Solomon Islands

Tilapia Aquaculture Action Plan

2010-2015

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Produced by Ministry of Fisheries and Marine Resources – Aquaculture Division

Solomon Islands

Secretariat of the Pacific Community
Noumea, New Caledonia
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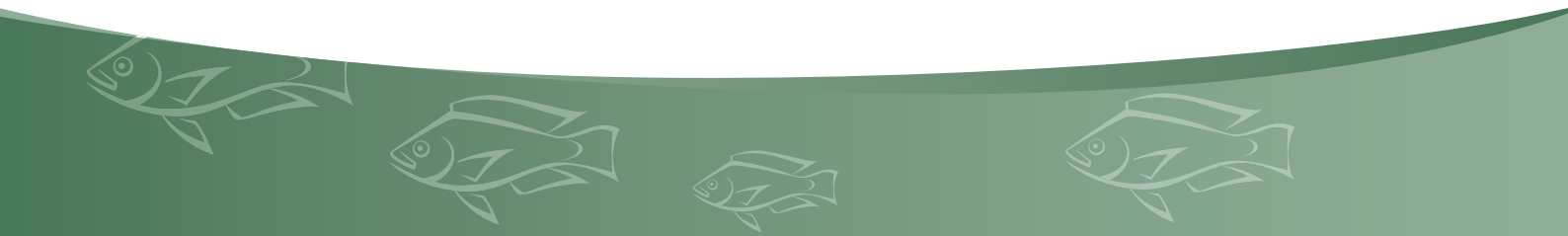

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ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
AD	Aquaculture Division (MFMR)
BMP	best management practice
FAO	Food and Agriculture Organization of the United Nations
FSPI	Foundation of the Peoples of the South Pacific International
FSPI-SI	Foundation of the Peoples of the South Pacific International – Solomon Islands
GIFT	genetically improved farmed tilapia
ICLARM	International Center for Living Aquatic Resources Management (now the WorldFish Center)
IRA	import risk analysis
MFMR	Ministry of Fisheries and Marine Resources
NGO	non-governmental organisation
NZAID	New Zealand's International Aid and Development Agency
PICTs	Pacific Island countries and territories
PNG	Papua New Guinea
R&D	research and development
SPC	Secretariat of the Pacific Community
SILMMA	Solomon Islands Locally Managed Marine Areas
USP	University of the South Pacific
WWF	World Wildlife Fund for Nature

FOREWORD

I am pleased to present to you the Solomon Islands Tilapia Aquaculture Action Plan 2010–2015. Preparation and implementation of the Plan will be a major contribution towards giving effect to the overarching Solomon Islands Aquaculture Development Plan 2009–2014. This identified tilapia as one of four priority aquaculture commodities that suit our national development needs.

Tilapia is an introduced fish that has had a mixed reception in the Pacific Islands region. Some countries regret having ever received it, while for others it is making a useful and ongoing contribution to food security and rural livelihoods.

We can place Solomon Islands in the second category. So far, tilapia has only been used for stocking into natural freshwater bodies to increase inland capture fisheries production. Nevertheless, we can point to successful cases, such as in Rennell and Tikopia, where people have come to depend upon their tilapia fisheries.

Times have changed since the early 1960s when these tilapia releases were done. It must nowadays be acknowledged that any release of an introduced alien fish will always have some environmental cost, and that the duty of care toward the environment has greatly increased. The era of intentional tilapia releases to establish it in new areas has passed. If we wish to gain further increases in tilapia production, we should look instead to responsible and sustainable aquaculture in those areas where tilapia is already firmly established.

Aquaculture is relatively new to Solomon Islands. Although tilapia is one of the easiest species to farm in freshwater environments, certain elements regarded as essential to support successful tilapia farm development have not yet been established in this country. The value of this Tilapia Action Plan is that it clearly spells out the various elements needed, and the steps that can be taken to acquire them.

I urge you to join with us to achieve our vision of a responsible and sustainable tilapia aquaculture industry for food security and income generation in Solomon Islands.

Hon. Minister Nollen C Leni
Minister for Fisheries and Marine Resources

EXECUTIVE SUMMARY

The Solomon Islands Tilapia Aquaculture Action Plan 2010–2015 has been prepared to (1) set out a logical and structured pathway for sustainable tilapia aquaculture development in Solomon Islands, and (2) identify potential roles for partner agencies in supporting tilapia aquaculture and helping meet national needs for food security and sustainable livelihoods.

Based on consultations with relevant stakeholders, a table of actions and timeframes is here presented. The actions are designed to meet these objectives:

- To ensure sustainable tilapia production through a tilapia development plan and responsible policies governing importation and farming, supported by relevant monitoring and compliance mechanisms
- To establish and support tilapia development by making available good-quality juvenile fish and feed
- To identify and establish regular market opportunities for tilapia products
- To promote awareness of tilapia farming practices, their benefits and constraints
- To build capacity at all levels in sustainable tilapia farming practices and management, and help overcome any constraints faced by people who want to engage in tilapia farming
- To monitor, assess and report on the progress of the tilapia sector
- To promote stakeholders' involvement and partnerships in tilapia development
- To monitor and where necessary take action to manage tilapia farming activity, to avoid resource-user conflicts and protect aquatic biodiversity

For sustainable tilapia aquaculture to become a reality in Solomon Islands, the main issues to be addressed are as follows:

Choose a good-quality variety of tilapia for aquaculture

While the feasibility of farming the local Mozambique tilapia should first be assessed, it is likely that successful tilapia farming will need to be based on importation of a domesticated variety of Nile Tilapia that is more suitable for pond aquaculture. Any importation will need to be consistent with national regulations for quarantine and protection of biodiversity, and with international obligations toward the environment. An Import Risk Assessment must be completed before a decision is made, and a suitable quarantine facility must be established.

Establish capacity and infrastructure to produce fish fingerlings for farming

A national master hatchery will need to be constructed and operated by trained staff to provide a fish broodstock facility that will maintain the genetic quality of tilapia and produce good-quality fingerlings for timely distribution to farmers.

Ensure that fish feed is available to farmers at acceptable quality and cost

Develop cost-effective local fish-food sources and feed formulations in preference to using imported feeds, and obtain suitable feed-making machinery.

Transfer of best-practice tilapia farming methods

Provide training and extension support in subsistence and livelihood farming methods for tilapia.

Avoid introducing tilapia into areas of high conservation value for aquatic biodiversity

Tilapia is regarded as an invasive species. An environmental cost is already being paid in areas where tilapia is currently established and cannot be eradicated. It is therefore appropriate that these areas should be able to benefit from responsible tilapia aquaculture. Solomon Islands is one of the few Pacific Island countries that currently retain tilapia-free catchments and there are areas that should remain free of tilapia. Historically, stocking to increase inland capture-fisheries production has been the main driver for tilapia translocations within the Pacific. This could remain a driver for translocations whether aquaculture takes place or not. So while the aquaculture sector cannot be held solely responsible for preventing any further spread of tilapia, actions taken under this plan do provide an opportunity to contribute towards conservation goals. There is a need to identify catchments that have high aquatic-biodiversity conservation values and to increase awareness about them. In attempting to secure the protection of these catchments, it is necessary to ensure that Solomon Islanders are able to make a decision to import or distribute tilapia based on sound scientific information and a full appreciation of risks.

1. ORIGIN OF THIS PLAN

In 2008, the Aquaculture Section of the Ministry of Fisheries and Marine Resources (MFMR) ran a national consultative process to produce the Solomon Islands Aquaculture Development Plan 2009–2014. Other arms of government, regional and international organisations, non-governmental organisations (NGOs) and private-sector stakeholders contributed to this planning process, which received financial and technical assistance from the Secretariat of the Pacific Community (SPC). Copies of the Aquaculture Development Plan are available from MFMR or SPC, or can be downloaded online from www.spc.int/aquaculture.

The Aquaculture Development Plan 2009–2014 is an overarching document that identifies the coastal and freshwater aquaculture commodities of highest priority to meet future needs for food and income in Solomon Islands. It describes the aquaculture goals of Solomon Islands, identifies roles for partner agencies in helping to meet these goals, and makes projections on the number of households that could be engaged in aquaculture by 2010, 2015 and 2020 if the plan is successful. It also sets out in broad terms the various steps that need to be taken for each priority commodity to make the plan a success.

The outcome of the 2008 prioritisation process was a set of commodity rankings, in which four commodities were rated highest in terms of feasibility and impact in Solomon Islands for the period 2009–2014. The four top-ranked commodities are tilapia, Kappaphycus seaweed, sea cucumber and giant clam.

It was envisaged at the outset that more detailed planning would be required for each priority aquaculture commodity identified in the Aquaculture Development Plan. The steps already broadly identified for each commodity now need to be elaborated into a set of specific actions, linked to targets and verifiable by indicators.

For this reason, during 2009 MFMR and SPC worked together on a Tilapia Action Plan discussion document, as a focus for stakeholder input and identification of issues in the development of a tilapia aquaculture sector in Solomon Islands. A stakeholders' meeting (17–18 November 2009) was attended by representatives of government ministries, regional and international organisations, educational institutions, community groups and environmental/community development NGOs.

This diverse group assessed the draft plan, and developed a set of objectives and actions that reflected their views on national priorities. This finalised plan is the outcome of those deliberations. It includes a statement of purpose and agreed objectives and actions, with supporting information about tilapia aquaculture and a description of the institutional setting for aquaculture in Solomon Islands.

A plan can only be useful if it is implemented. This will be a multi-stakeholder effort spanning government, civil society, regional and international organisations, and development partners. Formulating the plan has two advantages – it lists practical and agreed steps that can lead the sector forward while avoiding controversy, and it focuses attention and assistance on the bigger issues that will require effort to resolve.

2. PURPOSE OF PLAN

The purpose of the Tilapia Aquaculture Action Plan is to:

- Set out a logical and structured pathway for the development of sustainable tilapia aquaculture in Solomon Islands
- Define the roles of stakeholders in the tilapia sector
- Identify potential roles for partner agencies in helping to meet tilapia aquaculture development needs in Solomon Islands
- Describe tilapia aquaculture, its benefits, and constraints
- Summarise the aspirations of Solomon Islanders in tilapia aquaculture
- Identify tilapia aquaculture development needs in Solomon Islands

3. GOALS FOR TILAPIA AQUACULTURE

3.1 Vision

A responsible and sustainable tilapia aquaculture industry for food security and income generation in Solomon Islands

3.2 Goals

- Contribute toward ensuring an adequate and sustainable supply of fish for food security in Solomon Islands.
- Foster the creation of new income generation and employment opportunities for Solomon Islanders.

3.3 Objectives

- To ensure sustainable tilapia production through a tilapia development plan and responsible policies governing importation and farming, supported by relevant monitoring and compliance mechanisms
- To establish and support tilapia development by making available good-quality juvenile fish and feed
- To identify and establish regular market opportunities for tilapia products
- To promote awareness of tilapia farming practices, their benefits and constraints
- To build capacity at all levels in sustainable tilapia farming practices and management, and help overcome any constraints faced by people who want to engage in tilapia farming
- To monitor, assess and report on the progress of the tilapia sector
- To promote stakeholder involvement and partnerships in tilapia development
- To monitor and where necessary take action to manage tilapia farming activities, to avoid resource-user conflicts and protect aquatic biodiversity

4. TILAPIA ACTION PLAN

Objective	Actions	Indicators	Target
1. To ensure sustainable tilapia production through responsible policies governing importation and farming, supported by relevant monitoring and compliance mechanisms	1.1 Where appropriate promulgate, and seek compliance with, regulations or guidelines or consultative processes to address any adverse effects or user conflicts caused by tilapia aquaculture	Percentage of effects or conflicts identified that were resolved by regulatory or consultative processes	Ongoing
	1.2 Ensure that importation of tilapia varieties suitable for aquaculture is consistent with national regulations for quarantine and protection of biodiversity, and with international obligations toward the environment	National regulations International obligations Import Risk Assessments	Ongoing
2. To establish and support tilapia development by making available good-quality juvenile fish and feed	2.1 Assess the feasibility of farming local Mozambique tilapia for food security	Feasibility study report	By 2010
	2.2 If 2.1 is not feasible, then identify the options for introducing a better variety of tilapia for aquaculture, and carry out an important risk analysis (IRA) for each option	Options identified IRA(s) completed	By 2010
	2.3 If risks are within acceptable limits and subject to existing regulations and infrastructure, then introduce a better variety of tilapia	Better variety introduced	By 2011
	2.4 Develop cost-effective local feed sources and feed formulations in preference to using imported feeds	Local feed sources developed and tested	By 2011
	2.5 Establish a network of “satellite” hatcheries to provide good-quality fingerlings to provincial farmers	No. of fingerlings produced annually No. of people trained	Ongoing Ongoing
	2.6 Establish effective means for delivery of fish fingerlings, fish feed, and extension services to tilapia farmers	Fingerlings, feed and extension services are available	Ongoing

Objective	Actions	Indicators	Target
3. To identify and establish regular market opportunities for tilapia products	3.1 Carry out promotion and test-marketing of tilapia	Promotions completed, prices and consumer reactions evaluated	2013
	3.2 Assess demand for tilapia, both locally and for export	Needs assessment report that identifies areas of high fish demand, and sales opportunities	2011
	3.3 Facilitate sale of farmed tilapia products	Kg of fish product sold; no. of farmers that can access markets	Ongoing
	3.4 Carry out product development and value-adding of tilapia, in particular post-harvest preservation techniques that do not require ice	No. of new product forms, value added to product price, increase in shelf-life	2012
4. To promote awareness of tilapia farming practices, their benefits and constraints	4.1 Establish demonstration farms	No. of demonstration farms established	2012
	4.2 Look & learn visits by intending farmers	No. of visitors	Ongoing from 2012
	4.3 Training and work-experience attachments	No. of trainees, no. of attachments completed	Ongoing from 2012
	4.4 Prepare production manuals	Manuals written and disseminated	2011
	4.5 Establish a database of tilapia information for all to access	Database established	2011
5. To build capacity at all levels in sustainable tilapia farming practices and management	5.1 Establish a national freshwater fish quarantine facility and national fish broodstock maintenance facility	Facility completed and operational	2012
	5.2 Maintain the genetic quality of tilapia broodstock through implementation of a broodstock management plan	Broodstock quality maintained	Ongoing from 2012

Objective	Actions	Indicators	Target
	5.3 Establish a hatchery facility for pilot-scale production and training purposes	Hatchery operational	Ongoing from 2011
	5.4 Identify and help develop trial sites for tilapia farming	No. of sites identified and developed	Ongoing
	5.5 Develop farmer-assistance "start-up" packages for selected farmers entering the industry	No. of packages developed and distributed	Ongoing from 2012
	5.6 Provide training and extension support in subsistence and livelihood farming methods for tilapia	No. of farmers trained Extension support available	Ongoing Ongoing
6. To monitor, assess and report on the progress of the tilapia sector	6.1 Monitor tilapia farms to find out their fish production trends, and estimate their contribution to overall fish supply	Farm production data Market sales data Fisheries statistics	Annually
	6.2 Monitor number of farmers joining (or leaving) the sector, and obtain farmer feedback	Farm data, Farmer questionnaires	Annually
	6.3 Monitor and periodically review the Action Plan against the targets set, against farmer performance, and against any lessons learned 6.4 Evaluate progress to secure funding for plan actions, infrastructure requirements, staffing, and capacity-building	Annual review report of plan and progress, including re-assessment of staffing, resources, budgets, infrastructure, lessons learned, etc.	Every 3 years
7. To promote stakeholder involvement and partnerships in tilapia development	7.1 Networking and information sharing between tilapia sector stakeholders	Networks established Information shared	2011
	7.2 Seek technical and financial assistance from development partners to implement the plan	Technical assistance provided No. of development partners engaged Value of contributions	Ongoing from 2010

	7.3 Working partnerships to be explored; for example, collaborative projects on alternative livelihoods promotion, biodiversity surveys, etc.	Partnerships established	Ongoing from 2010
	7.4 Assess suitable options for establishment of Fish Farmer Associations or cooperatives, to optimise information exchange, procurement of farm inputs, and marketing	Associations established and involved in supporting farmers	Ongoing from 2010
Strategy	Actions	Indicators	Target
8. To monitor and where necessary, take action to manage tilapia farming activities, to avoid resource-user conflicts and protect aquatic biodiversity	8.1 Monitor tilapia farms to find any adverse effects or user conflicts, and link these back to Objective 1	Farm inspections, Community feedback	Ongoing
	8.2 Collaboratively with other research partners, conduct surveys of freshwater fish biodiversity to identify tilapia-free catchments in Solomon Islands	Survey reports Future biodiversity monitoring Anecdotal reports	Ongoing
	8.3 Collaboratively with other stakeholders, raise awareness about catchment areas identified as having high aquatic-biodiversity conservation value and support their protection	Awareness raised Protection efforts supported	By 2014
	8.4 Collaboratively with other research partners, identify and evaluate indigenous species of freshwater fish for aquaculture in tilapia-free catchments	Species evaluated Top-priority species selected for further investigation or culture trials	Ongoing
	8.5 Manage tilapia aquaculture to avoid it becoming a means of spreading this species beyond its present geographical range in Solomon Islands	Survey reports Anecdotal reports Adoption of best practices in farming	Ongoing

5. TILAPIA AQUACULTURE BENEFITS AND CONSTRAINTS

5.1 Tilapia – the "aquatic chicken"

Tilapia is a tropical freshwater fish with such good farming potential that it is known as the "aquatic chicken". It is suitable for family subsistence, extensive, semi-intensive or intensive farming. Tilapia farming can provide a source of fish protein to meet future food security needs, and livelihood opportunities for the increasing populations of developing countries.

Tilapia has several attributes that make it particularly suitable for aquaculture in Pacific Island countries and territories (PICTs), including:

- tolerance of a wide range of culture conditions, including brackish water
- easy to breed, with no special technology necessary
- fast growth
- lack of major diseases in semi-intensive production systems
- tolerance of live transport to markets
- availability of genetically improved (GIFT) varieties
- good market demand
- high (and increasing) economic value

5.2 A versatile fish for farming

Tilapia are suited to a variety of production systems, and can be farmed at both simple or more complex levels, e.g.:

- small pond production by rural households for subsistence (around 4 t of fish per ha per year)
- semi-intensive farms run as small businesses (10–20 t per ha per year)
- highly intensive farms (e.g. raceway, recirculation systems) for large commercial or export markets.

This versatility means that tilapia can perform multiple social and economic functions in a country. Tilapia aquaculture is accessible to rich and poor people alike. Tilapia farms can take the form of medium-scale enterprises. They can be an addition to traditional subsistence gardens to supplement household nutrition. They can be operated by boarding schools or training institutes to feed staff and students.

In tilapia markets overseas, customer preferences require that the fish be grown to quite a large size (500–1000 g). It is an advantage for Pacific Island tilapia aquaculture that consumers in our own domestic markets are accustomed to eating plate-sized whole fish of 200–400 g size. This means that tilapia can be harvested sooner and produced at less cost, if sold locally.

5.3 Some disadvantages of tilapia

No fish species is ever perfect for aquaculture. The biology of tilapia does have some disadvantages for farming:

Low fecundity

Although tilapia is fairly easy to breed, relatively few eggs are produced by mother fish at each spawning. A large number of mothers are needed each time to breed enough fish for pond stocking, which takes up a lot of hatchery space.

Poor cold-tolerance

Tilapia cannot grow well at high altitudes or in temperate climates. The best temperature range for rapid growth is 25–30°C, and the fish suffer at less than 20°C.

Less-attractive colour and taste than reef fish

Pacific consumers are more accustomed to eating reef fish. Even so, past prejudices against the taste or colour of tilapia are now being pushed aside by a shortage of fish overall. And once people have tried the taste of well-prepared tilapia, they soon admit that it is very good to eat. Demand for tilapia in the Pacific region is now becoming strong, though it commands a slightly lower price than that paid for reef fish.

5.4 Tilapia an "invasive" species

Tilapia has been widely publicised as being an "invasive" species. For example, Mozambique tilapia *Oreochromis mossambicus* is listed at No. 66 among the world's 100 worst invasive species on the Invasive Species Specialist Group – Global Invasive Species Database. Species that (i) readily establish and (ii) threaten other species or habitats or ecosystems in exotic locations, are termed "alien invasive species".

Tilapia clearly fit the first criterion for "invasive" species, due to the same characteristics that make them so good for aquaculture. They can readily establish because they breed easily, and because females care for their young by sheltering them in the mouth (they are "mouth-brooders"). Once introduced to a country and released into rivers or lakes, tilapia is almost impossible to eradicate.

In relation to the second criterion for "invasive" species, perspectives on what constitutes "harm" are subjective. For tilapia, the results of scientific research are unclear. Though primarily herbivorous and planktivorous, tilapia do have mouthparts capable of swallowing the baby stages of other fish. One recent study in Asia found that tilapia had little impact on indigenous fish[1]. Another study in Fiji Islands[2] found there was an association between the absence of up to 10 indigenous species from some Fijian

1 Arthur R.I., Lorenzen K., Homekingkeo P., Sidavong K., Sengvilaikham B. and Garaway C.J. 2010. Assessing impacts of introduced aquaculture species on native fish communities: Nile tilapia and major carps in SE Asian freshwaters. Aquaculture 299: 81–99.

2 Jenkins A.P., Jupiter S.D., Qauqau I. and Atherton J. 2009. The importance of ecosystem-based management for conserving aquatic migratory pathways on tropical high islands: a case study from Fiji. Aquatic Conserv: Mar. Freshw. Ecosyst. DOI: 10.1002/aqc.

rivers and the presence of tilapia. But the reported absence of species was simultaneously associated with several other major factors such as logging and siltation of formerly clear-water streams, so it is still not clear from this research just how much of the observed effect can be attributed to tilapia.

Tilapia are known to prefer muddy, warm and sunlit rivers with high primary productivity and they do not do well in cool, clear waters under forest cover[3], so in many cases it may well be that they simply move in after indigenous species have already moved out. Until this issue is settled however, it is sensible to take a precautionary approach and avoid introducing tilapia to new areas of the Pacific where it does not occur already.

Mozambique tilapia has already been introduced to 19 PICTs, including Solomon Islands. This was done a long time ago, during the 1950s and 1960s. The Nile tilapia *Oreochromis niloticus* has been introduced to 8 PICTs, where it is now being farmed.

These two species are able to inter-breed and hybridise, so are best regarded as belonging to the same "species complex". In some Pacific rivers, a gradation of forms can be seen, with more Mozambique-like forms in the lower reaches of rivers nearer the sea, while more Nile-like forms are found in upper reaches.

5.5 New introductions of tilapia

Countries that do not yet have any type of tilapia need to give full attention to its invasive characteristics (in particular, the difficulty of eradication) if its first introduction is being contemplated. Any such proposal should be considered very carefully, and in accordance with national regulations and international obligations toward the environment.

PICTs where Mozambique tilapia is present are already paying an environmental cost. The policy debate then shifts to an issue of how any type of tilapia can be responsibly utilised for food security and livelihoods; i.e. is it possible to obtain benefits without further increasing environmental costs.

Successful farming is most likely to be based on Nile tilapia because it performs much better in culture-pond conditions than Mozambique tilapia. The two species appear identical in terms of their environmental impacts, except that Mozambique tilapia is more salt-water tolerant so is potentially more widely invasive. Countries that already have feral Mozambique tilapia and that want to next introduce Nile tilapia for aquaculture will need to assess whether:

1. Nile tilapia has any environmental impacts or invasive characteristics additional to those of Mozambique tilapia;

2. special quarantine protocols need to be implemented to avoid unintentional introductions of any other aquatic species or fish diseases together with the imported fish; and

3. policies, planning and monitoring are necessary to contain tilapia within those catchments where it is already established, and to avoid its establishment in any areas of high conservation value for aquatic biodiversity.

3 De Silva S., Subasinghe R.P., Bartley D.M. and Lowther A. 2004. Tilapia as alien aquatics in Asia and the Pacific: a review. FAO Fisheries Technical Paper 453. Food and Agricultural Organization of the United Nations, Rome, 2004. 65 pp.

5.6 Pacific tilapia production and livelihoods

Domestic market potential is high and expanding rapidly in high-island countries like Fiji Islands and Papua New Guniea (PNG) with significant inland-rural and/or peri-urban populations. There are currently about 300 tilapia farmers in Fiji Islands, and an unknown but much larger number in the highlands regions of PNG. Total reported tilapia production in the Pacific Islands in 2007 was 272 t. However, there is known to be a lot of unreported production in remote highlands areas of PNG where more than 10,000 household-scale tilapia farms are thought to exist.

Although this amount of production is very small by global standards, tilapia aquaculture has become locally important in some places in the Pacific. The main PICT producers of tilapia in 2007 were PNG, which reported (under-reported) 100 t (USD 236,000) and Fiji Island with 143 t (USD 445,000), followed by Vanuatu (12.8 t, USD 32,000), Samoa (10 t), Northern Mariana Islands (2.7 t), and Cook Islands (1 t).

In the longer term, there is potential for export of value-added tilapia products to markets in Australia, New Zealand and USA, particularly if they can be labelled as "organic". To date, only a few small trial export shipments have been made. Presently there is a long way to go before PICT tilapia producers can even meet the demand for fresh fish in their own domestic markets.

5.7 Lessons learned from other places

Several PICTs have introduced tilapia for aquaculture in the last two decades. Experience in all these places has shown that tilapia aquaculture can be held back by any of the following reasons.

Lack of staff trained in tilapia culture practices and technologies

Although tilapia is an easy fish to breed, the task of breeding them in large numbers and sufficient quality for large-scale aquaculture does require skill and organisation. Hatchery operators need to understand and apply best management practices (BMPs) to avoid inbreeding and deterioration in the genetic quality of their broodstock fish. Farmers need to be aware of the importance of good feeding and avoidance of stress for farmed fish, but this knowledge is often lacking[4].

Limited infrastructure and resource availability

Even using BMP, there will be a slow deterioration in the genetic quality of broodstock over time owing to unavoidable inbreeding and reductions in effective population size. For this reason, most national master hatcheries need to replenish their breeding population every 5–10 years with new tilapia imported from a reputable source. This requires an appropriate quarantine facility and implementation of adequate biosecurity protocols.

Broodstock fish are valuable and need to be kept in a secure facility where they are protected from theft, or loss in a natural disaster. It is appropriate for government to operate a national master hatchery for this purpose, and to periodically distribute good-quality broodstock fish to satellite production hatcheries, which may be operated by other institutions or the private sector.

4 James T. and Tim P. 2009. Final report for Mini-project MS0507: Productivity and constraints in tilapia fish and freshwater prawn aquaculture in Fiji. [www.spc.int/aquaculture]

Farms built in very remote locations

Remote areas are difficult to keep supplied with seed, feed or advice. There must be efficient ways for making fish seed and fish feeds available to farmers, and feasibility studies for new farms must consider transport links for distributing such farming inputs in addition to technical advice.

Quality feeds expensive or unavailable

Often farmers cannot afford the cost of good-quality formulated fish feed, or the cost of transporting it from main centres to remote locations. Cheaper sources of feed, such as on-farm food sources – household food scraps, "green-water", or agricultural by-products like grated coconut or rice bran – result in slower fish growth and disappointing results for farmers. No-one should start farming fish unless they first know what fish feeds are available.

Farming the wrong variety of tilapia

Most countries that have tried to base their aquaculture on Mozambique tilapia have given up because this species is a slower-growing variety. It breeds at a very young age, and its many offspring compete with adults in the pond for food and oxygen, slowing their growth even further.

Ninety-seven percent of the tilapia farmed globally are Nile tilapia. This species has been introduced for aquaculture in some other PICTs (Fiji Islands, Guam, PNG, Northern Mariana Islands, American Samoa, Samoa, Vanuatu and French Polynesia) but is not yet present in Solomon Islands.

GIFT is an improved strain of Nile tilapia that is widely used by farmers in Asia and some Pacific countries. This strain grows 80% faster than unselected strains of Nile tilapia and also has a brighter color and better taste.

6. TILAPIA

6.1 Current situation

Solomon Islands is one of several PICTs where a future shortage of fish is predicted owing to rapid population growth and increasingly heavy pressure on coastal fisheries and reef[5]. Inland aquaculture is among the strategies recommended to address this projected shortfall in fish supply. Tilapia is considered one of the most suitable freshwater fish species for inland aquaculture based on low-technology methods, and it is already present in Solomon Islands.

Two tilapia species are potentially available to Solomon Islands. Mozambique tilapia has been present since the early 1960s and is widely distributed within the country. Internationally, this species is no longer preferred for aquaculture because, as mentioned above, it grows more slowly and breeds at a smaller size than Nile tilapia, the species now favoured for farming.

Mozambique tilapia presently inhabits many rivers, streams and swamps in Solomon Islands. Many people have become accustomed to eating it and enjoy its taste. In Lake Tegano on Rennell Island, Mozambique tilapia has literally become a lifesaver because previously only one other fish species (a small goby, *Eleotris fuscsa*) was found there naturally. The goby is still abundant. However, Lake Tegano communities have come to depend heavily on tilapia as their main source of dietary protein.

There have already been a few attempts to farm tilapia at household level in ponds. People are now looking to tilapia to help provide food for growing populations in urban/peri-urban areas, attracted by the idea of low-cost fish farming. Three-quarters of the aquaculture enquiries that MFMR receives from the public are about tilapia.

However, these initial attempts to farm tilapia in Solomon Islands have been abandoned because:

- fish growth was disappointingly slow (Mozambique tilapia is a poor-quality variety for aquaculture);
- fish food was difficult to obtain; or
- ponds were not well-constructed or managed, owing to lack of information about how to grow tilapia properly.

Nile tilapia is not present in Solomon Islands, but is of interest because it is the internationally preferred species of tilapia for aquaculture.

In 2009 MFMR, in collaboration with Solomon Tropical Products and with support from SPC and ACIAR, established an experimental-scale tilapia hatchery in Honiara. This was used to conduct a culture trial of Mozambique tilapia to assess the viability of aquaculture based on this tilapia species already present in Solomon Islands. The purpose of the assessment is to enable a decision to be made about whether or not a better-performing variety of tilapia needs to be introduced to Solomon Islands.

6.2 Proposed actions by MFMR

Tilapia aquaculture was given high priority by stakeholders consulted during the formulation of the Solomon Islands Aquaculture Development Plan 2009–2014. As a result, this plan contains some broadly worded actions for establishing a tilapia aquaculture sector in Solomon Islands:

5 Bell J.D., Kronen M., Vunisea A., Nash W.J., Keeble G., Demmke A., Pontifex S. and Andre´foue S. 2009. Planning the use of fish for food security in the Pacific. Marine Policy 33: 64–76.

√ Carry out an assessment of the suitability of Mozambique tilapia for small-scale, community-level aquaculture for food security

√ Carry out an IRA and develop quarantine protocols for the importation of GIFT Nile tilapia

If, based on IRA and other relevant matters, a decision is made to introduce Nile tilapia:

√ Establish a hatchery

√ Identify trial sites for fish farming

√ Develop cost-effective local feed formulations

√ Maintain the genetic quality of adult broodstock

√ Promote awareness of the benefits of Nile tilapia and provide training in subsistence and livelihood farming methods

√ Carry out promotion and marketing of tilapia

These actions have now been elaborated into detailed steps for implementation, and comprise the content of this tilapia plan (see Section 4).

6.3 Household participation vs. medium-scale enterprises

It is part of the Aquaculture Development Plan to set targets for the number of households that could be involved in priority aquaculture activities by 2020. The Solomon Islands population has an estimated growth rate of 2.8% per annum (as per the 1999 census). The total estimated population of 510,000 in 2007 is therefore predicted to reach 730,000 in 2020.

Data from 1999 showed the number of people per household (~ 6 people) and the per capita fish consumption (30 kg). The estimated national need for fish for food alone is 10,000 t in 2010, 11,500 t in 2015 and 13,500 t in 2020. For livelihoods, ~16,000 households were involved in selling fish at some level in 1999. For fisheries to remain an activity of comparable importance in 2020, an additional 4000 income-earning opportunities based on fisheries (including inland aquaculture) resources will need to be created by 2020. The plan projects that tilapia aquaculture could contribute 500 of these livelihoods by the year 2020.

This can be done in a variety of ways because tilapia is such a versatile fish for farming:

Small-pond household farms

Households can be directly assisted to establish and operate small-pond tilapia farms to supplement diets and produce a surplus for income.

Medium-scale enterprises

Large farms can be founded to supply the large numbers of fish needed in expanding peri-urban areas. If operated on a strictly business footing, these farms could provide the economies of scale needed for establishment and operation of infrastructure and services such as hatcheries and feed mills without the need for government subsidy. The availability of such services for “big players” would also benefit small-scale operators in tilapia farming.

Educational institutions

Institutions such as schools can establish farms to reduce their catering expenses and also provide training opportunities in fish farming.

Best places, best partners

Stakeholders will need to consider what types of tilapia aquaculture should be encouraged in Solomon Islands, and what resources to allocate to each.

Careful study will be needed on where, and with whom, tilapia projects can be established with best chances of success. In each place, tilapia will need to be assessed against other food-security and livelihood options, in both aquaculture and agriculture.

The areas where tilapia are most needed, or the areas where they are best able to be produced, are known from anecdotal evidence, but it is prudent that these areas be confirmed by proper surveys and needs assessments.

7. INSTITUTIONAL SETTING FOR TILAPIA AQUACULTURE

7.1 Suitability of Solomon Islands for tilapia aquaculture

The list of advantages presented in the Solomone Islands Aquaculture Development Plan for aquaculture as a whole highlights several Solomon Island attributes that favour the development of tilapia aquaculture:

√ Mozambique tilapia already present and widely established

√ Local feed ingredients available

√ Large areas of land and freshwater bodies with diverse opportunities

√ Relatively skilled labor force with experience in primary production

√ Low labour costs

√ Unpolluted environments and access to good quality water

√ Growing domestic market for farmed fish

On the other hand, there are also constraints and impediments to the development of tilapia aquaculture in Solomon Islands:

√ Unstable government with no clear policies regarding aquaculture

√ Scarcity of appropriate technical, business and management skills

√ Land disputes and traditional and custom inheritance

√ Lack of technical aquaculture know-how and access to proper information

√ Lack of infrastructure and communication or, where present, high costs and low reliability

√ Lack of encouragement for private-sector investment in medium-scale enterprises

√ Difficulty in transporting farm inputs and outputs between commodity production centres and markets

7.2 Organisations/partners in tilapia aquaculture sector

MFMR

MFMR is the lead government agency for statutory management of fisheries and aquaculture in Solomon Islands. MFMR issues licences to harvest fish commercially, and monitors and regulates fish harvesting activity. Draft regulations to enable and manage commercial aquaculture are under development. The ministry also has research & development (R&D) and community extension/capacity-building functions.

The Aquaculture Division (MFMR AD) has qualified and experienced staff with knowledge of tilapia farming. This ranges from practical hands-on husbandry experience gained by work attachment in Fiji Islands, to post-graduate research experience of tilapia farming. These staff have good working relationships with regional technical and research organisations such as SPC, the University of the South Pacific (USP) and Australian Centre for International Agricultural Research (ACIAR). Tilapia aquaculture is one of the main activities in the current MFMR AD work plan.

Other key ministries are the Ministry of Agriculture and Ministry of Lands. The Ministry of Agriculture supports the rural agrarian sector, for which aquaculture is a potential alternative land use. The Ministry of Lands oversees land survey and land tenure issues, which are key issues for aquaculture ventures, which require a sound legal basis to occupy coastal or marine sites and install farm infrastructure.

Private-sector investors in medium-scale enterprises

Currently, Solomon Islands has no medium-scale enterprises involved in tilapia farming. However, there are several local companies with the capability and resources to enter this industry, and some are already involved in other aquaculture commodities, e.g. seaweed and marine ornamental species.

Small-scale entrepreneurs

Interest in tilapia aquaculture has so far been strongest among people engaged in traditional agriculture in Guadalcanal and Malaita. Three-quarters of all enquiries about aquaculture to MFMR are from people interested in establishing household-level ponds to produce fish for their own consumption. The main driver for this appears to be serious concern about food security and household income for people living in these two densely populated areas.

Community stakeholders in subsistence-level aquaculture

Aquaculture for food security is attracting interest from institutions such as boarding schools. Government policy is for inshore fisheries management to be devolved to communities, which will be assisted to develop their own Management Plans. Aquaculture could be one of the tools for implementation of such plans through providing alternative local sources of fresh fish.

The WorldFish Center

The WorldFish Center has been present in Solomon Islands since 1986. Two field stations were originally established, the main one outside Honiara and another in Western Province. WorldFish works closely with MFMR and when possible the private sector, aiming to improve fisheries related livelihoods for rural Solomon Islanders.

WorldFish maintains an office in Honiara. Aquaculture operations are carried out from its field station at Nusa Tupe in Western Province. Since 2005, a marine hatchery has been operational at Nusa Tupe, primarily for giant clam culture.

WorldFish is working with the World Wildlife Fund for Nature (WWF) and has previously worked with Marine Aquarium Council (MAC) on supporting livelihood opportunities through environmentally sustainable forms of aquaculture. Much of this work has been funded under the New Zealand's

International Aid and Development Agency (NZAID). In 2007/2008, the European Union funded WorldFish and MFMR to assemble all the information needed by investors to make decisions about launching pearl farming in Solomon Islands.

WorldFish is a close partner of the MFMR aquaculture programme. Staff based elsewhere have been prominent in the development of tilapia aquaculture globally. WorldFish has the capacity and the facilities in Solomon Islands to run experiments on relevant aquaculture commodities, or to work directly with communities in socio-economic surveys or project management. Through their regional and international networks, Worldfish has potential to attract project funding for research on appropriate aquaculture development models for Solomon Islands and for identifying and addressing key constraints to agreed approaches to tilapia aquaculture development in Solomon Islands.

Foundation of the Peoples of the South Pacific International – Solomon Islands (FSPI-SI)

FSPI-SI is based in Honiara and currently has three permanent staff. It operates in areas such as the Central Islands Province in Gela, Marau Sounds in Guadalcanal Province and Langa Langa Lagoon in Malaita Province. FSPI-SI is one of a group of NGOs that operate under the supervision of Foundation of the Peoples of the South Pacific Internatioal (FSPI) in Fiji Islands.

FSPI-SI has been very supportive of reef management and conservation, and active in coral farming for the aquarium trade and restocking, and has the technical capacity to carry out community-based work in rural areas of Solomon Islands. Recently, FSPI published a study on the economic viability of producing farmed and wild corals for the aquarium trade.

FSPI-SI has a good track record in community-based marine resource management, experience in coral farming, and good linkages with MFMR and the communities it has worked with.

WWF

Whilst aquaculture is not a primary objective of WWF, the organisation has assisted the development of aquaculture in Solomon Islands. In recent years, WWF has been an active partner of WorldFish in identifying and training rural communities in types of aquaculture techniques that it believes provide a sustainable alternative livelihood. WWF could be one avenue for seeking support for surveys of freshwater fish biodiversity, to help identify areas of high conservation values.

Solomon Islands Locally Managed Marine Areas (SILMMA) Network

SILMMA promotes a network of locally managed marine areas that were established through participatory processes within communities as a response to the depletion of marine resources. Tilapia aquaculture can potentially provide alternative sustainable livelihoods as one part of the overall marine resources management “tool-kit” developed by participating communities in the SILMMA Network.

Secretariat of the Pacific Community (SPC)

SPC is an intergovernmental organisation that provides policy and technical support, research and training services to member governments. MFMR is the main counterpart in Solomon Islands for SPC’s fisheries and aquaculture programmes. The SPC Aquaculture Section based in New Caledonia and Fiji Islands includes specialists in freshwater and marine aquaculture. It provides technical assistance to MFMR through desk work and in-country field work.

SPC's Aquaculture Programme is already supporting the development of tilapia aquaculture in Solomon Islands in various capacities. At a strategic level, SPC assists MFMR to formulate national aquaculture strategies and assists government to develop the institutional capacity to meet its obligations. SPC organises regional forums and mechanisms that enable Solomon Islands to share information and collaborate with other Pacific Island countries and territories, expert agencies and donors.

At a technical level, SPC is providing advice for the current Mozambique tilapia culture trial, assisting with the development of a tilapia plan, and facilitating the conduct of a risk assessment for any proposed importation of Nile tilapia.

NZAID

New Zealand's bilateral development assistance to Solomon Islands has a rural development focus and currently includes the fisheries sector as an area for institutional strengthening.

ACIAR

ACIAR is an agricultural research organisation within the Australian government that includes fisheries and aquaculture within its mandate. Its projects aim to increase research capacity in eligible countries. In Solomon Islands, ACIAR is currently supporting a Mozambique tilapia growth trial to assess its suitability for aquaculture, and a project to develop a strategy to guide future development of sustainable inland aquaculture.

7.3 Tilapia aquaculture facilities and infrastructure

Tilapia hatchery

MFMR AD does not have any facilities or infrastructure of its own for freshwater aquaculture, and has only a bare minimum of equipment. Establishment of a national master hatchery and quarantine facility, with some pilot-scale feed-making machinery, will be the first big hurdle in building a tilapia aquaculture industry in Solomon Islands.

The WorldFish Center in Western Province is currently the only research-based hatchery operation in Solomon Islands. The operation has the ability and technical skills to produce marine aquaculture commodities such as giant clams, pearl oyster or other marine invertebrates or fish species. The facility is unsuitable for freshwater fish like tilapia, however.

This leaves the temporary "backyard hatchery" operated in 2009 by MFMR and Solomon Tropical Products as the only tilapia breeding facility currently operating in Solomon Islands.

On Guadalcanal, there are two derelict facilities that could be utilised for large-scale tilapia production. The giant clam cement tanks at the former WorldFish (ICLARM) site at Aruligo are close to a freshwater source and could be used to breed tilapia. The disused shrimp ponds nearby at Ruaniu also have a good freshwater source and could be used for large-scale tilapia growout. These ponds could be operated as a tilapia hatchery using the hapa method (breeding in net enclosures).

Inland from the Aruligo site is a suitable tract of gently sloping land with a piped water source that could be developed into a tilapia master hatchery using the earthen-pond method.

If Solomon Islands is to emulate the success of Fiji Islands, PNG and the other tilapia-producing countries in the region, there is a need to construct a freshwater hatchery for GIFT tilapia (including a quarantine facility) to supply good quality fingerlings to farmers. MFMR proposes to investigate available sites for a freshwater aquaculture facility; for example, re-vitalization of the former ICLARM site, possibly in conjunction with other institutional or private sector stakeholders. If successful, MFMR will encourage private sector entrepreneurs to join the venture and provide funds for extension.

Feed manufacture

The three main ingredients needed to produce tilapia pellet feed are fishmeal, copra meal, and mill run. The first two are produced within Solomon Islands, while the third is available as an imported commodity. In some districts of Solomon Islands (depending on availability) sago palm flour could be used instead of mill run. Other local ingredients, e.g. palm-oil cake, could also be investigated. There is a need for feed development research and growth trials to identify suitable ingredients and develop least-cost formulations for tilapia feeds using as high a proportion of local ingredients as possible.

Producing feed pellets locally will require installation of suitable pelletising machinery. Ideally, this is a role for a private sector investor, who could also utilise the same machinery to produce agricultural feed, e.g. for poultry and pork production.

7.4 Human resources

Aquaculture is not a traditional activity in Solomon Islands – it is quite new and recent. The Aquaculture Division was established only in 2000 to administer aquaculture activities in conjunction with the Coastal Fisheries Division and Provincial Fisheries Officers.

MFMR has assembled a team of experienced and qualified local staff, whose training and skills exceed the minimum requirements for tilapia aquaculture. Further staff training will nevertheless be required in some specialised aquaculture areas, e.g. feed formulation techniques and broodstock management.

7.5 Policies and legislation

There is a lack of legislation and policies for aquaculture in Solomon Islands. In 2002, the first Aquaculture Regulations were drafted and circulated for comments. The document was completed with the combined efforts of the Fisheries Legal Adviser and Deputy Director (Aquaculture).

These regulations also provide guidelines for the division and the Department as a whole. The draft is yet to be revised by the Attorney-General's Chambers to enable it to be forwarded for gazetting. When it is gazetted, the Aquaculture Division will be in a stronger position to guide the development of aquaculture in the country. The Fisheries Act is now under review and will also address these matters.

Lack of legislation and policies is more serious for the mariculture sector in Solomon Islands because marine tenure always involves more complex issues than land tenure. While land tenure in Solomon Islands cannot be said to be simple, it is nevertheless much more straightforward to acquire the necessary property rights to operate a freshwater aquaculture project on land than it is to operate in the sea.

In terms of measures to protect freshwater environments and biodiversity from any environmental impacts of tilapia farms, it will be necessary to review existing relevant legislation such as the new Wildlife Regulations to identify any gaps in MFMR's mandate to manage aquaculture.

7.6 Cross sectoral factors relating to tilapia aquaculture

R&D

MFMR AD will make best use of regional and international expertise in research and development. There have been a lot of success stories in the Pacific region (as well as failures). Solomon Islands is still at the early stage of aquaculture development and can learn from these experiences and avoid past mistakes.

Technical regional and international organisations (the Food and Agriculture Organization of the United Nations, SPC, WorldFish), regional universities (USP) and NGOs can undertake or commission research on behalf of MFMR, or source information to assist Solomon Islands to develop a tilapia aquaculture sector.

Training

MFMR AD will be launching training activities for staff. The division will ensure that national training needs are wisely addressed and intends to make best use of training opportunities available in country; for example, the WorldFish Center can assist with training.

Training should be in accordance with national policies and priorities set for aquaculture. In Solomon Islands' case, the Aquaculture Division should consult with its institutional and financial partners to identify the training required to lead to tangible outcomes. Regional organisations such as SPC or USP, for example, have experience in organising training workshops and individual attachments and this is one avenue that will be pursued by MFMR.

Information

MFMR will develop mechanisms to improve the flow of information; for example, from international/ regional partners including industry operators to MFMR headquarters then to MFMR provincial officers who can pass it on to rural farmers.

Biosecurity

MFMR, in partnership with key agencies such as quarantine and environment services, intends to build up national capacity for biosecurity to assess and protect against the risks involved in introducing species. Aquaculture in Solomon Islands will work within the framework of the National Biosecurity Strategy and Action Plan.

Under the draft aquaculture regulations, there are measures to control the introduction of exotic animals. MFMR will also utilise regional organisations and specialists to assist in developing these strategies.

Translocation of exotic invasive species within Solomon Islands is also a biosecurity issue. Because the country consists of a group of islands, there is an opportunity to develop tilapia aquaculture in some places but at the same time keep other places tilapia-free to protect the nation's rich biodiversity. Surveys will be needed to find out the current extent of the distribution of Mozambique tilapia within Solomon Islands, and to identify any areas of high conservation value for indigenous freshwater fauna. Consideration can then be given to developing clear policies that limit tilapia translocations to avoid adverse effects on aquatic biodiversity.

Historically the main driver for tilapia translocations within the Pacific has not been for aquaculture, but rather to stock rivers and lakes to increase inland capture-fisheries production[6]. This same motivation is likely to remain a driver for possible future translocations as well. This means that it is unrealistic to hold the aquaculture sector solely responsible for preventing any further spread of tilapia. To contain tilapia within their present distributions will require awareness and support from the wider community.

Actions taken under this plan provide an opportunity to contribute towards conservation goals, however. There is a need to identify catchments that have high aquatic-biodiversity conservation values, to increase awareness about such catchments and, while attempting to secure their protection, ensure that Solomon Islanders are able to make a decision to import or distribute tilapia based on sound scientific information and a full appreciation of risks.

7.7 Policy on private sector investment

It is in the interest of Solomon Islands to attract private sector investment both locally and from overseas. Successful aquaculture ventures in the Pacific have most often been based on early private sector involvement. To replicate this developmental model in the Solomon Islands, MFMR AD together with its partners within and outside government should provide information to prospective investors on the following issues:

Land tenure

Solomon Islands have customary rules on land access rights and ownership. There are many cases of conflicts in Solomon Islands and elsewhere in the Pacific regarding land ownership. This might be a limiting factor for private investment in Solomon Islands, so MFMR in conjunction with relevant departments such as the Lands Department, must clearly formulate rules and guidelines that may help make Solomon Islands more attractive for investors.

Licensing

There is as yet no specific licensing system for aquaculture in Solomon Islands. Licensing not only provides an opportunity for the government to ensure that large-scale aquaculture developments are in the public interest, but also provides certainty to the investor about any necessary property rights or privileges that need to be acquired. At the same time, aquaculture licensing should not be implemented in such a way that it acts as a barrier to small-scale operators wanting to engage in tilapia aquaculture.

Infrastructure

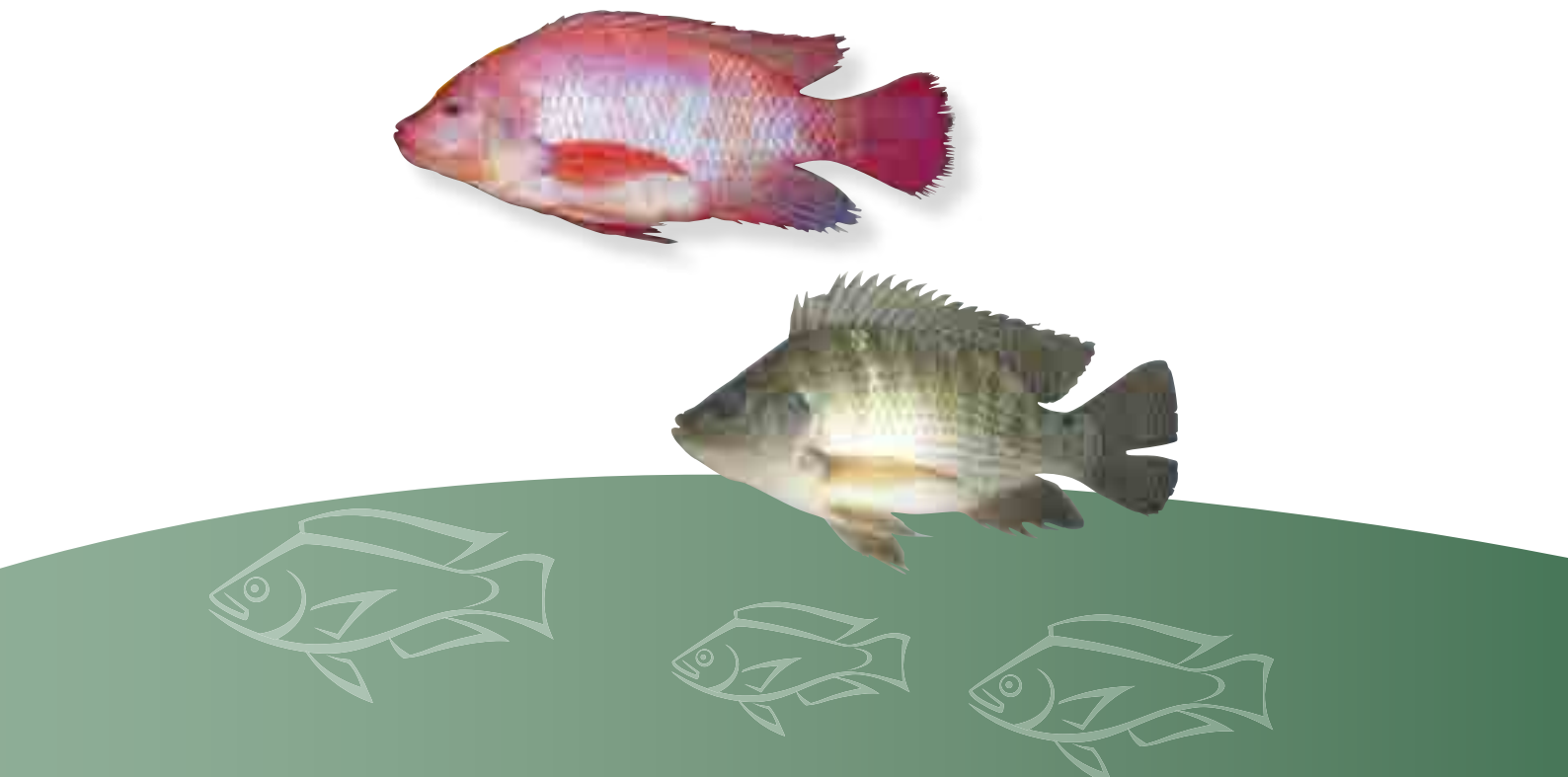
Infrastructure is one of the major limiting factors for aquaculture development in Solomon Islands.

6 Devambez L.C. 1964. Tilapia in the South Pacific. South Pacific Bulletin, October 1964: 27–28, 52

MFMR is well aware of this situation and will liaise with appropriate authorities to consolidate aquaculture in areas where there is adequate infrastructure, and extend it to new areas with potential.

Freight

MFMR should advocate pricing agreements for aquaculture commodities with shipping companies, whether the commodities are for domestic or export markets. For outlying provinces to realise the potential of tilapia production, there must be fair and cost-effective means for obtaining significant farming inputs such as seed and feed, and for gaining access to markets for farmed fish.



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