentiality, especially if governments become custodians of confidential company data.

Appropriate sites for aquaculture that have not been identified could be identified remotely using GIS and T4 on a laptop or PC computer. Currently sites are utilised opportunistically but there needs to be major effort in just identifying potential sites geographically.

It is worth pointing out that the adoption of Recirculating Aquaculture Systems (RAS) and smart technologies on commercial farms would allow for an unprecedented level of accountability, transparency and traceability. These data could also allay concerns about creditworthiness, opening up new funding opportunities from more risk adverse investors and improve insurance cover and lower premiums.

## **10. IMMEDIATE NEEDS OF PICTS**

There has been extensive work done on the needs of PICTs in aquaculture and the results are relatively consistent. The most recent is the survey work done by SPC FAME team and presented to the Regional Technical Meeting on Coastal Fisheries and Aquaculture (RTMCFA4) in 2021<sup>29</sup>. FAME conducted an earlier similar study on the potential of aquaculture in 2014<sup>30</sup>. During this survey both government officials and commercial operators were interviewed and a range of other reports consulted, but it was impossible to gain the opinion of the primary aquaculture stakeholders, “the small scale farmers and communities”, due to the restrictions resultant from Covid, and when the regional strategy is prepared their views must be sought and incorporated into the strategy.

With this gap in data collection in mind some of the most important immediate needs identified during this assessment include:

**Improve and increase capacity and capability through knowledge transfer**, specifically technical aquaculture skills (hatchery, growout, post harvest production and working on multi and single species aquaculture in traditional communities). Training by attachment is useful.<sup>31</sup> There is a shortage of trained staff in many PICT’s administrations; though government needs

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<sup>29</sup> PC FAME . 2021. Pacific Island country and territory coastal fisheries and aquaculture technical issues, challenges and priority needs. Information Paper 6 4th SPC Regional Technical Meeting on Coastal Fisheries and Aquaculture 12–15 October 2021 – Virtual meeting

<sup>30</sup> Amos M, Garcia R, PickeringT & Robert Jimmy. 2014. Study on the Potential of Aquaculture in the Pacific. ACP-EU Technical Centre for Agricultural and Rural Co-operation (CTA) Secretariat of the Pacific Community (SPC), Noumea August, 2014

<sup>31</sup> More long term placements in New Zealand and Australia, or in Asian countries where similar species and techniques are utilised, would be very useful.

different training from the commercial sector. Capacity and capability must also be further developed in departments and divisions in other government institutions that are involved in aquaculture (e.g. biosecurity, national planning, marine space allocations). Application of T4 may assist.

**Improve and increase small scale private initiatives**<sup>32</sup> by the use of “clustering”, where like minded individuals come together for mutual benefit, or a “nucleus estate”<sup>33</sup> approach<sup>34</sup>, where a successful commercial enterprise supports growout farmers or small producers. This is particularly appropriate for tilapia farming for food security and income, but also can be applied to a range of commodities currently being cultured throughout the PICTs (e.g. Mangrove oyster (*Saccostrea sp.*) production and mudcrab (*Scylla sp.*) farming). In some PICTs this has already happened, and groups of farmers in some case support each other where they have a local consensus and ties sufficiently strong, with limited recourse to government assistance; and also commercial enterprises acting as nuclear estates supporting “satellite” growout farmers, which buy and market the products, which the growers could not independently undertake themselves.

**Community based initiatives** require a different approach. In some countries there are close knit communities with strong leaders capable of running community based initiatives; however in others this tradition is weak. It does seem that strong leadership in community based projects is paramount; if this is lacking, and the community is fragmented, or the leadership changes frequently then the chances of success are much reduced. A lot more work needs to be done to assess probable success and reasons for failure. This would lead to a better selection of sites for community based activities. That said, community based initiatives do inculcate a sense of ownership amongst the communities that are affected, and this alone may be justification of continuing them even when past failures might indicate otherwise. Community based initiatives are themselves candidates for support via a “nucleus estate” approach.

**Improve post harvest quality.** For export, and also for produce destined for local markets (particularly tourist based markets) there has to be a guarantee of quality of the products of aquaculture. Though there are local rules in some countries these are often ignored due to the general lack of awareness and understanding resulting from the absence of access to training, knowledge, nor facilities for ensuring that the products of aquaculture are fit for human consumption.

The application of Hazard and Critical Control Point (HACCP), Good Manufacturing Practice (GMP), and the production of manuals regarding post harvest treatment of the products of aquaculture are lacking throughout the industry and the region, though these subjects are generally covered for wild coastal and oceanic fisheries where the products end up on the local or overseas markets<sup>35</sup> With the increase of bivalve culture (e.g. rock and pearl oysters for consumption) and freshwater fish farming there are dangers that toxins and contaminants may enter the food chain, possibly from feed, but also from the environment, released sewage in coastal areas or added by the farmer for another purpose (e.g.: chicken and duck/goose manure for fertilizing the ponds).

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<sup>32</sup> Note that the beneficiaries are private farmers and not whole communities.

<sup>33</sup> The nucleus estate is usually used to guarantee throughput for the processing plant but is sometimes used only for research or seed purposes. It is a model much used in agriculture.

<sup>34</sup> Also known as satellite farmers

<sup>35</sup> Cooperation between capture fisheries and aquaculture on HACCP and processing is an opportunity



A vital component of quality assurance is traceability, with big advances now being made in digitalization and blockchains that increase buyer and consumer confidence in the authenticity of a seafood product. Digitalized traceability provides a basis for secure and unequivocal supplier contracts, can act as a trigger for immediate electronic payments upon delivery, as well as provide farmers with assurance that their own hard-won good reputation is not being downgraded by sloppy handling of their product further along the value chain.

There are also fish diseases that are caused by pathogenic micro-organisms and parasites that also affect humans, particularly in freshwater environments. These dangers need to be identified and mitigation measures developed, such as depuration systems, proposed and then acted on. Furthermore, there are some dangers to human health from the activities associated with aquaculture, such as skin problems associated with seaweed farming, pneumoconiosis from calcium dust produced by processing shell products, hand and arm infections in processing of shellfish, and the usual dangers of operating machinery. These also need to be assessed and detailed SOPs and COPs that are suitable to the Pacific working environment produced, understood and implemented throughout the sector.

Action on these gaps is required, initially a review of the potential dangers to health of the products of aquaculture, and to the workers within the industry, specifically fish and shellfish farmers. This then needs to be further developed with some urgency by the public health authorities in PICTs where there is a significant market for freshwater fish, or a tourist based or export industry based on fish or shellfish for consumption. The actions developed need to be integrated into the individual PICTs countries legal documents. This can be done within a wider national goal of ensuring that farming can provide a decent living.

**Gender, youth and vulnerable groups** remain marginalized in many of the PICTs. A considerable body of work has been undertaken on gender development, and throughout the PICTs there are departments and divisions outside of fisheries that concentrate on the subject. PICTs are also bound by the Beijing Declaration and the Platform for Action (2000), and subsequent protocols on the subject,<sup>36</sup> as well as ILO policies on youth employment and the ILO Disability Inclusion Strategy 2020-23. It is important that there is progress in this area, and large scale investment in expanding commercial aquaculture will be able to contribute to achieving these goals..

**Environmental concerns** loom large in Pacific aquaculture. Global warming seems to be having negative effects on many aspects of the environment for aquaculture, though some are difficult to quantify. It does seem that El Nino and La Nina events are more frequent and stronger, and that typhoons and cyclones happen more often and are more powerful. Similarly pollution of the sea by microplastics and persistent chemical toxins present challenges. Preparedness is the correct response, but it needs to be based on realistic expectations and predictions, rather than on late and ad-hoc responses.

Environmental best practices need to be further developed for all aquaculture activities within the PICT's and integrated into all farming systems. Improved management of resources, especially waste and effluent resulting from aquaculture operations needs to be improved. This will become an increasing focus of scrutiny within the context of the UNFSS call for Sustainable Healthy Diets SHDs. There are many innovative systems developed and in use within the aquaculture sector worldwide and are available to be modified to suit PICTs individual situations

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<sup>36</sup> <https://beijing20.unwomen.org/en/about> for further information

and aquaculture systems. The development of these initiatives need to be at all levels of PICT aquaculture and integrated into all extension activities. Improved environmental management of aquaculture systems will result in improved health of the product, marketability and the environment it is cultured in.

**Strengthen biosecurity** but make biosecurity work for and support the needs of the aquaculture industry; rather than producing additional regulations and bureaucracy to further restrict the industry. A regional approach is required, which has already been acknowledged by many and acted upon by SPC FAME, rather than each country developing their own protocols independently of neighbours and the region.. This should result in the transfer of SPF<sup>37</sup> fish and invertebrates between countries made easier, rather than more difficult, less regulative paperwork and shorter lead times for exports and imports of necessary animals, seed or feed.

**Determine if local feed sources** will be sufficient for commercial aquaculture in the smaller PICTs; and whether the larger PICT's, particularly PNG and Fiji, will be able to supply their own needs and perhaps regional needs for aquaculture.<sup>38</sup> Several larger aquaculture farmers/growers have developed local supply chains and established simple feed mills, demonstrating that it is possible to produce feeds without a local commercial feed mill, but improvements in quality of the feed requires continued effort.<sup>39</sup> There is also much potential for expansion of the regional aquaculture footprint through a focus upon “extractive” (un-fed) species like filter-feeders or aquatic plants, subject to other constraints upon these species (e.g. hatchery capacity, food safety) being addressed successfully.

## 11. ESTIMATION OF THE EFFECTS OF COVID ON AQUACULTURE IN PICTS AND ANY REMEDIAL ACTIONS

Although COVID has had a large effect on aquaculture in PICTs, in most countries and territories it is very difficult to quantify.<sup>40</sup> The impacts have in some cases been dramatic, particularly in the commercial sector, but also spilling over into small scale operations and they should not be underestimated. The actual farming of fish and invertebrates has generally continued, albeit at a reduced scale in most places.

Some interruptions of supply of inputs has been reported; for instance supplies of seed and feed have been impacted. Marketing of some products has also been seriously affected, particularly in the aquarium trade where air transport links have been significantly affected, and also where

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<sup>37</sup> Specific Pathogen Free. For more information see:- FAO. 2021. *Tilapia health: quo vadis? The development and the benefits from use of SPF tilapia* 1-3 December 2021 Powerpoint presentation by Robins McIntosh, CPF

<sup>38</sup> De Koning, Dr C. 2019. Enhancing the role of small scale feed milling in the development of the monogastric industries in Papua New Guinea. Published by ACIAR, GPO Box 1571, Canberra ACT 2601, Australia

<sup>39</sup> The provision of high quality fish meal and fish oil from the established oceanic fisheries would be the best improvement in the quality of feed and the ingredients are available domestically. The plant is becoming more smaller scale and environmentally friendly due to a move away from solvents to super critical CO<sub>2</sub>.

<sup>40</sup> PC FAME 2021. *What do the statistics tell us about the Impacts of COVID-19 on PICT Economies*. <https://sdd.spc.int/news/2021/10/06/what-do-statistics-tell-us-about-impacts-covid-19-pict-economies> SPC Statistics for Development Division

tourism is an important industry and tourists buy the products of aquaculture<sup>41</sup>. In some countries<sup>42</sup> there has been an upsurge of interest in small scale fish farming for food security as a result of COVID, where people employed (particularly in the tourist industry) have returned to rural villages as opportunities in the towns have reduced.

Movements of people have been severely curtailed, though meetings and training on aquaculture have gone ahead remotely, using internet based communication systems where access is obtainable. Hands-on training has by necessity been curtailed, especially if the trainers are based outside of the recipient country.

In some countries civil servants have been locked down but also asked to provide COVID services, like taking part in vaccination campaigns and enforcing local travel restrictions. During these times there was little development, research, training or extension work undertaken, significantly delaying programme implementation and support for farmers.

Although electronic communications have remained intact, the substitution of remote meetings instead of workshops, and the loss of in-person contact, has certainly reduced the ability of international organisations to maintain the momentum of some parts of their programmes.

Unfortunately insurance for disruptions such as COVID is not readily available in the region, and banks are unwilling to lend to the sector, so some commercial companies have been almost bankrupted by their inability to maintain operations during this period, though most have managed to struggle through.

These effects will be generally short term, and once COVID disappears from the world consciousness and travel restrictions withdrawn, normality will return with remarkable rapidity, as has been demonstrated in those countries that have removed COVID restrictions in early 2022.

It really is not worth implementing a programme of post-Covid interventions specifically for aquaculture. FAME can do little more than record the progress of normalisation, note the negative effects and if thought useful outline a plan for the next pandemic or disaster based on the lessons learned. SPC is already doing this in a more general manner. (No doubt enhanced disaster/pandemic planning will go ahead for whole countries where it is thought necessary and aquaculture should be included in these plans).

No specific remedial actions by donor agencies and partners appear appropriate because by the time they are implemented they will be irrelevant. Best to learn the lessons and move on.

At a local level each PICT may receive continued aid-related assistance in 2022/3 as a result of COVID, and the various administrations should be ready to take advantage of this; allocating some to the requirements of aquaculture. Aquaculture departments and divisions must push for inclusion in the distribution.

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<sup>41</sup> In Fiji sales of pearls reduced 95% as a result of the loss of tourism as a market

<sup>42</sup> Fiji for instance

## **12. POTENTIAL SUBREGIONAL COOPERATIVE ARRANGEMENTS**

As documented above it can be seen that there are a host of areas where regional and sub-regional cooperative arrangements would be beneficial for aquaculture. Whether these have to be formalised through aquaculture associations, regional management and technological hubs, or achieved through ad-hoc efforts to harmonise rules and regulations, development of more cooperation covering biosecurity, production of feed and seed, regional laboratories, hatcheries and training facilities is not yet clear.

Regional hubs or centres of excellence for producing seed of the various species currently and/or potentially cultured are an obvious case where regional cooperation would significantly benefit all aspects of industry including considerable economic and effort savings. This would cut down on duplication of effort, particularly for those species where seed is small, light and easily transportable, such as rock oyster for food and pearl shell oyster. Already there are companies importing fish fry and microalgae from outside the region which could be replaced by regional production if it was simpler to move animals between PICTs. Most fry and Post Larvae (PLs) are small and large numbers can be transported by air fairly cheaply with high survival rates.

Capacity development is also another prime example where cooperation would benefit PICTs. Hatchery work could be improved quite easily by staff attachments or workshops in a country where the technology is well known and successful. This has been previously undertaken bilaterally by some countries, with the help of SPC and donor partners, and has been reported as being very useful.

There is a need to harmonise laws, regulations and policies on a wide range of topics, not all directly to do with aquaculture alone. This includes post harvest of the products of aquaculture (with Public Health authorities), biosecurity (with the various biosecurity agencies in PICTs), trade and transportation policies, export/import requirements for culture commodities and supplies/equipment, and clear legal pathways for allocation of marine space and fair valuation of that space for use by aquaculture. The nearer the whole region is to having closely conforming laws relating to aquaculture then the easier it will be for aquaculture to flourish.

## **13. RECOMMENDATIONS FOR FUTURE DIRECTION FOR AQUACULTURE IN THE REGION**

For future policy direction for aquaculture within the PICTs there is a need to look beyond just the Pacific Region and local needs and requirements.

All the PICTs must strive to achieve the Sustainable Development Goals (2020-30)<sup>43</sup>. This is an obligation. Whilst the SDGs are fairly broad in nature, they do pinpoint the 17 areas where

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<sup>43</sup> Anon 2020 Transforming our world: the 2030 Agenda for Sustainable Development. UN Department of Economic and Social Affairs Sustainable Development <https://sdgs.un.org/2030agenda>

action should be taken, and they are integrated, in that the achievement or non-achievement of one will affect the achievement or non-achievement of others. Some of the goals are more directly related to aquaculture than others.<sup>44</sup>

Specifically for Aquaculture there are other recent agreements which provides a clear mechanism for a sustainable way forward. The Shanghai Declaration<sup>45</sup>, emanating from the 2020 Global Conference on Aquaculture in Shanghai, which whilst not binding, lays down 5 recommended commitments. These include;

- Promote responsible aquaculture development;
- Promote good aquaculture governance;
- Strengthen partnerships to generate and share knowledge, information and technology;
- Invest in aquaculture innovation, research and development; and
- Create open and transparent communication about sustainable aquaculture.

It then goes on to recommend 14 strategic priorities for aquaculture:

- Expand the contribution of aquaculture to sustainable agri-food systems for nourishing nations, reducing poverty and providing healthy, nutrient-rich and climate-friendly food to people;
- Integrate aquaculture with the natural environment, with agriculture, capture fisheries, forestry, tourism, renewable energy and other sectors, and within agri-food systems for increased resilience;
- Continually improve the performance of aquaculture, and its capacity to minimize impact on and make better use of natural resources and enhance ecosystem services;
- Promote aquaculture development approaches that conserve and improve ecosystems and biodiversity, and reduce the carbon intensity of food production systems;
- Protect and develop aquaculture based livelihoods and promote decent work and socially responsible enterprises;
- Ensure women's empowerment by enhancing women's full access to equal opportunities through gender-transformative policies;
- Promote opportunities for young women and men;
- Promote participation in aquaculture;
- Prepare for and potentially mitigate impacts from global crises, such as climate

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<sup>44</sup> 1. No Poverty 2. Zero Hunger 3. Good Health and Well Being 4. Quality Education 5. Gender Equality 6. Clean Water 7. Affordable and clean energy 8. Decent work and economic growth 9. Industry, innovation and Infrastructure 10. Reduced Inequalities 11. Sustainable cities and communities 12. Responsible consumption and production 13. Climate Action 14. Life below water 15. Life on land 16. Peace and justice 17. Partnerships for the goals

<sup>45</sup> Shanghai Declaration 2021 *Aquaculture for food and sustainable development*. The Shanghai Declaration and its Call for Action were developed and adopted by the participants of the Global Conference on Aquaculture Millennium +20

- change, biodiversity loss, pollution and pandemics; and
- Strengthen data and information collection and analysis for monitoring the progress and contributions of aquaculture.

Each of these strategies is expanded upon in a call for action to address the overarching commitments and the priorities identified. There is a long list of actions and activities that are recommended.

The Food & Agricultural Organisation of the United Nations (FAO) International Year of Artisanal Fisheries and Aquaculture 2022 Global Action Plan<sup>46</sup> also offers guidance on the future of Aquaculture and has 7 pillars:

- **Environmental Sustainability:** Use biodiversity sustainably for the longevity of small-scale artisanal fisheries and aquaculture;
- **Economic Sustainability:** Support inclusive value chains for small-scale artisanal fisheries and aquaculture;
- **Social Sustainability:** Secure social inclusion and well-being of small-scale artisanal fisheries and aquaculture;
- **Governance:** Ensure effective participation of small-scale artisanal fisheries and aquaculture in building and strengthening enabling policy environment;
- **Gender Equality & Equity:** Acknowledge that women and men in small-scale artisanal fisheries and aquaculture are equals;
- **Food Security & Nutrition:** Promote the contribution to healthy diets from small-scale artisanal fisheries and aquaculture in sustainable food systems; and
- **Resilience:** Increase the preparedness and adaptive capacity of small-scale artisanal fisheries and aquaculture to environmental degradation, shocks, disasters and climate change.

The International Year of Artisanal Fisheries and Aquaculture also seeks opportunities to support the implementation of and benefit from activities related to international instruments. These include among others:

- the United Nations (UN) Convention on the Law of the Sea;
- the Code of Conduct for Responsible Fisheries;
- the 2021 Committee on Fisheries (COFI) Declaration for Sustainable Fisheries and Aquaculture;
- the Agreement on Port State Measures;
- the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication;
- the Voluntary Guidelines to support the Progressive Realization of the Right to

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<sup>46</sup> FAO. 2022 International year of artisanal fisheries and aquaculture 2022 Global Action Plan. FAO, Rome 2021

Adequate Food in the Context of National Food Security;

- the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security to Food;
- the UN Declaration of the Rights of Peasants and Other People Working in Rural Areas;
- the Principles for Responsible Investment in Agriculture and Food Systems;
- the Voluntary Guidelines on Food Systems and Nutrition; and
- the Rome Declaration: Ten Steps to Responsible Inland Fisheries.

It is important to re-emphasise that the FAO Code of Conduct for Responsible Fisheries (2001) mentioned above<sup>47</sup> and later updates and annexes which introduce the precautionary and ecosystems approach and concept of sustainable fisheries and covers aquaculture is an important guide that should be followed for the long term sustainable development of aquaculture in the PICTs.

For post harvest of fisheries and aquaculture products the World Health Organisation (WHO)/FAO Code of practice for fish and fishery products<sup>48</sup> is the essential reference point for technical guidance on the harvesting, processing, transport and sale of fish and fishery products.

There are many other treaties, agreements and protocols that affect aquaculture, even if not so directly targeted at the sector. These include The Paris Agreement<sup>49</sup> on climate change, The Protocol to the Convention on the Elimination of All Forms of Discrimination against Women, The Cartagena Protocol on Biosafety, Convention on International Trade in Endangered Species (CITES), and WHO agreements, to list just a selection. Moreover there are constantly new treaties and protocols being produced, an example being the United Nations Environmental Programme (UNEP) 2022 Draft resolution for ending plastic pollution<sup>50</sup>, which will have far reaching effects on fisheries and aquaculture<sup>51</sup> when it is ratified by PICTs.

It can be seen therefore that the future direction of aquaculture in the Pacific region is to be guided and informed but also constrained by these overarching agreements and policy documents.

## **13.1 The future strategy**

One of the objectives of this report is to identify the direction of aquaculture in the region and propose how a regional strategy could be developed and what it might look like. (see Appendix

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<sup>47</sup> <https://www.fao.org/3/v9878e/v9878e00.htm>

<sup>48</sup> <https://www.who.int/publications/i/item/9789240013179>

<sup>49</sup> to limit the increase in global average temperature to below 2°C

<sup>50</sup> UNEP 2022 Draft resolution. End plastic pollution: Towards an international legally binding instrument. UNEP/EA.5/L.23/Rev.1

<sup>51</sup> It is important that the administrations begin to think about how to implement the changes required before it is agreed and ratified.

V: TORs). It is anticipated that the Heads of Fisheries meeting in 2022 will discuss the findings of this report, and approve the next steps (see Section 14.1), which might be:-

- a) SPC is tasked with being the lead agency in the preparation of the Regional Strategy for Aquaculture and is requested to find funding to develop it.
- b) Once funding is secured SPC will assist with consultation with stakeholders in each of the PICTs to confirm the future contents of the Regional Strategy
- c) On completion of in country consultations three regional meetings will be held to validate the findings of the consultations
- d) SPC will produce a 1<sup>st</sup> draft of the Regional Strategy which is circulated widely
- e) SPC will incorporate any further comments and suggestions
- f) The document will be validated at a routine Regional Technical Meeting on Fisheries and Aquaculture and any final comments incorporated.
- g) The final Regional Strategy document is presented to the next HoF meeting for acceptance
- h) Implementation & monitoring of progress

## 13.2 Objectives

The overall goal of the future strategy should be something like:-

*“To increase the contribution by sustainable aquaculture to local, national and regional food systems supporting food security and health, economic growth and trade.”*

This is an overall goal in nearly all planning documents regarding the future of aquaculture, though the wording may vary.

It is possible to discern from the investigations detailed above a series of objectives that should be appropriate to aim for in Future Directions in Aquaculture Policy in the region so as to achieve the overall goal.

It is absolutely vital that these suggestions are confirmed by extensive consultations with primary stakeholders in the PICTs (see Section 14.2 on stakeholders below). Recent consultation so far has been, with some notable exceptions, with secondary stakeholders (Government departments, donors, etc) who have less to lose than the primary stakeholders<sup>52</sup>, who may depend on aquaculture for their food security and income. As such, it is essential to engage, understand and incorporate comments and concerns of the regions primary aquaculture stakeholders and provide valid outcomes to address these issues.

### **13.2.1 To mainstream aquaculture into the economic and social development agendas of PICTs**

It is extremely important that aquaculture becomes more visible and that the elected members

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<sup>52</sup> Covid has precluded widespread consultations with primary stakeholders over the last two years.



of the legislatures of the PICTs, and the civil service in each PICT, are educated so as to give the sector the attention that it requires. This does not only cover fisheries departments; many government bodies should be “thinking aquaculture”, since the integration of services to aquaculture involves much more than just the aquaculture departments and divisions of the PICTs; it is a cross sectoral activity. Governments must become “Aquaculture smart” and be prepared to invest their time and political capital in legislating for appropriate enabling pathways for aquaculture.

Without this support the sector will not thrive, and the other objectives below will not be achieved. Currently, although lip service is given to aquaculture most PICTs tend to emphasis offshore or coastal fisheries, for economic development and income, and agriculture gets the lions’ share of the “onshore” development budget.

An example is the financing of aquaculture. Currently it is often difficult to get funding and insurance from financial institutions for aquaculture. Whilst the issue of “blue” bonds and other “blue” financing mechanisms for the “blue” economy, as widely both publicised and promoted by donor organisations and institutions is hailed as a “great leap forward” in financing of aquaculture, these are currently little more than ordinary loans dressed up as “blue”, though sometimes at discount rates or with long maturity times<sup>53</sup>, as part of attempts to encourage the “blue” economy. The proposals still have to be scrutinised for viability, otherwise the loans are little better than direct subsidy. That is not to say that this type of loan should not be made, merely that it should be acknowledged that many of these types of loans are made for purposes other than purely commercial aquaculture; such as recovery after natural disasters, to aid in reducing rural poverty or to support rural development.<sup>54</sup>

Proper financing of aquaculture comes from commercial loans, at commercial rates; and this will only happen if the industry is shown to be a reliable income earner, with the active support of governments, and likely to be able to service the loan (i.e.: pay back the loan and interest). Currently banks and other lenders in the region generally are unwilling to lend to aquaculture start-ups, and even have doubts about established businesses, knowing that their survival depends on being able to weather natural disasters, continuity in policy and tax treatment of aquaculture by the government and generalized support for ancillary industries. Small scale farmers and communities are even less likely to be able to access bank loans or mortgage funding for start up or growth of activities than large commercial farmers. It is thus vital that the governments of the PICTs are seen actively to support aquaculture and demonstrate this by implementing sensible policies; then, as aquaculture grows, the financing institutions will move in and provide the funding necessary for the sector. Outside investment into aquaculture in the region will also benefit from visible and tangible government support and promotion of the industry. Aquaculture enterprises must themselves adopt data management practices that increase their own visibility and transparency to potential sources of finance.

Finance is not the only sector which would benefit from aquaculture being mainstreamed into government consciousness. Among others trade and transport, biodiversity and environmental protection, health and tourism would all benefit.

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<sup>53</sup> The “blue” just indicates that the loan should be for something to do with water. Just like the “blue” economy. It is currently a bit of a buzz word, to try to emphasise the opportunities in the sector.

<sup>54</sup> |Disaster risk, disease risk and tenure uncertainties are the three main issues that prevent funding from being available.

**13.2.2 To increase aquaculture production of edible and non-edible aquatic products for income and food security in the commercial, community and small holder subsectors**

As an objective this is perhaps rather obvious. It was certainly one of the most stated objectives of the PICTs respondents and interviewees, and it appears in documentation from SPC, FAO, country aquaculture policies, and other more generalised development plans. How to achieve this is another matter.

To increase production and make aquaculture more profitable there have to be some changes, since only in a few cases has aquaculture made a significant difference to the lives of large numbers of people (farmers or consumers), and in most PICTs aquaculture makes little contribution to food security or rural incomes<sup>55</sup>.

In the past, there have been many attempts at different types of aquaculture in different PICTs, and many have not proved worthwhile after much effort and funds has been expended.

Partly because it is so often not done, it is as a first step important to assess aquaculture projects on a series of criteria prior to attempting to introduce them generally. These criteria must include, at the very least:

- I. Proven or potential biological and technical viability;
- II. The likelihood of ecological and social sustainability (including compatibility with available skills and existing livelihood options);
- III. Risk factors, such as pollution, biosecurity, feed supplies, disease, natural disasters (cyclones, typhoons, earthquakes etc);
- IV. Proven or potential financial viability Future operational costs, cash flow forecasts and other financial tools for assessing viability must be used, but should include the social and environmental benefits (If necessary, a long term assistance plan for government backed interventions must be prepared if the social and environmental benefits are considered valuable enough);
- V. Use of proven technology;
- VI. Access to markets;
- VII. Access to finance;
- VIII. Availability of technical skills; and
- IX. Knowledge of business and money management skills.

Far too many attempts at aquaculture have not done this initial first step, and the projects fail to achieve satisfactory results.

There is also a need to promote aquaculture as an activity suitable for investment, both by those who wish to enter the industry, but also as one suitable for investment of time and money. This will require work by the PICT government departments in getting the message across. The best

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<sup>55</sup> Notable exceptions include PNG and Fiji

way to get the message across is to demonstrate that aquaculture, for large scale commercial activities, food security or even as a community activity is a success. In most PICTs this is not happening and the small scale and community based sectors fish farming is seen as an ancillary to other activities, such as farming, or in some cases tourism. Aquaculture really needs cheerleaders, and success.

Generally increasing production will depend on a wise strategy of concentrating on success and abandoning virtue signalling and doctrinaire programmes that have over the years not proven to work. In most cases the biology and culture technology is known, the economics are broadly known and the social factors in play are also known. Whilst aquaculture is not immune to natural disasters, their frequency and probable severity are also known, and an assessment of risk for each investment can be made.

### ***13.2.3 To improve capacity and capability in the aquaculture sector.***

Capacity and capability here is not just for aquaculture departments and divisions; farmers and processors/markets. Currently many government, NGO and donor personnel involved in aquaculture development are not 'technical' but rather 'academic'. The Pacific is often seen as trying to grow an industry that really is just an academic one established by academics; however biology is a very small component of a successful aquaculture operation, trade skills are needed much more. Aquaculture must reach beyond academia or the purely technical and trade skills and move to general business and aquaculture management, financial aspects, money management and the introduction of new technologies. A new model for support in capacity building to aquaculture needs to be found that will satisfy this broad requirement.

Capacity, both technical and financial and both in government and in communities, remains a serious shortcoming of most PICTs. This will have to be addressed through training, in regional institutions for diplomas and degrees, hands on workshops for hatchery techniques and grow out, and by introducing aquaculture into secondary school education. There is much to be done.

Regional cooperation is important. The knowledge and skills exist in the region, and they need to be disseminated. It will be important to use regional hubs such as USP and UPNG for higher level education; colleges, institutes and the secondary education system for inculcating local students, perhaps using unified regional curricula.

### ***13.2.4 To improve biosecurity in the region.***

Biosecurity is vital to successful aquaculture in the Pacific region, as it is in all aquaculture producing countries. Up to now the application of Biosecurity in aquaculture in the region has been geared towards the control of introductions of alien species, but there are other biosecurity issues that also need to be addressed, such as imported dry feed composition, live and frozen feed, wastewater pollution of reefs and pathogen release.

There is increasing evidence that some diseases of aquacultured fish can also be passed to humans, which opens a potential "Pandora's box" of issues of concern, some of which may be more related to public health, processing, and nutrition. Even the depuration of shellfish prior to sale to the public is not generally undertaken. These potential problems have to date been

largely disregarded<sup>56</sup>. The need to protect the public from potential negative effects of aquaculture, by ensuring that the products of aquaculture are not contaminated by toxins or pathogens which are injurious to health is pressing; as is the need to protect the workers on farms and in downstream processing from disease and conditions directly related to aquaculture.

Some or all of responsibility for biosecurity in the PICTs has tended to rest in other departments of government; normally agriculture or livestock, and customs and quarantine. Regionally biosecurity is also covered by Pacific Regional Environment Programme (SPREP<sup>57</sup>), a separate organization to SPC, and as a result there is sometimes some confusion as to who does what.

Biodiversity protection has been used in some PICT's as an excuse for an almost complete ban on introductions of non-native species. This is a perversion of the intention of the legislation, because if there is a proper risk assessment done, which finds no potential adverse effects, then there is little reason to ban the importation of non-native species.

The issue of genome editing and Genetically Modified (GM) organisms, either directly for aquaculture, or as a component of feed also needs closer attention that it has received in the past. The long term future of aquaculture may well rest in GM, though currently there is considerable public suspicion and opinion against it.

#### ***13.2.5 To assess the resilience of aquaculture to climate change and other natural disasters in the region and develop outline plans for mitigating measures.***

Climate change is real and is having effects on aquaculture. These effects will be both positive and negative.

The direct effects of climate change include influencing the physical and physiology of finfish and shellfish stocks in production systems, while indirect effects may occur through altering the primary and secondary productivity, and structure of the ecosystems, input supplies such as fishmeal, & fish oil costs and other feed ingredients or by affecting product prices, and other goods and services needed by aquaculture producers.

It is necessary to recognise that the aquaculture sector is not discrete and the effects of climate change on the environment in agriculture and oceanic fisheries are interlinked with those on aquaculture. The most obvious link between the three sectors is that of feed, in that existing fish feeds demand high protein fish meal and fish oil produced by capture fisheries<sup>58</sup> and also the products of agriculture such as carbohydrates (usually soya or maize), starch and fillers/binders; meaning that any changes in production in either sector could potentially have great consequences for the aquaculture industry.

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<sup>56</sup> There are occupational diseases associated with aquaculture, and the processing of aquacultured products. Seaweed farming can cause skin conditions, button making from shell can cause lung problems, bacteria on tilapia are sometimes pathogenic to humans; potential antibiotic residues and heavy metal contamination from feeds may also be a problem.

<sup>57</sup> Mainly on alien species

<sup>58</sup> Aquaculture feeds usually contain fish meal and fish oil of marine origin. Aquaculture uses around 60% of current fish meal production and about 80% of fish oil production. The growth of aquaculture could be greatly restrained by future shortages of fish meal and fish oil.

With wild fisheries providing seed for ongrowing, particularly in the case of milkfish in some PICTs, this dependence on wild capture fisheries can be critical.

Other effects that are becoming apparent include temperature rise on corals and reefs where habitat is altered and/or destroyed by bleaching events, sea level rises and increased severity of El-Nino and La Nina events, the latter two potentially causing havoc to agricultural production in those parts of the world affected due to droughts and extended periods of high rainfall, and potentially to supplies of inputs to feeds.

The primary objective for aquaculture must be adaption to climate change, coupled with an examination of how aquaculture generally can reduce emissions that are the primary cause of climate change or even sequester carbon and thereby gain “credits” for so doing. Whilst adaption is not a solution to climate change, and will have to be implemented on a country by country basis, it is the first step in reducing vulnerability and exposure to climate change, and furthermore integration of adaptation into planning, including policy design, and decision-making can promote synergies with development and disaster risk reduction<sup>59</sup>.

Various forms of adaption in aquaculture in the Pacific might include, initially, moving aquaculture ashore using RAS systems, so that as temperature rises, natural disasters and extreme weather conditions are largely protected against; using submersible cages offshore to avoid damage from typhoons and cyclones; and shifting to species of fish that require less fish meal and fish oils in the diet or which are known to sequester carbon.

However, even some of these forms of adaption are still at the mercy of the weather and climate change, such as low protein and oil feeds, as the countries that produce the carbohydrate required in the protein and oil reduced feeds will also be affected. Additionally, it needs to be understood the remedies required may be unacceptable to many. Genetically modified grains are already available to provide substitutes for fishmeal and fish oils and it is already possible to insert traits into aquaculture species using the same technology, but many countries and people do not accept GM products. Similarly, adjusting the genome of fish species<sup>60</sup> so that they are more adapted to climate change may well also rise ethical issues that go beyond aquaculture itself.

It is obvious that climate change is already affecting aquaculture and as temperatures rise and the extremes of weather and climate intensify adaption must be promoted. Longer term it must be ensured that aquaculture is also playing its part in reducing greenhouse gases, and this will require adoption of smart technology (T4), solar and wind power and significant investment in RAS (by bringing aquaculture ashore, controlling the environment of the fish and increasing intensity of operations).

### **13.2.6 To improve market access & supply chains**

Supply chains into the aquaculture industry in PICTs are generally long and slow, and

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<sup>59</sup> IPCC. 2022. *Climate change 2022. Impacts, adaption and vulnerability. Summary for policymakers*. Working Group II (WGII) contribution to the Sixth Assessment Report (AR6) of the IPCC.

<sup>60</sup> The European Court of Justice has recently assessed that gene editing is the same as “Genetic Modification”, but this is still in dispute.

streamlining the provision of inputs is important since interruptions to supply of seed, feeds (including micro-algae) and equipment can cause critical stoppages. Firstly, it is important to have a good understanding of supply chain processes and data, and this requires a regional study to understand what is actually currently happening. It is an essential first step required to try to assess what can be achieved to alleviate the situation.

Part of the problem is due to the difficulties in transportation with less than ideal shipping times, infrequent or non-existent flights from major supplying countries (especially the Asian region), and complex paperwork involved in importing into some countries and territories. The PICTs themselves are unlikely to be able to significantly change the shipping and airfreight situation, it being based on purely commercial considerations, and complex paperwork and tax systems for importers seem to be a feature of most countries, and unlikely to be changed unilaterally. It should however be possible to improve this situation through regional cooperation, at least between the countries within the region.

Furthermore, some PICTs have rules and regulations that make importing from the most obvious or cheapest supplier more difficult than it should be. Many of these are related to biosecurity where strict regulations and inspections cause delays and increased costs. As commercial aquaculture moves into a new expansionist phase the importation of feeds and seeds is going to much more important and delays could be catastrophic. Once again regional cooperation (on biosecurity in aquaculture) is required.

A third impediment to importation or even purchasing equipment, is that much of aquaculture in the region is run or at least financed by government or donors. Governments and donors, often have complex procurement systems, involving obtaining quotations, guarantees and even, in some cases bonds held against delivery. This can hold up the ordering (and hence delivery) of vital supplies needed to initiate projects or maintain equipment in hatcheries and grow-out facilities. With the move towards RAS, where equipment must be kept running to maintain production, delays of this sort should be avoided, perhaps through derogations to help to smooth the way and allow rapid response to breakdowns and other equipment failures.

Regarding marketing it is generally recognised that some form of certification is a way of assuring buyers, retailers and consumers that products are safe to consume (food safety) and originate (traceability) from aquaculture farms adopting responsible management practices. This applies to both local markets as well as export markets (indeed many export markets will demand appropriate certification). There is, a need for harmonization of product quality and safety standards within aquaculture in the PICTs, implying increased development and wider use of internationally accepted, scientifically based standards, though in some countries there is an emerging sophistication and capacity of domestic markets. Harmonised COPs and GMP for aquaculture<sup>61</sup> across the region will be important for this so that the same standards are applied everywhere. Fortunately the FAO Codex Alimentarius<sup>62</sup> includes standards for all principal foods (whether processed, semi-processed or raw) for distribution to the consumer, with provisions related to food hygiene, food additives, pesticide residues, contaminants, labelling, presentation, methods of analysis and sampling. Codex standards and related texts are

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<sup>61</sup> The principles of achieving harmonization of standards and equivalence in food control systems and the use of scientifically based standards are embodied in two binding agreements of the WTO: the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) and the Agreement on Technical Barriers to Trade (TBT Agreement).

<sup>62</sup> The Codex Alimentarius is a collection of internationally adopted food standards and related texts presented in a uniform manner. These food standards and related texts aim at protecting consumers' health and ensuring fair practices in the food trade.

voluntary in nature. They need to be incorporated into national legislation or regulations in order to be enforceable. It should be noted that small-scale farmers are already facing difficulties in producing for export; as they strive to meet such requirements, they may find themselves unable to afford this owing to the high cost of compliance. This is an area where farmer cluster, or satellite farm (“nucleus estate”), approaches could be beneficial.

It also needs to be emphasised that, alongside quality and safety issues, supermarkets and retailers around the world, largely in developed countries, buyers are demanding, on behalf of their customers, increasingly detailed requirements based on environmental and ethical criteria. The PICTs are well placed here as the region as a reputation for clean and unpolluted waters, but this aspect needs to be incorporated into any improvement in the quality and safety standards adopted, and ecolabeling prioritised. Advances in digitalization of data about on-farm and supply chain practices (e.g. blockchain technology), such as those now being adopted by the Australian rock oyster industry, provide real opportunities.

The generalized lack of adequate and quality infrastructure support remains a constraint on further development of both domestic and international markets for aquaculture products. This type of support broadly falls into two categories: support that is internal to the sector, such as establishment of quarantine facilities and hatcheries; and support that is external to the sector but benefits the sector as well, such as markets, laboratories, power facilities & supply, ice production, chill storage and good communications. Affordable and reliable domestic freight options from outlying maritime provinces to central exportation points is a particular challenge.

Whilst compliance with international food safety standards has improved, there is, a need for further support in capacity building in all PICTs to meet the increasingly stringent requirements for export of aquaculture products.

### ***13.2.7 To enhance quality of post harvest product.***

Whilst markets demand quality control so that the public is protected from possible contaminants, bacterial and viral contamination and unwanted residues there has been little action within PICTs to apply COP or GMP to post harvest aquaculture (there has been in capture fisheries) or pre-harvest monitoring of environmental water quality indicators. As an example depuration units for shellfish are not used and oysters and clams end up in the local markets with no guarantee of safety, and no indication of their origin. With increasing population pressure and less than ideal sewage systems in many areas the possibility for contamination with viral and bacterial pathogens in shellfish is increasing. Similarly, the use of animal manures in tilapia production can also be a problem. For export markets guarantees of quality will be essential, not voluntary, and as production increases it is possible that the importers will demand proof of testing for heavy metals, antibiotics and chemical pollutants. Attention paid to this area could unlock one of the last major under-utilized aquaculture development opportunities in the Pacific - that of farming “extractive” species like filter-feeding shellfish.

Whilst many PICTs have suitable laboratories to undertake tests as required, particularly those which have been exporting fish to the European Union (EU), many do not. In the future any large scale exporting country will have to have access to a suitable laboratory, though it does not have to be actually in country, and a regional hub could be used for necessary testing.

It is thus essential that aquaculture departments ensure that local producers adopt the Hazard Analysis Critical Control Point (HACCP) programme, which is proactive in identifying hazards.

Additionally will have to write and then get the producers to implement Good Manufacturing Practices (GMP), Good Hygiene Practices (GHP) (and Good Laboratory Practices (GLP)) measures. This will result in the overall improvement of the quality assurance chain allowing instituting traceability chains, and conducting regular monitoring and analysis of microbiological and chemical parameters in fish, water and sediments. Fishers and other stakeholders will have to be trained in sanitation and hygiene to ensure that the fish and fishery products are of the highest quality and safe for human consumption. Shellfish Harvesting Management Plans modelled on Australian or New Zealand practice, backed by government-led science and MCS, can be adopted in order to meet international standards. It is a long and arduous task but is essential for the long term success of aquaculture in the region.

### **13.2.8 To establish regional cooperative institutional frameworks**

Much is talked about regional cooperation in aquaculture and how it could benefit PICTs. This is apparent throughout all aquaculture activities, from import and export of materials, quality control, certification, legislation, harmonising import taxes and generally clearing up the myriad paperwork required to do run a successful aquaculture business exporting product and importing inputs.

Despite the obvious advantages there are more than a few hints of nationalism apparent where PICTs wish to have their own programmes, facilities and equipment and see no reason to subordinate their control over certain activities to another country. This is a waste of resources, because, logically, the country with the best training institute, research institution or capacity/expertise should naturally be responsible for work in the area where they excel, the results of which can then be used in neighbouring countries or throughout the whole region.

Capacity building is an area where cooperation greatly enhances results. The region has several institutions for developing capacity in a variety of fields, including aquaculture. USP is the foremost of these, being the centre of excellence for the whole of the non-US territories; and the UPNG also has aquaculture courses, as has Lae Unitech and the PNG National Fisheries College in Kavieng. Capacity development in the US Territories is mainly through the College of Micronesia (Palau, Federated State of Micronesia (FSM) and Republic of the Marshall Islands (RMI) and the University of Guam. These need to be supported so that they can provide services to all PICTs. There are also opportunities for regional cooperation in training researchers, and in aquaculturalists through internships, attachments and scholarships, linked with educational and training facilities in the greater Pacific region.

“Research”, which is often just the application of techniques perfected elsewhere to local conditions, is constantly repeated, both in-country and across the region. For instance there really is no need for several separate PICTs to be researching closing the life cycle of rabbit fish in the hatchery, particularly as they are all doing it at the same time, when the work has already been successfully achieved in at least one location already. Better that the results of this success in one PICT is transmitted to others, through hands on workshops and training, the production of hatchery manuals and follow up training. On the same theme there is probably no technological need for more than 2 or 3 countries to be actually spawning rabbitfish. Post larvae fish take up little room and can be transported long distances at relatively little cost with suitable survival rates. These lessons can be applied across the board; e.g. giant clam, pearl oyster, tilapia, rock oyster and other species.



Amongst the laws and regulations that would benefit from better cooperation are those relating to biosecurity, in that harmonisation of biosecurity regulations could perhaps assist in the movement of guaranteed healthy seed or broodstock between PICTs. The recognition of centres of excellence producing quality seed and broodstock should permit biosecurity concerns to be alleviated.

As alluded to above, COPs, GMPs and other quality control and post harvest tools and manuals also would benefit from being harmonised regionally.

### ***13.2.9 To mainstream cross cutting issues such as health, environment and gender in the whole aquaculture value chain throughout the region.***

There are numerous cross cutting sectoral issues in aquaculture. The technological, legal, health, marketing and trade issues have been detailed above under the individual objectives, and the advantages of some arrangement for regional cooperation to address the issues alluded to. These become apparent during any discussion on the future of aquaculture.

One of the most important is the inclusion of the diversity of people in communities, particularly based on gender, but also vulnerable and excluded groups (youth sometimes, but also outsiders & landless immigrants from another area) is imperative. Not only are PICTs obliged by global treaties, protocols and regional agreements to address the issue, but gender (in particular) is highly essential not only from a donor perspective, but also from the developmental planning and implementation points of view. Gender of course is not just about women, and men have to be included in the planning process.

Achieving this includes data solutions (e.g. qualitative and quantitative gender/age-sensitive indicators, sex-disaggregated data); high level policy solutions (e.g. responsible governance of tenure security, equitable resource access rights); resource control and access (e.g. control over access to aquatic resources); and the inclusion of gender and vulnerable groups in all development planning. Additionally, training and capacity improvements should include all marginalized groups, and government servants should be more aware, through the inclusion of the topic in all training programmes, in schools, colleges and universities.

## **14. THE FUTURE STRATEGY (OBJECTIVES AND EXPECTED OUTPUTS)**

### **14.1 Proposed process for consultation and preparation for development of a Regional Aquaculture Strategy**

Through information gained during the consultation process of this assessment and discussions and feedback from the SPC team the below is suggested process to further develop and finalise a mid to long term regional aquaculture strategy for the PICTs. These include;

1. On the basis of this report prepared by the external consultants, a decision at the SPC Heads of Fisheries (HoF) 2022 to proceed to develop the Regional Aquaculture Strategy and to initiate a wide ranging consultation; led by SPC.
2. Funding and the support of donor partners sought by SPC based on HoF decision.

3. SPC to initiate the process by contacting PICT Aquaculture sections in fisheries Departments and advise as to the next steps which are:

#### **Year 1**

- i. Initial video consultations with individuals in aquaculture departments and divisions;
- ii. Agreement sought (and obtained) for in-country needs and direction analysis for the Regional Strategic Plan and appointment of a government focal point for stakeholder consultations in each PICT.
- iii. Identification of key stakeholders, both primary and secondary, carried out by focal point/s (Brainstorming sessions).
- iv. Consultations with stakeholders. Either the country focal point/s undertakes consultation limited to a series of individual interviews, or in larger, countries with more complex aquaculture activities the focal point/s conducts one day workshops assisted if necessary by TA recruited by SPC; using techniques to identify/confirm stakeholders, define objectives and confirm proposed actions. Country based secondary stakeholders are included in the consultations.
- v. Three small sub-regional workshops in central locations geographically to consolidate the results of the in-country consultations, and involve sub-regionally based secondary stakeholders.
- vi. The results of the 3 sub-regional workshops are consolidated by SPC into a Draft Regional Aquaculture Strategy which is distributed to all PICTs for further comment.

#### **Year 2**

- vii. A validation session for the draft Regional Aquaculture Strategy is incorporated into the annual Regional Technical Meeting on Coastal Fisheries and Aquaculture (RTMCFA) and further adjustments made to the Draft Regional Aquaculture Policy for Aquaculture document as necessary.
- viii. Draft Regional Aquaculture Policy is distributed to all PICTs fisheries administrations for them to further distribute internally to all stakeholders; who make further comments as appropriate, which are incorporated in the document.
- ix. Draft Regional Aquaculture Policy is presented to HoF meeting for acceptance.
- x. On acceptance Regional Aquaculture Policy promulgated throughout the region with much media coverage and publicity.
- xi. PICTs proceed to implement the Regional Aquaculture Policy, assisted by regional institutions and partners.

Recent consultation on future strategy, needs and aspirations in the aquaculture sector in PICTs have been mainly with secondary stakeholders; those who's lives are not directly affected by or affect aquaculture activities. These have included government departments & divisions, and donor partners and their research affiliates, universities and colleges. During this study a number of the commercial operations were also interviewed, and it was significant that their needs and priorities were quite different from many of the other secondary stakeholders.

For the strategy to be both owned by the PICTs and the aquaculturalists operating, their consultation on the strategy must incorporate everyone, the primary and secondary stakeholders, including the young, women and disadvantaged groups. These people are often insufficiently represented in consultation meetings and workshops, and even if they are, they seldom speak out.

The strategy must also recognise the nature of aquaculture in the Pacific region and acknowledge the importance of;

- 1) Community based coastal aquaculture<sup>63</sup>;
- 2) Land or coastal based aquaculture for food security and income;
- 3) Commercial aquaculture (with the main motivation being profits); and
- 4) Reseeding and restocking.

Each have different characteristics and needs.

Similarly, the diversity of the peoples, the climate, topography and the oceanography of the PICTS need to be stressed, since each country or territory will be different from the others and require a slightly different approach.

## 14.2 Stakeholders

Stakeholder participation improves the quality, effectiveness and sustainability of development projects and enhance the commitment and ownership of governments, beneficiaries and other stakeholders. One of the main benefits is that the feeling of ownership by the PICTs of the Regional Strategy when it is completed will be enhanced, and they are more likely to implement it. It is therefore important to identify stakeholders.

Stakeholders are people/communities who may, directly or indirectly, positively or negatively, affect or be affected by the outcomes of projects or programs. The development of a regional aquaculture strategy includes the following key stakeholders.

**Primary stakeholders** in aquaculture are the beneficiaries or those directly affected (positively or negatively) by it. They include those already involved in aquaculture such as small holder farmers whether for food security or some income earning activity, community groups and commercial operators, but also includes individuals and/or communities who benefit from, or for some reason are excluded from aquaculture but are affected by it (such as women in some areas), as well as those involved in marketing and services directly associated with aquaculture.

They include:

- Fish and invertebrate small scale farmers and members of participating communities throughout the region;
- National and Regional Aquaculture Producer Organisations & Associations;
- Commercial farmers and their staff;
- Feed & equipment suppliers;
- Airlines & shipping companies;
- Import/export companies;

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<sup>63</sup> One possibility for a formal consultative link to this sector is via the Community Fisheries Dialogue component of the annual RTMCFA

- Local and regional business entities that wholesale and/or retail aquaculture commodities; and
- Consumers of the products of aquaculture, including tourists in hotels and those in importing countries.

**Secondary stakeholders** are those who influence aquaculture or are indirectly affected by it. They include governments, line ministries and project staff, implementing agencies, local governments, civil society organizations, private sector firms (consultants), and other development agencies.

They include:

- Central and provincial government bodies whose responsibilities also cover aquaculture (e.g.: Fisheries, Aquaculture, Biosecurity, Health, Trade & Commerce, Chamber of Commerce, Environment, Agriculture, Quarantine, Land Issues, Finance);
- Regional organisations and donors such as SPC, FAO, Australian Centre for International Agricultural Research (ACIAR), SPREP, Japan International Cooperation Agency (JICA), Overseas Fisheries Cooperation Foundation (OFCF), World Bank (WB), Asian Development Bank (ADB), UNEP, International Fund for Agriculture Development (IFAD), World Organisation for Animal Health (IOE), Centre for Tropical and SubTropical Aquaculture (CTSA), Sea Grant, Land Grant;
- Locally based NGOs
- Regional Non-Government Organisation (NGOs), including Conservation International (CI), The Nature Conservancy (TNC), Worldfish.
- Research institutions and bodies, both in PICTs and in other host nations.
- International bilateral partners such as Australia (AusAID), New Zealand (Ministry of Foreign Affairs – MFAT), Japan, France, Peoples Republic of China (PRC), Taiwan, United Kingdom and United States Agency for International Development (USAID);
- Ancillary support industries including banks, finance institutions and foreign investors;
- Consumers;
- Landowners;
- Phone companies (communications and banking); and
- Consultants.

This indicative list must be verified, modified and enhanced at the PICT country level once consultations in-country begin.

### **14.3 Roles and responsibilities in the development of the strategy**

Initially the PICT administrations will be involved in the further development of the regional strategy through participating in the consultative process, concentrating on the primary stakeholders, those that are directly affected positively or negatively by the strategy, and those that tend not to be consulted sufficiently.

Most of the consultation to date, including this review study, has been with the administrations

and to some extent the larger commercial aquaculture farmers/producers: this is unsatisfactory for a variety of reasons, but mostly because it skews the priority actions towards the wishes and prejudices of these secondary stakeholder actors, and large operators, rather than the small scale aquaculture community, the “little people”<sup>64</sup>. This is of course a mistake, as these small scale and community farmers are the people many of the aquaculture efforts by governments are aimed at, for community aquaculture, poverty alleviation and food security. They can be difficult to include in consultations, sometimes due to physical access and time required to engage the stakeholders, language difficulties, because traditional practices exclude some individuals and partly because of their gender, age, poverty or remoteness. Also they may not be accustomed to being consulted, often because they have to work when consultations run by government functionaries take place.

Another failure of past consultation has been to be concentrating on the community and traditional leaders, without involving women and the younger and more productive sections of society. In many communities the older leaders tend to speak for themselves and their world view: but they are often not representative of youth, women (young and old) and other vulnerable or marginalized groups. It is therefore paramount to be far more inclusive in participation than just inviting the “community elders & leaders” to come round to a meeting and talk about aquaculture.

It is hard work making a consultation of primary stakeholders really representative and as such needs to be factored into the stakeholder planning process and appropriate funding allocated. As a result administrations will have to provide staff, venues and incidental expenses for the participatory phase of the development of the Draft Regional Strategy, and also consolidate the results of the various consultations and workshops so that they can be presented at the Regional Workshops to be held later.

## 14.4 Results of achieving the objectives

The following table lists the expected results if the proposed objectives are pursued.

Proposed Objective	Expected Results
Proposed Objective	Expected results
To mainstream aquaculture into the economic and social development agendas of PICTs	<ul style="list-style-type: none"> <li>• Aquaculture given more emphasis in government planning</li> <li>• More support for aquaculture development generally</li> <li>• Financial institutions more likely to lend into the industry.</li> <li>• Outside investment from Asia/USA/Europe into aquaculture in PICTs</li> <li>• National resources for improved support for aquaculture</li> </ul>

<sup>64</sup> Covid has played it's part in reducing consultation as many cannot be contacted

Proposed Objective	Expected Results
	development mobilised
To increase aquaculture production of edible and non-edible aquatic products for income and food security in the commercial, community and small holder subsectors	<ul style="list-style-type: none"> <li>• Aquaculture projects and programmes are assessed for viability (either economic or on other criteria) before being pursued</li> <li>• Aquaculture success, particularly in the small scale sector is demonstrated.</li> <li>• Growth in aquaculture production and investment in medium and large scale commercial aquaculture operations</li> <li>• Small holder / community based aquaculture transformed into successful and productive businesses</li> <li>• Technology introduced to establish functional linkages between farmers, extension service, data collection knowledge bases and research.</li> <li>• Technology introduced to reduce costs and improve production efficiency in aquaculture and the introduction of RAS.</li> <li>• Inclusion of women youth and other vulnerable groups in aquaculture technologies and fish processing.</li> <li>• Promotion of aquaculture by demonstrable success</li> </ul>
To improve biosecurity in the region.	<ul style="list-style-type: none"> <li>• Sound regional policies and legal frameworks for species introductions, feed, GM and general aquaculture developed, harmonised and applied across regions</li> </ul>
To improve capacity in the aquaculture sector	<ul style="list-style-type: none"> <li>• More government departments obtain a knowledge of aquaculture principles and needs</li> <li>• Aquaculture department staff skills improved</li> <li>• Use of technology to improve training at all levels in the industry</li> <li>• Business skills and money management introduced to all farmers</li> <li>• SPC, USP, UPNG and College of Micronesia become Regional Hubs for training and data storage</li> </ul>
To assess the effects of climate change and other natural disasters in the region and develop outline plans for mitigating measures.	<ul style="list-style-type: none"> <li>• Climate change adaptation and mitigation measures for aquaculture developed.</li> <li>• Technological resolutions to some climate change threats developed.</li> </ul>
To improve market access & supply chains	<ul style="list-style-type: none"> <li>• Value chains across the region understood and bottlenecks dealt with.</li> <li>• Expanded domestic markets for fish, including the growing urban demand.</li> <li>• Expanded export markets</li> </ul>
To improve quality of post harvest product	<ul style="list-style-type: none"> <li>• Regionally consistent GMPs, COPs and SOPs for aquaculture developed, adopted and practiced.</li> <li>• Regional aquaculture production input, product development and trade support enhanced.</li> </ul>
To establish regional	<ul style="list-style-type: none"> <li>• Improved and consolidated cooperation in aquaculture research and development initiatives among and between</li> </ul>

Proposed Objective	Expected Results
cooperative institutional frameworks	<ul style="list-style-type: none"> <li>• PICTs established.</li> <li>• Responsible commercial and small-scale aquaculture development facilitated and not hindered by Regulatory Frameworks.</li> <li>• Harmonised policies, laws and regulations such that they promote sustainable aquaculture development.</li> <li>• Development of regional hubs for research, seed production, training and biosecurity throughout the region.</li> </ul>
To mainstream cross cutting issues such as health, environment and gender in the whole aquaculture value chain throughout the region.	<ul style="list-style-type: none"> <li>• Food policy in the region includes aquaculture</li> <li>• COPs and GMP prevent contamination of the products of aquaculture</li> <li>• Zoning of areas of possible aquaculture development</li> <li>• EIAs incorporated into aquaculture planning</li> <li>• Gender, youth and vulnerable groups included in all national aquaculture development plans, which are harmonised and integrated to regional plans and policies</li> <li>• Regional policy on genetically modified organisms in aquaculture and feed</li> </ul>

## 14.5 Roles and responsibilities

Once the regional strategy is approved the roles and obligation of the individual PICTs will be to provide leadership, establish supportive administrative mechanisms and monitor the in-country implementation of the Regional Strategy. States will have to focus on:

- Co-operating with one another to ensure that the objectives of the strategy is achieved.
- Harmonising their national policy and strategies with the regional strategy/s.
- Strive to create an environment in which the sector is valued and supported at the most senior levels of government.
- Push for aquaculture development needs to be given prominence in national development agendas.
- Engaging with and ensuring the participation of all other stakeholders, notably the secondary stakeholders, in the promotion of the objectives of the Strategy.
- Assist with the transfer of skills and technologies between PICTs, and from outside the region to enhance effective regional research and cooperation.
- Work with relevant donor and cooperation partners including the private sector, NGOs and communities
- Working with regional organisations and development partners to obtain external funding to support the implementation of strategy.
- Report to HOF meeting biennially national progress against the objectives.

The SPC will be responsible for the coordination of the consultation process, the preparation of 3 separate sub-regional reports and the consolidation of these 3 reports into the Draft Final Report to be submitted to the RTMCFA and HoF meetings in Year 2. Appropriate funding will have to be sourced, and appropriate technical assistance sought where necessary.

## **14.6 Implementation Mechanisms, roles and responsibilities**

The SPC, in collaboration with the institutions responsible for aquaculture in the PICTs as well as regional and international agencies will guide the implementation of the strategy once it is approved. The success of the implementation of the strategy presupposes the various stakeholders, but particularly the institutions and governments of the PICTs, actively playing their roles.

Policies and strategies are of little value in the absence of supporting political will and financial resources.

## **14.7 Resource requirements**

There is currently no funding for the preparation and adoption of a regional strategy for aquaculture. Resources will have to be sourced as soon as possible for the work leading to the preparation of the Draft Regional Strategy and then as required on a case by case basis for its' implementation.

## **14.8 Monitoring and evaluation**

The SPC FAME will ensure that monitoring provides for aggregate indicators to monitor the overall development of aquaculture in the region by tracking developments at the operational and technical level. The SPC FAME will also play the role of advisor and facilitator in ensuring that appropriate interventions are implemented, and supplementary programmes are developed, as may be required, to ensure that targets are met or that changing scenarios are addressed.

The draft regional strategy will include priority actions, indications of who is to carry them out and a basic timeline for each activity. This will provide a basis for assessment of progress and should also indicate where problems are being encountered and remedial actions need to be implemented.





## SPC FAME

Assessment of the aquaculture needs, priorities and future direction in the Pacific Islands region

8 May 2022

### Appendices to the Report



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## APPENDIX I. COUNTRY AQUACULTURE INFORMATION 2022.

Based on video interviews, e-mail exchanges, published information, donor and regional organisations reports and news reports. It was impossible to visit the PICTs due to Covid restrictions on travel. American Samoa and Tokelau were not interviewed and the information comes from written reports and internet archives.

The SPC aquaculture programmes covers all these countries. Visit: <https://aquaculture.spc.int/> for more information; particularly good for a historical description of the aquaculture attempted.

Also visit [https://aquaculture.spc.int/index.php?option=com\\_statistics&view=statistics&Itemid=85](https://aquaculture.spc.int/index.php?option=com_statistics&view=statistics&Itemid=85) for historical production figures.

For statistics use <https://www.fao.org/fishery/en/statistics> or <https://data.worldbank.org/>.

For details of the people in the organisations use the SPC address book. <https://spc.int/resource-centre/publications/spc-fisheries-address-book-2022>.

<b>American Samoa. Department of Marine and Wildlife Resources (DMWR)</b>	
Current species cultivated commercially	None
Current species used for food security & small scale community based production	Tilapia. Small scale, backyard. 20 tonnes per year estimate (2018). Mostly for home consumption but some sold locally.
Other species attempted or planned	Attempted: Baitfish, giant clams. Threadfin (moi), mangrove crab.
Research	Currently none. American Samoa Community College/Sea Grant on occasional basis as grants permit.
Legislation etc	American Samoa Marine Conservation Plan US law generally applies.
Major problems	Lack of incentives to engage in Aquaculture Competition for land use from housing Shortage of suitable sites.
Web sites	<a href="https://www.ctsa.org/region/american_samoa">https://www.ctsa.org/region/american_samoa</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=1&amp;Itemid=4">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=1&amp;Itemid=4</a>
Useful references	American Samoa Government. 2018. American Samoa Marine Conservation Plan. Dept of Marine and Wildlife Resources.

<b>CNMI. Division of Fisheries and Wildlife</b>	
Current species cultivated commercially	Tilapia. Only 4 farms, 2 commercial and 2 backyard operations. All product sold locally. 2 in Saipan and 1 each in Rota and Tinian. 42 tonnes in 2016. Clams and corals for reef restoration and aquarium trade. Based in Saipan, very small scale.
Current species used for food security & small scale community based production	Some small scale milkfish, details very sketchy but known to be negatively affected by Covid.
Other species attempted or planned	Attempts at sea cucumbers, clams, corals for reef restoration, but mostly small scale. Rabbitfish.
Research	On going at the Northern Marianas College. Spinefoot Rabbitfish. Closed the life cycle and now hoping to expand to exporting of seed to Guam for ongrowing. Some corals for re-seeding, not an aquaculture project. Reef restocking. <i>M var</i> in country but <i>M rosenburgii</i> is preferred and a clean source would be required (probably Hawaii).
Legislation etc	Follows USA.
Major problems	International logistics. No feed for Rabbitfish. Limited markets. Difficult to get land for inshore aquaculture.
Web sites	<a href="https://www.marianas.edu/">https://www.marianas.edu/</a> <a href="https://www.fisheries.noaa.gov">https://www.fisheries.noaa.gov</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=13&amp;Itemid=44">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=13&amp;Itemid=44</a>
Useful references	Commonwealth of the Northern Mariana Islands Aquaculture Development Plan 2011-2015.
Effects of Covid	There used to be some milkfish being grown (very small scale) but this has now stopped due to covid. Clam & coral exports were not affected as the air transport system still worked, though irregularly.

<b>Cook Islands. Ministry of Marine Resources</b>	
Current species cultivated commercially	Black pearl. This is the major species and accounts for more than 90% of aquaculture in the Cooks, and is concentrated in Manihiki Island. MMR marine & food safety laboratory available to support the industry. The industry was badly affected by the lack of tourists during Covid. Aquarium fish and corals – small scale. The Cook Islands statistics department produces import and export figures and this shows that Pearls reduced from a peak of NZ\$297,000 in 2016 down to NZ\$174,000 in 2019 and just NZ\$23,000 in 2000 (due to Covid). Aquarium fish was recorded at NZ\$56,000 in 2019 and zero in 2000.
Current species used for food security & small scale community based production	Milkfish – very limited on outer islands. Giant clam export to aquarium trade – small scale - closed down due to Covid.
Other species attempted	Attempted: <i>Pinctata maxima</i> oyster (long ago). Trochus (abandoned) <i>Macrobrachium</i> Shrimp.

or planned	Planned: Milkfish & mudcrab in with the milkfish. Shrimp. Possibly local species of rock oysters.
Research	Aitutaki Island: Araura Marine Research Centre hatchery to grow clams, has trialled milkfish.
Legislation	Marine Resources Act 2005. Lacking specifically for aquaculture. Cook Islands Aquaculture Development Plan 2012 -2016.
Major problems	Shortage of various skills/capacity in the pearl industry. Climate change and climatic events. Microplastics and genetic drift in pearls. Difficulties with transport internally and internationally.
Web sites	<a href="https://www.mmr.gov.ck">https://www.mmr.gov.ck</a> <a href="https://www.mmr.gov.ck/inshore-fisheries-aquaculture/">https://www.mmr.gov.ck/inshore-fisheries-aquaculture/</a> <a href="http://www.ck/pearls.htm">http://www.ck/pearls.htm</a> <a href="https://environment.gov.ck/island-futures-division/biodiversity/">https://environment.gov.ck/island-futures-division/biodiversity/</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=3&amp;Itemid=5">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=3&amp;Itemid=5</a> <a href="http://mfem.gov.ck/statistics/economic-statistics/overseas-trade-stats">http://mfem.gov.ck/statistics/economic-statistics/overseas-trade-stats</a>
Useful references	Cook Islands Aquaculture Development Plan – 2012 -2016 Manihiki Natural Resources Bylaws 2003. Anon. 2018. National Strategy on Aquatic Biosecurity for the Cook Islands.
Effects of Covid	Devastating to the pearl industry as no market to tourists. Aquarium fish exports stopped, company has been reducing sales for several years?

<b>FSM. Department of Resource and Development – FSM National Government (FSM R&amp;D)</b>	
Current species cultivated commercially	Pohnpei bath sponge, sea cucumber (Pohnpei Island) both small scale (pilot projects), hard and soft coral and clams (Pohnpei) for aquarium trade. Pohnpei operations receive subsidy from various sources. Hatchery on Kosrae used for commercial production of giant clams, hard corals.
Current species used for food security & small scale community based production	Black pearl oysters continuing under Sea Grant – low scale. Distributed to communities but no commercial operations successful.
Other species attempted	Milkfish in Yap and commercial in Pohnpei – abandoned long ago. Giant clam growout in all states, various hatcheries over the years, Sea sponges in all states – except Kosrae small scale not working except Pohnpei – small scale
or planned.	Sea cucumber, but not proved commercially
Research	College of Micronesia has an aquaculture section, and working on sea cucumber. Ample US based funds for many years.
Legislation	<a href="https://fsmlaw.org/">https://fsmlaw.org/</a> provides all laws in the 4 states of FSM <a href="https://fsmlaw.org/fsm/regulations/index.htm">https://fsmlaw.org/fsm/regulations/index.htm</a> Regulations on quarantine, biosecurity etc.

	Member of Micronesian Association of Aquaculture.
Major problems	Remoteness and transport problems. Legal rights to land and coastal areas. Capacity at all levels. 4 state system. Projects not evaluated properly for sustainability.
Web sites	<a href="http://www.fsmrd.fm">www.fsmrd.fm</a> <a href="https://www.ctsa.org/region/federated_states_of_micronesia">https://www.ctsa.org/region/federated_states_of_micronesia</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=4&amp;Itemid=16">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=4&amp;Itemid=16</a>
Useful references	Anon 2004 Aquaculture Profile for Pohnpei Federated States of Micronesia September 2004 Publication #2004-1. Ellis, S. 2009. Feasibility Study of Aquaculture Potential for MPA Communities in the State of Chuuk, FSM. Society, (November), 1-20. Available under request at: <a href="http://www.meripmicronesia.org/">http://www.meripmicronesia.org/</a> . FSM Government 2014 FSM Aquaculture Development Plan Produced by SPC for FSM Government, R&D Department 2014. Draft National Strategy on Aquatic animal health and biosecurity for the Federated States of Micronesia. (2021–2024).

Fiji. Ministry of Fisheries	
Current species cultivated commercially.	Tilapia, intercropped by <i>M. rosenbergii</i> . One large scale commercial farmer. Round Pearls. Two farmers. (Used to be 4). Devastated by Covid as no tourists. Mudcrabs; also affected by covid.
Current species used for food security & small scale community based production.	Tilapia for food security and as a small business. 500 fresh water finfish farmers. 2 million fry/year production. These are distributed free to farmers. 90% come from the hatchery in Nausori, with 10% from the other government hatcheries and there are 3 private hatcheries. There is capacity to produce all-male fry both in government and in private hatcheries, though many batches continue to be mixed-sex for lower cost and smaller target size at harvest (up to 300g). Private hatcheries sell for 10-20c/piece. Farmers are given fry initially and have to buy them after that. They also get free feed for the first cycle only. Also farm <i>M. rosenbergii</i> and grass carp in the ponds. The grass carp are there to eat the plants in the pond. The data shows a production of 50-60 Tonnes. Lots of data missing from the dataset so real production is probably 150-200T. Objective 1000T by 2029 Seaweed, <i>Kappaphycus</i> , but production has slowed due to year 2020 disruptions and subsequent low prices and shipping problems. World Bank data (from FAO) for 2018 gives a total aquaculture production of 795 tonnes.
Other species attempted.	There have been many attempts at commercial aquaculture in Fiji and most have failed. <i>P. monodon</i> and <i>P. vannamei</i> are examples due to hatchery technical issues. Milkfish – up to the year 2000 by wild capture, hatchery effort now being attempted. Previous Giant clam and coral exporter stopped as license revoked. Giant clams on Makogai Island still there but only just. Oysters for the tourist trade (private with community outgrowing). Rabbitfish, mullet and grouper experimental. Sea cucumber experimental

or planned	Other seaweeds, sponges, reef finfish, sea cucumber, mud crabs and pacific oyster.
Research	Oysters, Giant clam. Mabe pearl. Community based. Wild spat collection. Sea cucumber.
Legislation etc	Aquaculture bill 2016 (Bill No. 9 of 2016). Fiji 10 year Aquaculture Plan 2005 to 15.
Major problems	Feed. Two local feed mills (private aquaculture) of reasonable quality but insufficient production.. Overseas imports expensive but high-quality and with regular shipments Major hindrance to all large scale production. Large Tilapia farmer produces own feed. Land tenure problems particularly in coastal areas. Not possible to grow for export from Fiji either prawn ( <i>M vannamei</i> ) or Tilapia as feed costs too high. Skills shortage everywhere. Notably microalgae for sandfish production. Capacity in shrimp and sandfish and tilapia. Need lots of technical training but also training in business and money management for farmers. Need a depuration facility for oysters to ensure food safety. Big challenge. Need a seafood safety policy for aquaculture. Should adopt social media for communication and data collection. Poor statistics.
Web sites	<a href="https://www.facebook.com/fisheriesfiji/">https://www.facebook.com/fisheriesfiji/</a> <a href="https://www.fisheries.gov.fj/index.php/divisions-fisheries/aquaculture-division">https://www.fisheries.gov.fj/index.php/divisions-fisheries/aquaculture-division</a> <a href="https://womeninfisheriesfiji.org/">https://womeninfisheriesfiji.org/</a> <a href="https://www.fnu.ac.fj/agriculture-forestry-fisheries/">https://www.fnu.ac.fj/agriculture-forestry-fisheries/</a> <a href="https://www.usp.ac.fj/">https://www.usp.ac.fj/</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=5&amp;Itemid=17">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=5&amp;Itemid=17</a>
Useful references	Fiji Ministry of Fisheries Strategic Development Plan 2019 – 2029. Fiji 10 year Aquaculture Plan 2005 to 2015.
Effects of Covid	Huge increase in demand for tilapia during Covid – positive outcome. Transport. Air and sea. Irregular and limited. People moving back to the village having lost their jobs in the tourist industry and wanted to do something so went in to Tilapia farming. Limited extension work and not enough funding capacity. Civil servants assisted the Covid activities of government. Vaccination, awareness, borders etc. So didn't do the routine work like monitoring. High decrease in pearl sales – tourism all but dead during Covid.

<b>French Polynesia. Direction des ressources marines et minières</b>	
Current species cultivated commercially.	Black pearl. Largest export. US\$68 million/year at it's peak, but declined recently due to Covid and now US\$44 million in 2021. Pearl oyster culture has grown quickly since the 1980's. 19 atolls of the Tuamotus island have currently one or more farms and this activity is still growing. The rise of this industry has consequently a lot of socio-economic repercussions on these atolls. Aquarium trade. Corals, fish and seahorses . Blue shrimp ( <i>Litopenaeus stylirostris</i> ), small scale but increasing. Aquaculture production was reported at 1355 metric tons in 2018, according to the World Bank.
Current species used for food security & small scale community based production.	Batfish ( <i>Platax orbicularis</i> ), Rabbitfish ( <i>Siganus argenteus</i> ) 3 farms. Small scale but shows signs of becoming important. Siganids declining production to ~13 tonnes/yr (2019).
Other species attempted.	Historically: Various algae for hatchery operations. The cockle ( <i>Tapes japonicus</i> ) , Culture trials of carangids ( <i>C. ignobilis</i> and <i>C. melampygus</i> ). Milkfish and <i>Poecilia sp</i> (molly). as bait for the skipjack tuna fishery. Green mussel ( <i>Perna viridis</i> ) was introduced in 1978 and successfully cultured in suitable sites. Freshwater prawn <i>Macrobrachium rosenbergii</i> during 1980-90s. Oysters ( <i>Saccostrea cucullata</i> ) were traditionally cultured in some parts of the Society Islands. None moved to commercial viability.  Recently: Batfish ( <i>Platax orbicularis</i> ), and tilapia (in aquaponic farms). Giant clams as well as the collection and husbandry of reef finfish larvae.
or planned	Development of oysters and sea-cucumbers for export to Asiatic market.
Research	IFREMER is the main research and provides technical support to develop aquaculture.
Legislation	Mainly follows French law.
Major problems	Need support and expertise to supervise transfer of product between islands (genetic and contamination problematic, notably sea-cucumber and pearl oysters). More support for legislation and biosecurity. Need technical assistance for the development of the macroalgae sector.
Web sites	<a href="http://www.ressources-marines.gov.pf/aquaculteurs/laquaculture-en-polynesie-francaise/">http://www.ressources-marines.gov.pf/aquaculteurs/laquaculture-en-polynesie-francaise/</a> <a href="https://www.enezgreen.com/polynesie-projet-daquaculture-massive-a-hao/">https://www.enezgreen.com/polynesie-projet-daquaculture-massive-a-hao/</a> <a href="https://www.ispf.pf/bases/Repertoires/CommerceExterieur/Prsentation.aspx">https://www.ispf.pf/bases/Repertoires/CommerceExterieur/Prsentation.aspx</a>
Useful references	Lassauce. H. 2022. French Polynesia and New Caledonia Aquaculture Review. IAS, Australia <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=6&amp;Itemid=18">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=6&amp;Itemid=18</a>
Effects of Covid	Halved the pearl industry exports, to about \$44 million in 2021 (ISPF 2022). Partly due to fewer tourists. Badly affected the aquarium fish industry due to reduced tourism and lower numbers of flights.



<b>Guam. Department of Agriculture (DA)</b>	
Current species cultivated commercially.	Two larger farms. One has a hatchery (PPP, College of Natural and Applied Sciences University of Guam/Private Individual) concentrates on SPF <i>M vannamei</i> for export of PL to China & Taiwan, but also produces, at a fairly low scale, red and black tilapia and shrimp for the local market. Red shrimp salt tolerant so apparently have a better taste. Can also produce fry of walking catfish <i>Clarias batrachus</i> . The other grows tilapia importing GIFT fry from overseas. Has no hatchery. Also tilapia on a small scale. Mostly backyard operators farming on their own land. But seed from the UoG hatchery. Farmers retiring, so numbers going down. No good statistics. World bank indicates 2018 production was 110 tonnes.
Current species used for food security & small scale community based production.	Tilapia & (some) catfish ( <i>C. batrachus</i> )
Other species attempted.	Eel. <i>P monodon</i> . Milkfish. <i>M rosenbergii</i> .
or planned.	Perhaps Rabbitfish, if funding can be found (Private)
Research	Over the years - freshwater prawn, eel, tilapia, carp, catfish, milkfish, mangrove crab, mullet and ornamental carp. Hatchery now commercialised so less pure research going on.
Legislation	Follows USA Member of Micronesian Association of Aquaculture.
Major problems	Land use problems. Lack of available land. Other employment opportunities. No feed industry.
Web sites	<a href="https://www.ctsa.org/region/guam">https://www.ctsa.org/region/guam</a> <a href="https://www.uog.edu/wptra/aquaculture">https://www.uog.edu/wptra/aquaculture</a> <a href="https://www.uog.edu/news-announcements/2019-2020/2020-uog-coreseed-boost-local-food-security-by-farming-shrimp-prawns-and-saltwater-tilapia.php">https://www.uog.edu/news-announcements/2019-2020/2020-uog-coreseed-boost-local-food-security-by-farming-shrimp-prawns-and-saltwater-tilapia.php</a>
Useful references	Centre of Tropical and Subtropical Aquaculture and Sea grant publications.
Effects of Covid	Tourist industry collapsed, but little effect on UOG or small scale producers.

<b>Kiribati. Ministry of Fisheries and Marine Resources Development (MFMRD)</b>	
Current species cultivated commercially.	Giant clam produced by one commercial hatchery (Atoll Beauties). No flights recently so no exports. Previously exported clams to RMI and elsewhere to international markets.
Current species used for food security & small scale community based production.	Sea cucumber for restocking and also community farmers. Done in the hatchery but some problems so no real progress on the ground so far, though the hatchery process is now known – small scale pilot projects. Giant clams for restocking – very small scale.



	Milkfish. The Ambo hatchery is working with a monthly spawning of milkfish. Fingerlings sent to the outer islands. Also supplying a newly installed cage farm in Tarawa lagoon. Also exported milkfish fry to Nauru in the past – biosecurity issues are hindering further development. Temaiko ponds are undergoing rehabilitation and will be restocked with milkfish in the near future. World Bank gives 3652 Tonnes as production for 2018 presumably this was mostly seaweed.
Other species attempted.	Brine shrimp, mullet, black lip pearl oyster Seaweed (now abandoned due to no buyers and lack of interest after early successes).
or planned	Sponge, Corals, Mangrove crab, Sea Grapes all for the future.
Research	Only sea-cucumber currently in Government hatchery.
Legislation etc	Ministry of Fisheries and Marine Resources Development. Kiribati National Fisheries Policy 2013-2025 covers aquaculture. Member of Micronesian Association of Aquaculture.
Major problems	Feed access particularly. Distance from markets/transport, restricted and expensive freight. Internal and external. Capacity generally. Weather events in El-Nino periods.
Web sites	<a href="https://www.mfmr.gov.ki/">https://www.mfmr.gov.ki/</a> <a href="https://www.kiribaticoastalfisheries.net/">https://www.kiribaticoastalfisheries.net/</a> <a href="https://www.facebook.com/MFMRD">https://www.facebook.com/MFMRD</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=8&amp;Itemid=19">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=8&amp;Itemid=19</a>
Useful references	FAO 2019 In-Depth aquaculture risk assessment and business investment planning for Kiribati FAO TCP/KIR/3602/C2. World Bank. 2020. Kiribati: PROP Environmental and Social Management Framework World Bank: P165821 VERSION: Final, January 2020. Jimmy R, Pickering T & B Tioti 2019 Improving community-based aquaculture in Fiji, Kiribati, Samoa and Vanuatu final report published by ACIAR.
Effects of Covid	No transport. Disaster to the clam exports. Experts can't come in so no in country training. 2 years lost.

<b>RMI. Marshall Islands Marine Resources Authority</b>	
Current species cultivated commercially	Giant clams for aquarium trade. Two companies now. Aquaculture Technologies of the Marshall Islands (ATMI) Moi. (Threadfin). For export to Hawaii. No production recently due to Covid. Woja Hatchery at Majuro now sold to MIMRA. 12 newly constructed race way tanks at the Woja hatchery and spawning of larva (2020), Majuro Pearls – stopped due to covid. World Bank gives 2018 production as 2 tonnes.

Current species used for food security & small scale community based production	Giant clams - clam seed from RRE-Mili and College of Micronesia provide. <i>H hippopus</i> , <i>T. derasa</i> , <i>T. maxima</i> and <i>T. squamosa</i> . No <i>T. gigas</i> any more.
Other species attempted	Various (Historical). More recently Seaweed. Pearl – no significant production.
or planned	Rabbit fish on hold. Pearl on hold.
Research	State run hatchery in Majuro is raising moi and Rabbitfish (Rabbitfish on hold). Affected by Covid 19
Legislation	Government of the Marshall Islands Marine Resources Act 1997. Government of the Republic of the Marshall Islands. 2019. Aquaculture regulations 2019 MIMRA Majuro. Marshall Islands. Member of Micronesian Association of Aquaculture.
Major problems	Sites for lagoon and offshore cage farming. Suitable sites for other species. Feed. Have to make their own using waste fish and whatever else they can find, plus starch from Vietnam. Need outside help to provide technical and business training as local staff not qualified enough. Need a marketing strategy.
Web sites	<a href="http://www.ctsa.org/index.php/projects/">http://www.ctsa.org/index.php/projects/</a> <a href="https://www.ctsa.org/region/republic_of_the_marshall_islands">https://www.ctsa.org/region/republic_of_the_marshall_islands</a> <a href="http://rmimimra.com/index.php/resources">http://rmimimra.com/index.php/resources</a> Gives annual reports to 2020 covering aquaculture <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=9&amp;Itemid=20">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=9&amp;Itemid=20</a>
Useful references	FAO. 2021. In depth aquaculture risk assessment and business investment planning for Republic of Marshall Islands. F.A.O TCP/ SAP/3603. Gov of Marshall Islands. 2004 Policies and Priority Actions for Sustainable Mariculture Development in the Republic of the Marshall Islands MIMRA June 2005. Gov of Republic of the Marshall Islands. 2019. The Aquaculture Regulations 2019. MIMRA, Majuro, Marshall Islands.
Effects of Covid.	Pearl farming and research on Rabbitfish stopped. Moi also suspended. Not much achieved over the last 2 years.

<b>Nauru. Nauru Fisheries and Marine Resources Authority</b>	
Current species cultivated commercially	None. There is no room for commercial aquaculture, focussing on restocking and small scale production for food security.
Current species used for food security & small scale community based production	Milkfish. Traditional. Declined as introduced tilapia outcompeted the milkfish. Some milkfish fry have been imported from Kiribati. Good cooperation. Fry distributed to interested people, sold, at cost price. Backyard operations. World Bank gives 2 tonnes as 2018 production. Giant Clams. Spat imported from Kiribati. For communities, but communities don't work together well.

	Hatchery used as a quarantine for incoming fry. No production presently as facilities badly constructed. Pumped water.
Other species attempted  or planned	Seaweed. Bought in from Indonesia. Currents too strong. Hoping to build raceways for Giant Clam, and coral farming for local communities.  Mullet and Rabbitfish and seagrapes in the future Also possibly Tilapia but not liked by the population.
Research	None
Legislation etc	Government of Nauru. 2017. Fisheries Amendment Act 2017 No. 18 of 2017. FAO 2021. National aquaculture business development strategy Nauru. Nauru Fisheries and Marine Resources Authority with assistance from FAO. Member of Micronesian Association of Aquaculture.
Major problems	Remoteness. Transport costs. Small land and reef area. Competition from housing for coastal sites. Must upgrade the extension and technical people in government. No academic people in Nauru in aquaculture. All the technicians are practical people. Training by attachment is useful and SPC have helped to get people to Kiribati for hatchery work. Also need people to be trained in working in communities.
Web sites	<a href="http://naurugov.nr/government/ministries.aspx">http://naurugov.nr/government/ministries.aspx</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=10&amp;Itemid=21">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=10&amp;Itemid=21</a>
Useful references	Government of Nauru 2021. National aquaculture business development strategy Nauru. Nauru Fisheries and Marine Resources Authority SPC/FAO. Government of Nauru. 2020. Coastal Fisheries and Aquaculture Act 2020.
Effects of Covid	Cannot not get feed in for the milkfish. Cannot not get giant clam seed – some from Kitibati. Cannot not get milkfish seed – some from Kiribati. Could not import feed and equipment (main effect), but hard enough even without Covid.

<b>New Caledonia. Gouvernement de la Nouvelle-Calédonie – Direction des Affaires Maritimes de Nouvelle-Calédonie (DAM NC)</b>	
Current species cultivated commercially.	Blue shrimp ( <i>Litopenaeus stylirostris</i> ) Approx 2000 tonnes per years. Mostly exported. Native rock oyster ( <i>Saccostrea cucullate</i> ) 12000 dozen produced/year for local market. Wild spat collection. Small scale aquarium trade: Fish (species depending on collection), soft coral, clams (mainly Tridacnids), soft corals (mainly <i>Sarcophyton spp</i> and <i>Sinularia spp</i> ) and the coral sea seahorse ( <i>Hippocampus semispinosus</i> ). World Bank gives production in 2018 as 1716 tonnes (presumably mostly prawn).
Current species used for food security & small scale community based production	None
Other species attempted	Sea cucumber ( <i>Holothuria scabra</i> ) in prawn ponds. Not commercial yet.

or planned	Fish: 'Pouatte' (Emperor red snapper, <i>Lutjanus sebae</i> ), 'Picot rayé' (Golden-lined spinefoot, <i>Siganus lineatus</i> ), 'Picot gris' (Mottled spinefoot, <i>Siganus fuscescens</i> ). Wild & farmed seed. Not yet commercial, but should be soon. Local sales.
Research	IFREMER is the research centre in NC for aquaculture.
Legislation	Generally follows French laws Strong legislation to protect local production from introduction of foreign species. <a href="https://juridoc.gouv.nc/JuriDoc/JdWebE.nsf/Juristart?openpage">https://juridoc.gouv.nc/JuriDoc/JdWebE.nsf/Juristart?openpage</a> - lists all aquaculture codes etc.
Major problems	Locally produced feeds are low quality. Complicated local political scene with 2 provinces and central government. Research not tested against criteria to assure validity. Underfunding of aquaculture. Capacity issues everywhere. Access to coastal areas suitable for aquaculture. Legislation is not existent for the exportation of CITES classified species. High freight costs for the aquarium trade. General high costs of doing business in New Caledonia.
Web sites	<a href="https://juridoc.gouv.nc/JuriDoc/JdWebE.nsf/Juristart?openpage">https://juridoc.gouv.nc/JuriDoc/JdWebE.nsf/Juristart?openpage</a> <a href="https://www.youtube.com/watch?v=33yTJ2_wSyA&amp;t=1090s">https://www.youtube.com/watch?v=33yTJ2_wSyA&amp;t=1090s</a> - Aquaculture in NC <a href="http://www.aquariumfish-nc.com/">http://www.aquariumfish-nc.com/</a> <a href="https://protege.spc.int/fr/news/peche-cotiere-et-aquaculture/l-aquaculture-en-nouvelle-caledonie">https://protege.spc.int/fr/news/peche-cotiere-et-aquaculture/l-aquaculture-en-nouvelle-caledonie</a>
Useful references	Lassauce. H. 2022. French Polynesia and New Caledonia Aquaculture Review. IAS, Australia.
Covid effects	Reduction in transport generally has affected trade and tourism. Trade has continued but disrupted. No tourism.

Niue. Niue Department of Agriculture, Forestry and Fisheries	
Current species cultivated commercially	None Lack of suitable sites.
Current species used for food security & small scale community based production	None Topography not suitable for most aquaculture. Freshwater species of interest have included freshwater crayfish and tilapia, but there are serious problems which make both unfeasible.
Other species attempted	Tilapia introduced long ago. Trochus introduced long ago. Seaweed trials (Limu fua = seagrape) undertaken 2019 very small scale.
or planned	Giant clams ( <i>Tridacna maxima</i> and <i>Tridacna squamosa</i> ), and more recently green snail. But the site selection of a hatchery is problematical. Still have natural seed for giant clam.
Research	None.
Legislation	None specifically for aquaculture. Niue National Biodiversity Strategy and Action Plan 2015.

Major problems	Topography and danger of cyclones.
Web site	<a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=12&amp;Itemid=43">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=12&amp;Itemid=43</a>
Useful references	Tuart I and Bermudes M. 2019. Limu fua (seagrape) farming trials in Niue. SPC with the support of New Zealand Foreign Affairs and Trade. May 2019.
Effects of Covid	Travel and transport restricted. Tourism went to zero.

<b>Palau. Bureau of Marine Resources. Ministry of Agriculture, Fisheries and the Environment</b>	
Current species cultivated commercially	Biota is a aquarium fish business, ornamentals, corals and clams. Based at the Airai Old Dock. Clams and corals for aquarium trade from old Taiwanese hatchery which fell into disrepair and now renovated. Clams & others exported to USA by air. Unaffected by Covid.
Current species used for food security & small scale community based production	Small farms primarily raise mangrove crabs, rabbitfish, and milkfish. Rabbitfish through the communities but it's stopped due to Covid World Bank gives 2018 production as 23 tonnes.
Other species attempted or planned.	Species which have been trialled in Palau include seaweed, corals, giant clams, crocodiles, milkfish, mollies, mullet, oysters, shrimp, rabbitfish, sponge, trochus, and turtles. (FAO 2002)  Rabbitfish. No feed currently but export of fry to Guam anticipated.
Research	Palau Community College does aquaculture, cooperatives and extension. Research more than extension. Freshly renovated mariculture demonstration center (2019) which will provide research facilities and seedlings for giant clam aquaculture in the country's waters. Giant Clam, Tilapia, mangrove crab, rabbitfish & milkfish. TNC and partners from Bureau of Marine Resources, Environmental Quality Protection Board (EQPB), and the Palau Community College (PCC) have done rabbitfish extension and trial cage culture.
Legislation	Palau National Code Title 27 1990 as amended from time to time. Marine Protection Act 1994. Member of Micronesian Association of Aquaculture.
Major problems	Feed for Rabbitfish. Electricity costs. Fuel costs. Typhoons.
Web sites	<a href="https://www.ctsa.org/region/palau">https://www.ctsa.org/region/palau</a> <a href="https://www.palau.gov.pw/executive-branch/ministries/agriculture-fisheries-and-environment/bureau-of-fisheries/">https://www.palau.gov.pw/executive-branch/ministries/agriculture-fisheries-and-environment/bureau-of-fisheries/</a> <a href="https://pcc.palau.edu/">https://pcc.palau.edu/</a> (Palau Community College) <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=13&amp;Itemid=44">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=13&amp;Itemid=44</a>
Useful references	Government of Palau. 2021.National aquaculture business development strategy Palau. Palau Bureau of Fisheries SPC/FAO.
Covid effects	Limited. Some problems with feed supply to hatcheries.

<b>Papua New Guinea. National Fisheries Authority, Port Moresby</b> (Note that it was not possible to speak to the NFA for this survey)	
Current species cultivated commercially	Barramundi at Daru in Western Province. Hatchery established. Collapsed but being regenerated with outside investors.
Current species used for food security & small scale community based production	<p>Tilapia – widely throughout the country. Mostly back yard production with some larger semi-commercial produces. Numbers of farmers and production figures very hazy, (figures for numbers of farmers vary between ~6000 to ~20,000) but undoubtedly much more than generally reported. GIFT tilapia introduced. NFA hatchery in New Ireland Training Centre is doing tilapia now, and training in aquaculture.</p> <p>Brown &amp; rainbow Trout – concentrated in the highlands. Widespread. Polyculture with carps. Rainbow trout released into streams.</p> <p>Total Aquaculture production is given by World Bank as 6001 tonnes in 2018. (<a href="https://data.worldbank.org/">https://data.worldbank.org/</a>).</p> <p>University of Papua New Guinea carried out giant clam culture and stocking of wild clams as a research activity.</p>
Other species attempted	<p>Pearl oyster – for a long time in Milne Bay province, but now no longer operating.</p> <p>Carp – several species introduced.</p> <p>Barramundi at Madang – collapsed. Feed, marketing &amp; management problems.</p> <p>Carpenters had a prawn farm in New Britain, but difficulty with disease (white spot), issues with exporting and seed.</p> <p>Seaweed has not been successful, except in Bougainville, and details are very sketchy.</p> <p>Local Freshwater prawn <i>Macrobrachium spinipes</i> (formerly known as “eastern” strain of <i>M. rosenbergii</i>) successfully domesticated by SPC, NFA and UPNG research, but no commercial take-up of this opportunity.</p>
or planned	Continued expansion and redevelopment of the current species under cultivation and additional fin fish.
Legislation	<p>Fisheries Management Act 1998 (No. 48 of 1998).</p> <p>PNG Fisheries Regulations 2005.</p>
Major problems	<p>Feed is a major problem. Should be possible to produce good feed in PNG, given the fish meal from the canning factories, but there is stiff competition for this ingredient from the swine industry. There have been regular imports of tilapia fish feed from Vietnam in the past.</p> <p>How to get people with experience to lead when there is no industry where they can get experience.</p>
Web sites	<p><a href="https://www.fisheries.gov.pg/aquaculture">https://www.fisheries.gov.pg/aquaculture</a></p> <p><a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=15&amp;Itemid=46">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=15&amp;Itemid=46</a></p>
Useful references	<p>PNG NFA. 2017. A Roadmap for coastal fisheries and marine aquaculture for Papua New Guinea 2017 to 2026.</p> <p>The National Aquaculture Policy Anon. 2019. <i>National Aquatic Biosecurity Strategic Plan for Papua New Guinea 2019–2023</i>.</p> <p>PNG Government Economy and Society (Book).</p> <p>2019 National Aquatic Biosecurity Strategic Plan for Papua New Guinea 2019–2023.</p> <p>Fisheries Strategic Plan 2021-2030.</p> <p>NFA Corporate Plan 2021 to 2025.</p> <p>2019 ACIAR PNG Enhancing role of small scale feed milling in the development of the monogastric industries in Papua New Guinea 2019 ACIAR PNG Building Mariculture capacity in PNG.</p>
Covid effects	<p>Has reduced all extension work.</p> <p>Fewer opportunities for training.</p>

<b>Samoa. Fisheries Division of the Ministry of Agriculture, Forests, Fisheries and Meteorology</b>	
Current species cultivated commercially	None. Hope to commercialise tilapia soon. Big problems with feed. Importation from Fiji is possible – there is already importation of chicken and pig food.
Current species used for food security & small scale community based production	Giant clam. Hatchery near to the HQ. Distribute to 120 coastal communities. 2021 success with spawning. 10000 juveniles produced in raceways now. Can produce as many as wanted. Put on the reef for restocking. Communities have to look after. Communities like a successful giant clam project. They can showcase them and also if they do ecotourism the tourists like them. Community seagrapes projects. Tilapia. Hatchery near the airport but has water quality problems. Tilapia for food security and some income. Grown in earth ponds, cement ponds and also natural water bodies Trochus introduction was successful years ago and now some jewellery production. SPC been very helpful. Understands Samoa. Aquaculture production (metric tons) in Samoa was reported at 12.93 metric tons in 2018, according to the World Bank.
Other species attempted  or planned	Tilapia ( <i>Oreochromis mossambicus</i> ) introduced long ago. Trochus introduced long ago and now some jewellery production. Seaweed ( <i>Kappaphycus</i> ). Green mussel, <i>Macrobrachium</i> , Penaeid shrimp, native oyster, freshwater crayfish.  More giant clams ( <i>T. maxima</i> and <i>T. squamosa</i> ), and more recently green snail. But the site selection of a hatchery is problematical. Interested in Sea cucumber. No capacity. SPC will assist and use the hatchery. Interested in sea grapes, this has reached pilot production. Interested in mangrove oysters, and mullet (which fetch high prices in Samoa).
Research	None. Hatcheries capable of undertaking research but currently producing tilapia and giant clams.
Legislation	Samoa Fisheries Management Act 2016. Samoa. <i>Aquaculture Management and Development Plan 2013–2018</i> SPC Community Aquaculture Section.
Major problems	Feed. Can import but expensive. Big difference between imported and local feeds, high cost of imported and low quality of the locally produced. Capacity generally, Government, and technology and skills in communities. Must have COPs, SOPs and manuals due to staff turnover.
Web sites	<a href="https://maf.gov.ws/fisheries/">https://maf.gov.ws/fisheries/</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=16&amp;Itemid=47">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=16&amp;Itemid=47</a>
Useful references	Government of Samoa. 2016. Fisheries Management Act. Government of Samoa. 2012. Aquaculture Management and Development Plan. 2013-2018. Graham A. and Ariella D'Andrea. 2021. Gender and human rights in coastal fisheries and aquaculture: A comparative analysis of legislation in Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu.



<b>Solomon Islands. Ministry of Fisheries and Marine Resources</b>	
Current species cultivated commercially	Kappaphycus Seaweed. Local farmers, private buyer. Single monopoly buyer, but recently production has declined due to low prices and competition from other income earning opportunities. Wagina in Choisl is currently the most active area in seaweed. Maximum production (2014) was 1500 tonnes/year, but now only ~345T/year. World bank data shows 5520 Tonnes of aquaculture production in 2018 (?)
Current species used for food security & small scale community based production	Tilapia ( <i>Oreochromis mossambicus</i> ) on Guadalcanal and Malaita Islands, expanding to other islands small scale. Sea cucumber for communities. OFCF research has targeted the “peanut-fish” ( <i>Stichopus horrens</i> ), and many juveniles have been distributed (2020).
Other species attempted	Tilapia introduced long ago, in early 1960s. Freshwater species of interest have included freshwater crayfish but there are serious problems which make it unfeasible. Penaeid prawn on Guadalcanal which stopped after the tensions in 2000. Aquarium fish and corals now stopped.
or planned	Giant clams ( <i>T. maxima</i> and <i>T. squamosa</i> ), and more recently green snail. But the site selection of a hatchery is problematical. Introduction of GIFT Nile tilapia to improve the genetic stock.
Research	ICLARM research centre in Guadalcanal destroyed in the 2000 tensions. Wide research on various organisms. Research moved to Gizo in W Province, and continues – smaller scale. No success with commercialisation of research so far. OFCF supported studies of the green snail and trochus hatchery seeding. Results inconclusive. ACIAR post larval research. Results inconclusive.
Legislation	Fisheries Management Act 2015. Solomon Islands Ministry of Fisheries and Marine Resources (2019) Solomon Islands National Fisheries Policy 2019–2029.
Major problems	Unstable government with no clear policies for aquaculture. Difficulties in gaining access to suitable land (land disputes and traditional and custom inheritance). Lack of appropriate technical, business and management skills. Lack of infrastructure and communication technology (existing services expensive and unreliable). Lack of encouragement for private investment. Remoteness/transportation. Internal and international.
Web sites	<a href="https://www.fisheries.gov.sb/divisions/aquaculture">https://www.fisheries.gov.sb/divisions/aquaculture</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=17&amp;Itemid=48">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=17&amp;Itemid=48</a>
Useful references	Government of Solomon Islands. 2018. Solomon Islands National Aquaculture Management and Development Plan 2018 – 2023. Solomon Islands Tilapia Aquaculture Action Plan 2009–2014 Graham A. and D’Andrea A. 2021. Gender and human rights in coastal fisheries and aquaculture: A comparative analysis of legislation in Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu. Noumea, New Caledonia: Pacific Community. 108 p.



	Harohau D, Blythe J, Sheaves M and A Diedrich. 2020. Limits of Tilapia Aquaculture for Rural Livelihoods in Solomon Islands Sustainability 2020, 12, 4592. Jimmy R, Pickering T & B Tioti 2019 Improving community-based aquaculture in Fiji, Kiribati, Samoa and Vanuatu final report published by ACIAR GPO Box 1571 Canberra ACT 2601 Australia.
Covid effects	Restrictions on travel. Training overseas stopped.

Tokelau	
No information. Understood no aquaculture undertaken at the moment	

Tuvalu.. Ministry of Natural Resources	
Current species cultivated commercially.	None
Current species used for food security & small scale community based production.	Small scale milkfish in cages, but farming has stopped due to covid. Vaitupu. Problems with feed and cage maintenance Aquaculture production in Tuvalu was reported at 2.5 metric tonnes in 2018, World Bank 2022.
Other species attempted	None recently
or planned	Small hatchery in Funafuti for giant clams for restocking.
Research	Active plans to build a hatchery for giant clams, mainly for stocking in lagoons.
Legislation	Marine Resources Act (2006): CAP 48.16. Marine Resources Amendment Act (2012). Marine Resources Amendment Act (2017).
Major problems	Remoteness. Shortage of land sites. No follow up to research or pilot projects. Funding. Seed access. Technical skills. Regulations and laws lacking.
Web sites	<a href="https://tuvalufisheries.tv/">https://tuvalufisheries.tv/</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=19&amp;Itemid=50">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=19&amp;Itemid=50</a>
Useful references	None recent
Effects of Covid	Cut off for 2 years so limited training opportunities and training and difficulty in importation of supplies.

<b>Tonga. Ministry of Agriculture, Food, Forests and Fisheries (MAFF)</b>	
Current species cultivated commercially.	Seaweed – <i>Cladosiphon</i> sp “Limu Tanga’u” collected from wild. Quality control problems, destruction from recent volcano. 1 license and 1 exporter. Corals and others for the aquarium trade. Slowed during Covid due to transport difficulties. Only two companies still operated during Covid. Wing Pearl oyster for mabe pearls – nascent. Delayed by Covid. Markets locally and in Hawaii. Some production. World Bank gives 20 tonnes as production in 2018.
Current species used for food security & small scale community based production	Giant clams in communities. Government hatchery. Various species. Sea cucumber from a joint venture distributed to communities all over the country, pilot scale.
Other species attempted	Giant clam reseeded. Pearl oysters, mussels (not adapted to the climate), trochus and green snail for reseeded. Mullet (wild fry).
Or planned	Sea grapes. Sea urchin. Both for community aquaculture Tilapia, Milkfish, Mullet and <i>P monodon</i> (already present in Tonga).
Research	None specifically. Would need Technical Assistance.
Legislation	Aquaculture Management Act 2003. Kingdom of Tonga. 2016 Tonga Fisheries Sector Plan for the Kingdom of Tonga. 2016-2024. Kingdom of Tonga. 2018. Kingdom of Tonga National Aquaculture Management and Development Plan 2018–2022. Pacific Community (PC) and Tonga Ministry of Fisheries 2018 Kingdom of Tonga. 2020. Tonga Marine Aquarium Fishery Management and Development Plan 2020- 2021.
Major problems	Natural disasters like the recent volcanic eruption (Jan. 15, 2022). Transportation links. Capacity Issues, technical and in government (major). Lack of aquaculture regulation. Need COPs etc for biosecurity for Tilapia and other imports. Poaching from community programmes.
Effects of Covid	Lockdowns affected everything. Transportation made very difficult both internally and internationally. No technical training undertaken.
Web sites	<a href="https://tongafish.gov.to">https://tongafish.gov.to</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=18&amp;Itemid=49">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=18&amp;Itemid=49</a>
Useful references	Anon. 2012. Tonga National Marine Seaweed (Limu Tanga’u) Fisheries Management and development plan (2012 – 2013) Government of Tonga. 2016 Tonga Fisheries Sector Plan for the Kingdom of Tonga. 2016-2024. Anon. 2014. Tonga National Aquaculture Management and Development Plan (2014 – 2019). Kingdom of Tonga. 2006. National Biodiversity Strategy & Action Plan.

<b>Vanuatu. Ministry of Agriculture, Live stock, Forestry, Fisheries and Biosecurity (MALFFB)</b>	
Current species cultivated commercially.	Sea cucumber ( <i>H. scabra</i> ). Private hatchery on Aore Island in Sanma Province. Seed moved to Havannah Harbour in Efate and some released locally. No harvest yet, so cannot be judged to be fully commercial. Major problems with ownership of end product. Gets feed for larvae in from Netherlands.
Current species used for food security & small scale community based production	Tilapia. Using GIFT tilapia from Fiji in Santo and Efate. Now been put on Tanna, Erromango, Ambae. Pentecost, Vanua Lava. Back yard ponds. Ponds at the Tagabe Agric centre in Efate and in Santo for seed production etc. Feed provided by government, so doubts over sustainability. Teoma Farms on Efate are producing shrimp for the local market but reduced production due to Covid. Overall production given as 6 tonnes in 2018 (World Bank).
Other species attempted or planned	Trochus, green snail for reseeding of reefs. Mangrove oysters, <i>M. rosenbergii</i> prawn. <i>M. lar</i> prawn Giant clam. Seaweed (communities didn't like the low returns). Shrimp <i>Litopenaeus stylirostris</i> . Coral culture for aquarium trade. Giant clams and trochus in Santo. Sea cucumber later.
Biosecurity	No problems. Imports of fingerlings are quarantined 14 days. Everything comes from Fiji so no problem, as basically disease free. No imports recently as someone has to accompany them and Covid means they have to quarantine for 14 days. Aquatic Biosecurity is not in the Fisheries Act so not a Fisheries responsibility. Will be inserted in the future but no time frame for that.
Research	Very limited but hatchery at Palekula in Santo being put together. Bad water quality. Will do clams and trochus first. Have introduced the AQUANETIX system for data collection, but it's not been proved as useful as hoped, probably because it is too advanced for the purposes and people. Need research to be done on genetic drift in GIFT tilapia and new varieties such as "mountain mullet" which is found in Santo. Must do research on feed for tilapia. No 1 problem.
Legislation	Fisheries Act No.10 of 2014 & amendments Government of Vanuatu. 2016. Vanuatu National Fisheries Sector Policy 2016-2031.
Major problems	Feed. Have ordered from Fiji. No laboratory. Capacity – everywhere. Money management and finance needs to be improved. There is a national qualification in aquaculture, however there is nobody at the Agricultural Training Centre who is, trained up to run it.
Web sites	<a href="https://fisheries.gov.vu/index.php/what-we-do/coastalfisheries/research.html">https://fisheries.gov.vu/index.php/what-we-do/coastalfisheries/research.html</a> <a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=20&amp;Itemid=51">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=20&amp;Itemid=51</a>
Useful references	Jimmy R, Pickering T & B Tioti 2019 Improving community-based aquaculture in Fiji, Kiribati, Samoa and Vanuatu final report published by ACIAR. Graham A. and Ariella D'Andrea. 2021. Gender and human rights in coastal fisheries and aquaculture: A comparative analysis of legislation in Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu. Noumea, New Caledonia: Pacific Community. 108 p.

Effects of Covid	<p>More interest in Tilapia.</p> <p>Damage to tilapia development in Santo, and reduced throughput for Efate Teouma (Prawns) due to no tourists.</p> <p>No shipping for feed.</p> <p>Can't bring in new GIFT tilapia.</p> <p>Limited travel and low assistance from donors due to covid.</p>
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<b>Wallis and Futuna.. Direction des Services de l'agriculture, de la forêt et de la pêche des îles Wallis et Futuna</b>	
Current species cultivated commercially	None
Current species used for food security & small scale community based production	None
Other species attempted or planned	<p><i>M lar</i> in taro ponds very small scale.</p> <p>Under consideration: Sea cucumber - <i>H. scabra</i>, Clams - <i>Tridacna spp</i>, Oysters - <i>Sacchostrea echinata</i>. Rabbitfish <i>S. vanaliculatum</i>, <i>S. lineatus</i>, Prawn - <i>L. stylirostris</i> or <i>L.vannamei</i>, Tilapia <i>O. mossambicus</i></p>
Research	None presently though sea grapes been looked at on a small scale.
Legislation	Generally follows French law.
Major problems	<p>Feed. Transport costs.</p> <p>Land ownership.</p> <p>Capacity at all levels.</p> <p>Resistance to importing non native species.</p>
Web sites	<p><a href="https://www.wallis-et-futuna.gouv.fr/Services-de-l-Etat-et-du-Territoire/Les-autres-services-de-l-Etat-et-du-Territoire/Service-de-l-Agriculture-de-la-Forêt-et-de-la-Pêche">https://www.wallis-et-futuna.gouv.fr/Services-de-l-Etat-et-du-Territoire/Les-autres-services-de-l-Etat-et-du-Territoire/Service-de-l-Agriculture-de-la-Forêt-et-de-la-Pêche</a></p> <p><a href="https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=21&amp;Itemid=52">https://aquaculture.spc.int/index.php?option=com_countries&amp;view=country&amp;id=21&amp;Itemid=52</a></p>
Useful references	<p>Teittelbaum, &amp; Lauffenburger M. 2021. Étude de faisabilité de développement d'une filière aquacole durable à Wallis et Futuna. Analyse technique et socio-économique. PROTEGE Project, Direction des services de l'agriculture, de la forêt et de la pêche de Wallis et Futuna, 115 pages.</p> <p>PROTEGE Project. 2021. Stratégie de développement de l'aquaculture à Wallis. PROTEGE Project, Direction des services de l'agriculture, de la forêt et de la pêche de Wallis et Futuna.</p>
Covid effects	Slowed things down.

## APPENDIX II. POTENTIAL PRIORITY OBJECTIVES

The following table lists the potential priority objectives that could be addressed during the development of a regional strategy for the Pacific and possible responses. It is intended to be merely indicative.

Potential priority objectives to be addressed when developing the Regional Strategy	Possible responses (Note that all may not be applicable in all PICTs)
To mainstream aquaculture into the economic and social development agendas of PICTs.	<ul style="list-style-type: none"> <li>• Improve reliability of statistical data by improving the frequency of collection and better collation of statistics to better inform decision making.</li> <li>• Assess the potential of aquaculture over the next 15 years realistically with respect to potential production, revenue generation, social benefits and job creation, based on the last 30 years of experience. Make the results generally available to all PICTS' so as to inform and educate governments on the economic, environmental, financial, health, trade and social development opportunities provided by aquaculture.</li> <li>• Develop and present aquaculture investment strategies to appropriate ministries in PICTs, such as Ministry of Finance, Planning, Trade and Industry, Environment (e.g. Biosecurity) and urge their incorporation into their own policies and plans.</li> <li>• Within Government institutions maintain a presence on all committees, donor groups and other groups to present aquaculture as an important development sector with high potential for economic growth, food security and poverty alleviation.</li> <li>• Ensure, through the Planning Ministries/Departments that aquaculture is prioritised in national 5 and 10 year national and state development plans, donor country and regional strategies and regional agreements.</li> <li>• Ensure that funding of the "Blue Economy" includes aquaculture.</li> <li>• Enhance the visibility of aquaculture by working with the media outlets in each country.</li> <li>• Enhance visibility of aquaculture by employing modern social media to spread positive news and images of aquaculture activities and publicise opportunities.</li> </ul>
To increase aquaculture production of edible and non-edible aquatic products for income and food security in the commercial, community and small holder subsectors.	<ul style="list-style-type: none"> <li>• Assess all opportunities and potential for aquaculture production, support industries such as feed and marketing, realistically and disseminate the information to investors, the Chamber of Commerce, relevant ministries and the private sector.</li> <li>• Encourage private sector investment in aquaculture through developing policies that facilitate access to finance (banks, development banks, donor investment schemes, NGOs, PPP, government matching grants, or blue bonds).</li> <li>• Work towards creating an enabling investment, regulatory and business environment so that the private sector can flourish.</li> <li>• Collate and disseminate information on best available techniques for small scale and community aquaculture with an emphasis on T4 technology, feed, seed and post-harvest.</li> </ul>

Potential priority objectives to be addressed when developing the Regional Strategy	Possible responses (Note that all may not be applicable in all PICTs)
	<ul style="list-style-type: none"> <li>• Develop instruments for evaluating aquaculture projects and programmes on a “Total Economic Value” that measures their value on social and environmental criteria as well as monetary success.</li> <li>• Promote collaboration between private commercial operators and the public sector for mutual benefit, particularly regarding hatcheries, seed and feed production.</li> <li>• Develop and maintain a continuous flow of technical, biological and market information to all sections of the aquaculture industry using T4.</li> <li>• Collect and circulate to PICTs information on the aquaculture supply chain in the region, with an emphasis on local feed production and imports.</li> <li>• Recognise that some PICTs have severe land use conflicts between agriculture, housing, roads and aquaculture, and where this occurs assess the suitability of RAS systems to relieve land usage pressures.</li> <li>• Develop and publish commercial aquaculture investment guides for investors.</li> <li>• Encourage regionally competitive fiscal incentives to promote investment (e.g. Blue bonds etc).</li> <li>• Exploit the region’s reputation as a clean and uncontaminated environment displaying an increased environmental responsibility to increase overseas demand for sustainable/certified aquaculture products.</li> <li>• Move towards the introduction of T4 to improve communications, to provide platforms for cluster and community groupings and to assist with feeding, security and monitoring in commercial farms.</li> <li>• Produce practical Code of Practice (COP) for feed production based on best practice and regional requirements.</li> </ul>
To improve capacity in the aquaculture sector.	<ul style="list-style-type: none"> <li>• Undertake a gender sensitive training needs assessment for aquaculturalists, and for those who market or process the production from aquaculture.</li> <li>• Assist PICT governments to prepare a national Human Resource Development Plan for Aquaculture based on aquaculture requirements and potential identified.</li> <li>• Improve contacts with universities and colleges in the region regarding development of diploma, graduate and post graduate training.</li> <li>• Develop appropriate courses for fisheries/aquaculture for the private sector in technical colleges throughout the region, particularly in business management, money management and basic technical skills; including women and other vulnerable groups.</li> <li>• Involve regional bodies, other development partners and NGOs in assistance to the PICTs in strengthening their extension services.</li> <li>• Strengthen regional cooperation in best management practices through fish farmer internship, study tours and workshops, exchange programmes with universities and other institutions.</li> <li>• Improve regional collaboration between institutions in PICTs through workshops and seminars specifically designed to address this.</li> </ul>
To improve biosecurity in the region.	<ul style="list-style-type: none"> <li>• Continue work with regional and international agencies (e.g. OIE, SPC, and SPREP) to ensure that all the PICTs are following recommended practices in the Regional Framework for monitoring of biosecurity issues</li> </ul>

Potential priority objectives to be addressed when developing the Regional Strategy	Possible responses (Note that all may not be applicable in all PICTs)
	<ul style="list-style-type: none"> <li>• Further develop and maintain, with SPC, SPREP and OIE, the disease outbreak notification system.</li> <li>• Streamline regional biosecurity by ensuring that national legislation and regulations and certification are harmonised wherever possible, allowing relatively free passage of feed, SPF seed or animals between PICTs.</li> <li>• Produce standard regional Standard Operation Procedures (SOPs) for best practice in biosecurity, including introductions and transfers, imported feeds, import of ornamentals, treatment of waste water and pollution of natural water bodies from aquaculture activities.</li> <li>• Enhance capacity in organisations responsible for biosecurity through training, internships and workshops.</li> <li>• Harmonize regional regulations for species introductions, promotion and translocation from outside the region.</li> <li>• Identify and develop a regional gene bank for maintaining improved germ-plasm for selected species.</li> </ul>
<p>To assess the effects of climate change and other natural disasters in the region and develop outline plans for mitigating measures.</p>	<ul style="list-style-type: none"> <li>• Assess international climate change adaptation and mitigation measures for aquaculture and adapt for the Pacific region.</li> <li>• Review the effect of recent climatic events (Cyclones, Typhoons, Tsunamis, Volcanic eruptions and El Nino/Niña events) on aquaculture in the region and use the results to influence future policies.</li> <li>• Learn the lessons of the COVID pandemic and incorporate them into future planning for aquaculture.</li> <li>• Develop multi-trophic and multi species aquaculture to mitigate against climate change risk and for disaster preparedness.</li> <li>• Assess the urgency to move aquaculture onshore (through RAS) or offshore(submersible cages) in response to climate change and other climatic and pandemic events.</li> <li>• Investigate the use of RAS and T4 technologies in mitigating against the effects of climate change and communicating with farmers in the case of disasters.</li> <li>• Attempt to integrate renewable energy (wind/solar) with aquaculture operations to reduce costs and mitigate against climate change.</li> <li>• Develop policy advice for aquaculture to contribute to wider government responses to climate change and disaster management</li> <li>• Disseminate widely the information and recommendations.</li> </ul>
<p>To improve market access &amp; supply chains.</p>	<ul style="list-style-type: none"> <li>• Improve the structure of aquaculture producer organisations through formalisation of the status of clusters and community led initiatives so as to give them more control over their own directions.</li> <li>• Understand the aquaculture value chain in the region through targeted studies.</li> <li>• Promote adoption of safety standards by producers including the application of HACCP in aquaculture for quality control particularly for export fish and molluscs.</li> <li>• Introduce SOPs and COPs to improve post-harvest handling, processing, value addition and quality assurance.</li> <li>• Develop and implement traceability guidelines and promote regionally agreed certification schemes for export fish. T4 could assist.</li> </ul>



Potential priority objectives to be addressed when developing the Regional Strategy	Possible responses (Note that all may not be applicable in all PICTs)
	<ul style="list-style-type: none"> <li>• Develop a safe, cost effective and environmentally sustainable approach to the disposal of seafood processing waste via natural processes, or innovation and technological developments.</li> <li>• Develop regional aquaculture products certification mechanisms for trade.</li> <li>• Blue food. Promote aquaculture products as a source of healthy protein.</li> <li>• Blue food. Promote eco-labelling and branding of aquaculture products from the Pacific as a value enhancing mechanism.</li> <li>• Undertake a region wide study on potential hazards to health from current aquaculture species, consumption of aquaculture products and production practices. Using this, develop COPs for post harvest products of aquaculture, and for workers in the industry, both in production and marketing.</li> <li>• Harmonise where possible regulations for import and export of aquaculture products within the region.</li> <li>• Work further toward harmonising import taxes and levies across the region.</li> <li>• Produce a COP for feed production based on best practice and regional norms to ensure species specific harmonisation of feed quality.</li> </ul>
To establish Regional cooperative institutional frameworks.	<ul style="list-style-type: none"> <li>• Continue to support and promote cooperative relevant aquaculture research in the region.</li> <li>• Marine aquaculture R&amp;D coordination consolidated in most appropriate maritime member state related to species, disaster readiness and capability.</li> <li>• Inland aquaculture R&amp;D coordination consolidated in most appropriate inland member state related to species, disaster readiness and capability.</li> <li>• Designate regional reference laboratories to meet CODEX norms for the products of aquaculture.</li> <li>• Recognise the strengths of the existing further education universities and colleges and build on their aquaculture programmes and courses.</li> <li>• Attempt to standardise curricula throughout the region at all levels of the education system; secondary schools, diploma, degrees and post graduate so as to ensure equality in attainment.</li> <li>• Continue to harmonise policies, laws and regulations across the region such that they promote sustainable aquaculture development.</li> <li>• Harmonise regional regulations for species introductions, promotion and translocation.</li> <li>• Strengthen regional cooperation in best practices through farmer internship, study tours and exchange programmes with universities and other tertiary institutions.</li> <li>• Develop regional Best Management Practices (BMPs), for different forms of aquaculture.</li> <li>• Strengthen regional capacity in Environmental and Social Impact Assessment (ESIA) so as to ensure continuity across national boundaries.</li> <li>• Develop a system of communication with each of the Aquaculture PICT states, and if possible with farmers, big and small, allowing constant flow of data and information.</li> </ul>



Potential priority objectives to be addressed when developing the Regional Strategy	Possible responses (Note that all may not be applicable in all PICTs)
To improve quality of post harvest product.	<ul style="list-style-type: none"> <li>• Undertake a review of the potential hazards to health from aquacultured fish and invertebrates, including occupational disease, and hazards to health from bacterial and viral pathogens, persistent pollutants, and heavy metals. Link the results to the need for local and regional laboratories.</li> <li>• Where necessary write codes of practice &amp; manuals for post harvest handling of the various types of aquacultured products. These COPs and manuals to be compulsory and compliant to local and international standards (CODEX Alimentarius, WTO, HACCP, EU Directives, etc).</li> <li>• Train fish/aquaculture farmers, processors, wholesalers, exporters and retailers in fish processing and post harvest. An emphasis on training women is necessary.</li> <li>• Introduce depuration units for molluscs (particularly oysters destined for the restaurant trade or export) so as to reduce the possibility of pathogens entering the food chain.</li> </ul>
To mainstream cross cutting issues such as health, environment and gender in the whole aquaculture value chain throughout the region.	<ul style="list-style-type: none"> <li>• Integrate aquaculture into National Food Security Programmes and ensure active participation in programming for food security.</li> <li>• Further develop country by country policies on zoning, tenure and secured land systems and property rights, particularly for private investors in the commercial aquaculture sector.</li> <li>• Where applicable through local planning systems establish aquaculture development zones particularly in coastal areas.</li> <li>• Work with health departments on the avoidance of toxins, infections and non-communicative diseases associated with aquaculture and the products of aquaculture.</li> <li>• Inclusion of relevant concerns about aquaculture into the decisions of institutions that drive national, and sectoral development policy on the environment.</li> <li>• Guarantee the preservation of and protection from aquaculture of protected habitats and areas (eg: MPAs sites).</li> <li>• PICTs to incorporate EIA into regulatory frameworks.</li> <li>• Nature Based solutions to be prioritised across all projects and programmes.</li> <li>• Promote the formal recognition of employment and equality of women, youth and vulnerable groups in aquaculture through adoption of national, regional and global standards.</li> <li>• Develop training opportunities for women, youth and other vulnerable groups in aquaculture, processing technologies, business management, and money management.</li> <li>• Support the inclusion of women, youth and other vulnerable groups on aquaculture study tours.</li> <li>• Begin, with other groups and institutions, discussion on the introduction of genetically modified (GM) and genome altered organisms into aquaculture (including in feeds) in the Pacific.</li> </ul>

## APPENDIX III. DOCUMENTS CONSULTED

- ACIAR. 2021. *Improving technologies for inland aquaculture in Papua New Guinea*. Fact sheet FIS/2014/062 [https://www.aciar.gov.au/sites/default/files/project-page-docs/fact\\_sheet\\_fis\\_2014\\_062\\_a.pdf](https://www.aciar.gov.au/sites/default/files/project-page-docs/fact_sheet_fis_2014_062_a.pdf)
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## APPENDIX IV. LIST OF PEOPLE CONTRIBUTING TO THE STUDY

**Note.** All video meetings have a brief written record of important points of discussion, prepared by IAS, for back reference in case needed.

Individuals who did not reply to invitations to comment or meet on a video link are not included on this list.

During the review fish farmers, institutions and government departments were contacted in:- Cook Islands, Commonwealth of the Northern Mariana Islands (CNMI), Fiji, Federated States of Micronesia (FSM), Kiribati, Nauru, Palau, Papua New Guinea (PNG), Republic of the Marshall Islands (RMI), Solomon Islands (& through subcontract), Tuvalu, Tonga, Vanuatu, Wallis and Futuna, New Caledonia (& through subcontract), French Polynesia (through subcontract), Guam, Tonga & Niue. American Samoa and Tokelau were not interviewed, and the NFA in PNG were requested to participate but no response was received. Additionally contacts were made in the UK (for Kiribati), Samoa (for FAO), and New Caledonia (for SPC FAME).

Country	Name	Title	Location / Organisation	Contact Details	Interviewed or participated
AUS	Mr. Nandal. Satya	Lecturer	Queensland University of Technology	s.nandlal@qut.edu.au	Video meeting
Cook Islands	Ms. Maru. Pam	Secretary	Ministry of Marine Resources (MMR)	p.maru@mmr.gov.ck	Video meeting
Cook Islands	Mr. Story. Richard	Senior Fisheries Officer.	Station Manager. Ministry of Marine Resources (MMR)	r.story@mmr.gov.ck	Video meeting
CNMI	Mr. Ogo. Michael	Aquaculture Specialist	Northern Marianas College	michael.ogo@marianas.edu	Video meeting
Fiji	Mr. Chandra. Prashneel	Fisheries Assistant	Aquaculture Division. Freshwater Section Ministry of fisheries	prashneel.chandra@govnet.gov.fj prashneelchandra001@gmail.com	Video Meeting
Fiji	Mr. Govan. Dr Hugh	Adviser Policy and Advocacy	The Locally-Managed Marine Area (LMMA)/ Suva - Fiji	hgovan@gmail.com	Email comments
Fiji	Mr. Justin Hunter	CEO	Hunter Pearls	jhunter@fijipearls.com	Video meeting
Fiji	Ms. Nanise Kurudrani	Principal Fisheries Officer research	Ministry of Fisheries. Research Station	Mobile: +679 9986867 Nanise.tuqiri@govnet.gov.fj	Video meeting
Fiji	Mr. Wilco Liebrechts.	Consultant & Crab farmer	The Crab Company, Navua, Fiji	ecoconsult@gmail.com	Video Meeting

<b>Country</b>	<b>Name</b>	<b>Title</b>	<b>Location / Organisation</b>	<b>Contact Details</b>	<b>Interviewed or participated</b>
Fiji	Mr. Paul Ryan	CEO	Pacific Ocean Culture	paul@pacificoceanculture.com	Video meeting
French Polynesia	Mr. Moana Maamaatuaiahutapu	Technical manager	Direction of Marine Resource.	moana.maamaatuaiahutapu@partenaire-exterieur.ifremer.fr	Interviewed from NC
French Polynesia	Mr. Cédric Ponsonnet.	Director of Marine Resources	Direction of Marine Resource.	cedric.ponsonnet@drm.gov.pf	Interviewed from NC
French Polynesia	Mr Georges Remoissenet.	Aquaculture programs manager	Direction of Marine Resource.	georges.remoissenet@drm.gov.pf	Interviewed from NC
FSM	Ms. Vanessa Fread.	Assistant Secretary	Department of Resources and Development - Fisheries Section	freadv@yahoo.com	Video Meeting
FSM	Dr. Manoj Nair.	Director & Chief Scientist.	Aquaculture Research, Extension, Training & Technology Development College of Micronesia	manojnair999@yahoo.com	Video meeting
FSM	Mr. Martin Selch.	Commercial aquaculturalist	Kosrae FSM	info@imtrona.de	Video meeting
Guam	Mr. David Crisostomo.	Aquaculture Extension Specialist	University of Guam Sea Grant	UOG Sea Grant	Video meeting
Kiribati	Mr. Karibanang Tamuera.	Principal Fisheries Officer	Coastal Fisheries Division Fisheries Department, Kiribati	karibanangt@fisheries.gov.ki	Video meeting
Kiribati	Ms, Tooreka Teemari.	Director	Coastal Fisheries Division Fisheries Department, Kiribati	toorekat@mfmrd.gov.ki	Exchange of e-mails
Kiribati/UK	Mr Simon Diffey.	Consultant	Currently based in UK. Manager NZ funded programme in Kiribati	SD@Fishtech.eu.com	e-mail comments Video meeting
Nauru	Mr. Wynson Bill.	Fisheries Extension Officer - Aquaculture	Nauru Fisheries and Marine Resources Authority	NFMRA naurufish@gmail.com	Video meeting
Nauru	Mr. Barry Cook.	Fisheries Extension Officer - Aquaculture	Nauru Fisheries and Marine Resources Authority	NFMRA naurufish@gmail.com	Video meeting

<b>Country</b>	<b>Name</b>	<b>Title</b>	<b>Location / Organisation</b>	<b>Contact Details</b>	<b>Interviewed or participated</b>
Nauru	Mr. Jake Debao.	Coastal Fisheries Officer	Nauru Fisheries and Marine Resources Authority	NFMRA naurufish@gmail.com	Video meeting
Nauru	Mr. B'Jorn Detageouwa.	Fisheries Extension Officer - Aquaculture	Nauru Fisheries and Marine Resources Authority	NFMRA naurufish@gmail.com	Video meeting
Nauru	Mr. Giovanni Gioura.	Senior Coastal Fisheries Officer	Nauru Fisheries and Marine Resources Authority	NFMRA naurufish@gmail.com	Video meeting
Nauru	Mr. Shardack Rodiben.	Aquaculture Fisheries Assistant	Nauru Fisheries and Marine Resources Authority	NFMRA naurufish@gmail.com	Video meeting
Nauru	Mr. Jona Star.	Senior Science and Research officer	Nauru Fisheries and Marine Resources Authority	NFMRA naurufish@gmail.com	Video meeting
Nauru	Mr. Being Yeeting.	Fisheries Adviser	Nauru Fisheries and Marine Resources Authority (NFMRA)	byeeting@gmail.com	Video meeting
New Caledonia	Mr. Pablo Chavance.	European programme officer	Science and Technology Park of New-Caledonia (ADECAL-Technopole).	pablo.chavance@adecal.nc	Interviewed in NC
New Caledonia	Dr. Hugo Lassauce.	Manta Initiative in New Caledonia	Ecologist & freelance consultant	hugo.lassauce@gmail.com	Hired as a ST consultant Report on NC and FP
New Caledonia	Mr. Patrick Morlet.	Business owner	Huitriere d'Arembo (Oysters)	morletpatrick@lagoon.nc	Interviewed in NC
New Caledonia	Mr. Antoine Teitelbaum.	Business owner	Aquarium Fish NC (aquarium trade)	aquariumfishnc@gmail.com	Interviewed in NC
New Caledonia	Mr. Thomas Tiburzio.	Manager	Aquaculture and Fisheries department, Southern Province.	thomas.tiburzio@province-sud.nc	Interviewed in NC
Niue	Mr. Brendan Pasisi.	Project Manager	Niue Ocean Wide Project	niueoceanwide01@gmail.com	Video meeting
Palau	Mr. Tom Bowling.	CEO	Biota Palau Inc	botting@me.com	Video meeting
Palau	Dr. Yimnang Golbuu.	CEO	Palau International Coral Reef Center	ygolbuu@gmail.com	Video meeting

<b>Country</b>	<b>Name</b>	<b>Title</b>	<b>Location / Organisation</b>	<b>Contact Details</b>	<b>Interviewed or participated</b>
PNG	Dr. Jeff Kinch.	Principal	National Fisheries College. Kavieng. PNG	jkinch@fisheries.gov.pg	e-mail comments & video meeting
RMI	Ms. Florence Edwards.	Deputy Director	MIMRA	fedwards@mimra.com	Video Meeting
RMI	Mr. Ryan Murashige.	COO & research Scientist	Aquaculture Technologies of the Marshall Islands Rongelap Atoll Local Government	hukilau11@gmail.com	Video meeting
RMI	Ms. Melba White.	Adviser and head researcher	MIMRA. Coastal and Community Affairs	mwhite@mimra.com	Video meeting
Samoa	Ms. Su'a Ulusapeti Tiitii.	Principal Fisheries Officer,	Inshore/ Coastal Fisheries and Aquaculture. MAF.	sapeti.tiitii@maf.gov.ws	Video meeting
Samoa/FAO	Ms. Mele Tautai.	Small-scale Fisheries Consultant	FAO Samoa	Mele.Tauati@fao.org	Video Meeting
Solomon Islands	Mr. Wesley Garofe.	Assistant head Aquaculture Division	MFMR. SI	WGarofe@fisheries.gov.sb	Interviewed in SI
Solomon Islands	Dr. Toru Komatsu.	Advisor	OFCF Resource Management of Sea Cucumbers in Solomon Islands project.	turbo-m@cba.att.ne.jp	Interviewed in SI
Solomon Islands	Ms. Michelle Lam.	Consultant	Solomon Islands, Honiara	michellelam761@gmail.com	Hired as a ST consultant. Report on SI.
SPC	Mr. Robert Jimmy.	Aquaculture Officer	SPC FAME	robertj@spc.int	Regular video and e-mail contact
SPC	Mr. Tim Pickering.	Inland Aquaculture Adviser	SPC. Fiji-based position	timp@spc.int	Regular video and e-mail contact
SPC	Mr. Jamie Whitford	Marine Aquaculture Advisor	SPC FAME	jamiew@spc.int	Regular video and e-mail contact

<b>Country</b>	<b>Name</b>	<b>Title</b>	<b>Location / Organisation</b>	<b>Contact Details</b>	<b>Interviewed or participated</b>
SPC	Mr. Smith Andrew	Deputy Director FAME (Coastal Fisheries)	SPC FAME	andrews@spc.in	Video meeting and e-mail exchanges
Tonga	Ms. Tracy Aisea.	Senior Fisheries Officer	Assistant Head of Section		Video Meeting
Tonga	Mr. Meletoli Fa'anunu.	Senior Fisheries Officer	Biosecurity	meletoli.faanunu@tongafish.gov.to	Video Meeting
Tonga	Mr. Martin Wesley Finau.	Principal Fisheries Officer	Head of Aquaculture Section	martin.finau@tongafish.gov.to	Video Meeting
Tonga	Ms. Louina Laulaupea'alu.	Aquaculture Lead	World Bank project	louina.laulaupeaalu@tongafish.gov.to	Video Meeting
Tonga	Ms. Siola'a Malimali.	Deputy CEO	Head Fisheries Management and Policy Division	siolaamalimali@gmail.com	Video Meeting
Tonga	Mr. Poasi Ngaluafe.	Deputy CEO	Head of Fisheries Science and Extension Division	poasi.ngaluafe@tongafish.gov.to	Video Meeting
Tonga	Mr. Ratu Tonga Tuiano.	Fisheries Officer	Lead – giant clam production	tongafisheries2014@gmail.com>	Video Meeting
Tonga	Mr. Siaosi Vi.	Fisheries Officer	Lead – pearl oyster production	siaosi.vi@tongafish.gov.to	Video Meeting
Tuvalu	Mr. Mike Batty.	Fisheries Adviser	Tuvalu Fisheries Department	michaelb@tuvalufisheries.tv	e-mail comments
Tuvalu	Mr. Petaia Maani.	Fisheries Officer,	Coastal Fisheries Management (OIs)	maanip@tuvalufisheries.tv	Video meeting
Tuvalu	Mr. Falani Matapua	Senior Fisheries Officer	Coastal Fisheries Management (OIs)	matapuatali@gmail.com	Video meeting
Tuvalu	Mr. Lopati Paeniu.	Fisheries Officer	Resource Assessment & Monitoring	paeniul@tuvalufisheries.tv	Video meeting
Vanuatu	Mr. Glen Alo.	Fisheries Aquaculture North	Santo Office Research & Aquaculture Division	galo@vanuatu.gov.vu	Video meeting
Vanuatu	Mr. Dick Lency.	Principal Mariculture Officer	Research & Aquaculture Division	dlency@fisheries.gov.vu	Video meeting

<b>Country</b>	<b>Name</b>	<b>Title</b>	<b>Location / Organisation</b>	<b>Contact Details</b>	<b>Interviewed or participated</b>
Vanuatu	Ms. June Molitaviti.	Manager	Research & Aquaculture Division	jbmolitaviti@fisheries.gov.vu Phone: +678 7749000	Video meeting
Vanuatu	Mr. Derrick French	Director	Aquaculture Solutions Vanuatu - Private sector Aquaculture	aoreaquaculture@gmail.com aquaculturesolutionsvanuatu@gmail.com	Video meeting
Vanuatu	Mr Garry Preston.	Fisheries Adviser	Vanuatu Fisheries Department	Private e-mail	e-mail comments
Wallis & Futuna	Mr. Baptiste Mugeron.	Chef de Service	Direction des Services de l'agriculture, de la forêt et de la pêche des îles Wallis et Futuna	aptiste.jaugeon@agripeche.wf	Video meeting
Wallis & Futuna	Mr. Bruno Mugneret.	Project Facilitator PROTÉGÉ	Direction des Services de l'agriculture, de la forêt et de la pêche des îles Wallis et Futuna	bruno.mugneret@agripeche.wf	Video meeting

## **APPENDIX V TERMS OF REFERENCE**

**Project Title and Background:** An assessment of the aquaculture needs, priorities and future directions in the Pacific Islands Region.

The Coastal Fisheries and Aquaculture Programme (CFAP) of the Division of Fisheries, Aquaculture and Marine Ecosystems (FAME) within the Pacific Community (SPC) seeks a suitable consultant, or team of qualified consultants, to examine and assess the aquaculture needs, priorities and future directions of the 22 SPC Pacific Island Countries and Territories<sup>1</sup> (PICTs), to contribute to improved food security, livelihoods and economic resilience, and to be better positioned in the near future to be more resilient to climate change impacts and to adapt to the post-COVID world. The outputs would be a draft PICT Regional Aquaculture Assessment Report that identifies the needs and priorities and recommends future directions, and a draft Pacific Regional Aquaculture Futures Strategy based on the recommended future directions.

### **A. Background**

Aquaculture contributes to food security and income generation. Culturing of low value fish such as tilapia and milkfish for food security is gaining higher priority in the Pacific islands' region. Pearls, shrimps, seaweed, marine ornamentals, and finfish culture are successfully farmed as important cash crops contributing significantly to improving livelihood development in many PICTs.

The COVID-19 global pandemic has disrupted markets and supply chains for almost all primary production in and among PICTs, including aquaculture. Due in large part to the COVID-19 pandemic, there has been a shift in focus from export to domestic markets within the Pacific region over the last year and a half. Aquaculture businesses are struggling as a result of COVID-19 and national food security needs and priorities have also changed, and continue to change. Meanwhile the UN Food Systems Summit UNFSS 2021, and the upcoming 2022 UN Year of Small-scale Fisheries and Aquaculture, are bringing to the fore the central and critical role of Aquatic/Blue Foods in global food systems. These international processes are highlighting the ways in which aquaculture, through integration and adoption of food systems approaches, can be harnessed to contribute to Sustainable Healthy Diets (SHDs) and thereby help meet the sustainable development goals (SDGs) for 2030. It is therefore timely to take stock of where PICT aquaculture is now and what direction(s) it should take from here to remain resilient and to meet the expectations of Pacific peoples.

FAME provides aquaculture advice, technical support and assistance to SPC PICT members in the region under Objective 3 of the current FAME Business Plan "Support the sustainable development of aquaculture", with the following sub-objectives: enhanced regional and national capacity in aquaculture policy and planning to establish clear priorities for aquaculture meeting current and future needs; provide technical and analytical support for aquaculture to support production and economic sustainability; enhanced the management of aquatic biosecurity risks.

### **B. Scope of Work**

The study will undertake an assessment of the aquaculture sector needs and priorities in the Pacific islands region, provide recommendations for future directions over a medium-to longer-term (5-10 year) horizon, with the aim to refresh and, if necessary, re-set the future priorities

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<sup>1</sup> American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Republic of the Marshall Islands, Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna.



and direction of CFAP's aquaculture advice and support to members through a Pacific Regional Aquaculture Futures Strategy.

### **Specific Tasks**

The consultant(s), working closely with the SPC CFAP Aquaculture Section, will:

- I. Describe and justify the proposed methodology and regional consultation process to undertake this consultancy. The methodology, including the reporting structure and content, must be agreed to between the consultant(s) and SPC.
- II. Review and assess the literature and available reports on the aquaculture sector relevant to the Pacific islands region, to identify the opportunities, the impacts, and the issues.
- III. Undertake consultations with PICT aquaculture, fisheries and biosecurity agencies and other key aquaculture sector stakeholders, to identify key aquaculture priorities, regional directions, emerging issues, innovations, or threats important to PICT members that the region should be considering in terms of medium and longer-term strategic priorities.
- IV. Assess PICT members' capacity in the aquaculture sector, including challenges faced by the sector in terms of current capacity, supply-chains and markets, policy, legal, financial, technical, business skills and socio-cultural issues, public-private arrangements and provide recommendations on how to address these constraints.
- V. An assessment of SPC PICT members' immediate and on-going needs that FAME could support, including specific needs as members transition towards the post-COVID-19 pandemic phase.
- VI. Assess the potential for sub-regional cooperative arrangements and/or centralised hubs to play roles that increase capacity and delivery of services in areas of common needs, such as identify aquatic biosecurity infrastructure and central distribution centres for broodstock including public private partnership facilities that exists in the region and identify members who may have the capacity to undertake, and to benefit from, such roles.

Through all the above consultations, discuss with member stakeholders the options preferred for a comprehensive process to develop a regional aquaculture strategy.

### **C. Outputs**

The expected key outputs are:

- Approved work plan, methodology and content outlines for ii. and iii. below, within 10 working days of signing. Regional Aquaculture Assessment report that examines the needs and priorities for SPC PICTs on aquaculture and provides recommendations for future directions.
- A report outlining the recommended consultative process for the development of the regional aquaculture futures strategy, what might be included in the strategy, and what it would look like based on the findings of the regional aquaculture assessment.

### **D. Institutional Arrangements**

The review can be undertaken by an individual, or a small team of independent consultants, with the support of CFAP Aquaculture staff.

The review will be managed by the SPC FAME CFAP Aquaculture Adviser who will be responsible for day-to-day management and administration of the review.

## **E. Duration of the Work**

Around 40 working days are expected for this work to be conducted including in-country consultations (in-person and/or virtually as necessary). It is intended to award a consultancy contract in November 2021. It is expected that the consultancy will start in late November or early December 2021. The consultant will submit a preliminary draft Regional Aquaculture Assessment Report and preliminary draft Regional Aquaculture Futures Strategy will be submitted to SPC by late January 2022. The Final Draft Regional Aquaculture Assessment Report and Final Draft Regional Aquaculture Futures Strategy will be submitted at least one month prior to the 14th SPC Heads of Fisheries Meeting (HoF14; expected to be held in March 2022) and presented by the consultant(s) to HoF14 for their consideration. The Regional Aquaculture Assessment Report and agreed consultative process report to develop the Regional Aquaculture Futures Strategy will be finalised within a month after the HoF14, taking into consideration the feedback and directions from HoF14.

## **F. Duty station**

The work will be desk-based at the [lead] consultant's usual work location. The use of in-country local consultants, where appropriate, would be encouraged.

The consultant will be expected to consult with SPC PICT members for the purpose of producing this work and should include, but not limited to the following:

- Aquaculture stakeholders such as business entities, community, and individual farms.
- The national agency responsible for Fisheries, Aquaculture and Marine Resources.
- The national agency responsible for aquatic biosecurity.
- Non-governmental and civil society organizations.
- Provincial and Local Municipal Authorities.