Pacific Community
Communauté du Pacifique

Technical guidelines for quarantine, broodstock management and hatchery operations of introduced GIFT Nile tilapia

FAME
Fisheries, Aquaculture and Marine Ecosystems Division

NEW ZEALAND
FOREIGN AFFAIRS & TRADE
Aid Programme

Technical guidelines for quarantine, broodstock management and hatchery operations of introduced GIFT Nile tilapia

Sylvester Diake (Jnr)
Solomon Islands Ministry of Fisheries and Marine Resources

Tim Pickering and Ruth Garcia-Gomez
Fisheries, Aquaculture and Marine Ecosystems Division of the Pacific Community

Pacific Community
Communauté du Pacifique

Noumea, New Caledonia,
2019

Original text: English

Pacific Community Cataloguing-in-publication data

Diake, Sylvester

Technical guidelines for quarantine, broodstock management and hatchery operations of introduced GIFT Nile tilapia / Sylvester Diake, Tim Pickering and Ruth Garcia-Gomez

1. Aquaculture – Management.
2. Tilapia.
3. Nile tilapia.
4. Fishes.

I. Diake, Sylvester II. Pickering, Timothy III. Garcia-Gomez, Ruth IV. Title V. Pacific Community

597.74 AACR2

ISBN: 978-982-00-1190-8

Prepared for publication at SPC's Noumea headquarters,

B.P. D5 98848 Noumea Cedex, New Caledonia, 2019

www.spc.int | spc@spc.int

Contents

1. Introduction 1

2. Import requirements 1

2.1. Pre-border quarantine measures at the exporting country (Malaysia) 1

2.2. During transportation 2

2.3. Post-border quarantine measures at the importing country (Solomon Islands) 2

3. Technical specifications of the quarantine and hatchery areas 4

3.1. Technical design, site plan and specifications 4

3.1.1 Specifications of each section 4

3.1.2 Functions of each section 5

3.1.3 Technical design features of each section 5

3.1.4 Evaluation of production capacity 9

4. Management and administration protocol 10

4.1. Principles of broodstock management policy 10

4.2. The guiding principles for the breeding nucleus centre are shown below 11

5. Definitions 11

6. Procedure to breed replacement broodstock 12

Summary of key steps 13

Annex 1: Diseases to be absent in introduced GIFT tilapia stock 15

Bacterial diseases 15

Parasitic diseases 15

Fungal diseases 15

Viral diseases 15

Annex 2: General quarantine protocol - Infrastructure andoperations 16

1. Period of quarantine 16

2. Standards of construction 16

2.1. Location of quarantine facilities 16

2.2. General requirements 16

2.3. Specific construction and equipment requirements 17

3. Standards of operation 18

3.1. Influent water 18

3.2. Wastewater sterilisation and disposal 18

3.3. Disinfection of equipment 18
3.4. Disposal of dead aquatic animals 19
3.5. Disposal of packing materials 19
4. Work practices 19
4.1. Cleanliness and sanitation 19
4.2. Handling of aquatic animals 20
4.3. Occurrence of an outbreak of a serious exotic disease 20
5. Record keeping requirements 21
5.1. Summary records 21
5.2. Tank record sheets 21
5.3. Operations and entry logbooks 22
6. Auditing 22
7. Security 22
8. Contingency plans 22
Annex 3: Other risk management measures complementary to quarantine 23
1. Introduction 23
2. Pre-border measures 23
3. Post-border measures 24

1. Introduction

The Solomon Island Ministry of Fisheries and Marine Resources (MFMR) took the decision, after various national stakeholder consultations, to facilitate the introduction of an improved strain of the aquatic species Nile tilapia (*Oreochromis niloticus*), known as the genetically improved farmed tilapia, or Genetically Improved Farmed Tilapia (GIFT).

This improved strain has been developed during 20 years of selective breeding under the umbrella of WorldFish (initially based in Philippines and currently based in Malaysia).

The main goal of this introduction is to promote and encourage small-scale tilapia farming in rural areas of Solomon Islands in order to improve food and nutritional security and promote income generation. Nile tilapia is a very robust species with rapid growth rate. It is the second most important aquatic farmed species in the world, being relatively easy to breed and farm. The species is originally from Africa, but most of the selective breeding programmes have been implemented in Asian countries. Nile tilapia is the most important aquatic species farmed in the Pacific Island region in continental waters, and has the largest impact on food security and poverty alleviation.

Solomon Islands MFMR, after years of promoting farming trials with another tilapia species, *Oreochromis mossambicus*, which was introduced in the 1980s and 1990s from various Asian countries for mosquito control, has taken the decision to facilitate the import of the Nile tilapia. This is due to the low performance of the Mozambique tilapia specimens, which have very limited growth rates and early sexual maturation.

The purpose of this basic guideline is to present the import requirements, quarantine protocols/operations and hatchery strategies to be followed during and after the introduction of the improved strain of GIFT Nile tilapia.

2. Import requirements

2.1. Pre-border quarantine measures at the exporting country (Malaysia)

1. The shipment of GIFT tilapia specimens to be introduced into Solomon Islands should be of "high health status" and have an **animal health certificate** or a **clear sanitary certification** issued by the competent authority in charge of biosecurity and aquatic animal health management of Malaysia, and signed by an authorised veterinary officer.

1. The **animal health certificate** must conform to the principles of the World Organisation for Animal Health (OIE) International Aquatic Animal Health Code, eighth edition 2005, Part 6, Section 6.1 Appendix 6.1.1, International Aquatic Animal Health Certificate for Live Fish and Gametes.

2. A detailed health checklist of each individual in the batch of stock destined for export should be followed before transportation from the facility of origin (WorldFish Centre).

3. The facility of origin (WorldFish Centre) in Malaysia will demonstrate a proven track record of main diseases and pathogens, including clinical signs, differential diagnoses, final diagnoses, mortalities and morbidities, if these occurred to the specimens to be introduced into Solomon Islands during the pre-border quarantine.

1. The facility of origin (WorldFish Centre) will present the **screening results** signed by a veterinary doctor for the diseases listed in **Annex 1** of this document, with special emphasis on the screening of the Tilapia lake virus (TiLV).

2. The facility of origin (WorldFish Centre) will have evidence of adherence to strict bio-security protocols and an over-all health management plan.

3. The facility of origin (WorldFish Centre) must provide Solomon Islands with sufficient guarantees as to the health status and history of its stock.

4. An external disinfection treatment with formalin or chlorine will be implemented at the facility of origin (WorldFish Centre) to the stock to be introduced, prior to transportation.

5. If possible, and if deemed appropriate, an on-site inspection visit to the production facility (WorldFish Centre) by a recognised expert on behalf of the Government of Solomon Islands could be made to ensure that the pre-border quarantine protocols are adequate to validate guarantees of health status.

6. The batch of the stock destined for export should be separated as early as possible from other stocks reared in the facility of origin (WorldFish Centre) and should be maintained in tanks separate from the rest of the stocks.

7. Detailed records should be kept of the health status and mortality rates of the batch of organisms to be transported. Such records should be made available to the veterinary competent authority in Malaysia responsible for health certification.

2.2. During transportation

1. The consignment must be exported direct to Solomon Islands in new, clean, sealed packaging containers, complying with IATA standards that prevent any leakage or entry of contamination.

2. The containers must be transported according to the recommendations set out in Chapter 5.4 of the OIE Aquatic Animal Health Code of 2009.

3. Any transhipment that occurs between freight vessels must be conducted in a manner that ensures no risk of contamination of the consignment. No exchange of water or food is to occur during transport.

4. Consignments must not contain any undeclared foodstuff, animal material, or any other aquatic organisms other than the species that is intended to be introduced for aquaculture.

5. Consignments will be inspected upon arrival.

6. In the event of the consignment arriving in Solomon Islands without the correct documentation or in any other way not having met these requirements, the consignment may, at the discretion of the Solomon Islands quarantine officers, be retained in quarantine for: (1) additional testing and examination; (2) returned to the country of origin; or (3) destroyed at the owner's expense.

7. Upon arrival in Solomon Islands, the consignment must be put in quarantine in an aquaculture facility that has adequate monitoring systems and procedures in place and has been approved by the Solomon Islands Biosecurity Authority. (See **Annex 2** for detailed information on quarantine procedures for live aquatic animals.)

8. If other fish or aquaculture species are already present on the property, the consignment is to be isolated in an area/pond/tank that does not share water or feeding systems with the rest of the facility and has been pre-approved by the Solomon Islands Biosecurity Authority.

2.3. Post-border quarantine measures at the importing country (Solomon Islands)

9. The receiving quarantine area/facility in Solomon Islands must implement standardised quarantine measures and operations such that the risk of pathogen exposure and spread is minimised. (The detailed quarantine protocols are described in **Annex 2** of this document, which has been adapted from the *FAO manual on quarantine protocols for the movement of live aquatic organisms*).

10. The stock will be received at the quarantine area/facility that should be previously approved by the Solomon Islands Biosecurity Authority.

11. The quarantine area/facility should be excluded from any day-to-day activities related to other culture species.

12. The intake and outlet waters should be separated and contained, as described in **Annex 2** of this document.

13. The **animal health certificate** or sanitary certification and related documentation provided by the competent authority of Malaysia will be analysed and reviewed, either at the airport or at the quarantine area/facility, by the Solomon Islands Biosecurity Authority.

14. The Solomon Islands Biosecurity Authority should check the species, size, amount and general health status of the specimens received, either at the airport or at the reception into the quarantine area/facility.

15. The specimens will be monitored daily by quarantine and/or fisheries officers during a quarantine period of 10 days, based on the daily assessment of the quarantine and fisheries officers.

16. The specimens should be acclimatised to the water temperature and water quality before being released into the stocking tanks at the quarantine area/facility.

17. Stocking tanks at the quarantine area/facility should be cleaned and disinfected with hypochlorite at 200 ppm (or other disinfectant solution), prior to reception of the stock and after release of the stock.

18. Intake water will be sand filtered and then passed by 50/25-micrometre cartridge filters.

19. Water outlets will be disinfected before being released to the environment (using hypochlorite treatment – 200 ppm).

20. Independent water inlets and outlets will be available for each tank at the quarantine area, for easy of filtration and disinfection treatments.

21. The stock should be kept for a minimum of 10 days at the quarantine area/facility. After this period, the general health status of the specimens will be checked prior to stocking them for further culture.

22. The quarantine area/facility operators will follow a general health monitoring system, keeping a daily record of health status, mortalities/morbidities and any disease outbreaks.

23. No specimens will be removed from the quarantine area/facility without prior permission from the Solomon Islands Biosecurity Authority.

24. In the event of a serious mortality or disease outbreak, all specimens will be destroyed and disposed of (incinerated) in an approved sanitary method and the facility fully disinfected (with hypochlorite 200 ppm) before stocking new specimens.

Water quality control, Ministry of Fisheries and Marine Resources

3. Technical specifications of the quarantine and hatchery areas

3.1. Technical design, site plan and specifications

The hatchery and quarantine facility contains four sections, each having a unique function in quarantine, breeding and seed production.

These four sections with their functions are listed below.

1. Quarantine facility – manages pathogen and hitchhiker-species risks
2. Breeding nucleus – maintains the genetic quality of GIFT broodstock fish received from the WorldFish Penang Breeding Centre. (N.B. MFMR does not intend to operate an in-country genetic improvement programme for tilapia fish.)
3. Multiplier hatchery – production of high-quality seed for delivery to farmers. (N.B. This function will be subservient to 2 and is expected to decrease over time as lead farmers gain the capacity to adopt hatchery roles).
4. Educational facility – demonstration pond for training in fish farm management and integrated agri-aquaculture, for use by NGOs and/or community tilapia farmers in western Guadalcanal districts.

3.1.1 Specifications of each section

Section	Specifications
Quarantine facility	Capacity for a minimum of 8,000 fry in four separate families of 2000 fish, each to be imported at 1g size, acclimated into 4 x 1000 L or 2000 L quarantine tanks, and held for a two-week quarantine period.
Breeding nucleus	Broodstock maintenance holding-facility capacity: a minimum of 4,320 adult-size (100–300 g) broodstock fish in four separate families of 1,080 fish each, to be maintained for about 10 years without re-introduction, with replacement broodstock generated on-site at two-yearly intervals in accordance with WorldFish GIFT rotational-cohort cyclic mating scheme protocols.
Multiplier hatchery	Fingerling production target will be 200,000 per year initially of approximately 1-inch size fish, increasing to 1 million fingerlings per year within five years. As a matter of policy, MFMR's primary roles will be: (i) quarantine; and (ii) maintenance of a nucleus of high-quality broodstock fish. The multiplier hatchery function will be important initially but, over time, the multiplier function will be transferred from MFMR to private-sector lead farmers located in each of the outlying tilapia-farming provinces and districts in Solomon Islands. MFMR responsibility will become mainly one of supplying quality broodstock to multiplier hatcheries. The breeding nucleus centre may thus not be required to develop its multiplier hatchery function up to the full 1 million per year target here anticipated for supply directly to grow-out farmers.
Educational facility	One pond is needed for experiential learning about tilapia monoculture grow-out and for demonstration of integrated agri-aquaculture, using pond water to irrigate vegetable/fruit gardens and feed vegetables/fruits to fish. There is no production target associated with these functions.

3.1.2 Functions of each section

Section	Function
Quarantine facility	Capacity for a minimum of 4000 fry in four separate families (J. Pant pers. comm.; Ponzoni et al. 2012) of 1000 fish each to be imported at 1 g size, acclimated into 4 x 1000 L or 2000 L quarantine tanks, and held for a 2-week quarantine period.
Breeding nucleus centre	Broodstock maintenance holding facility capacity: minimum of 1,920 adult-size (100–300 g) broodstock fish in four separate families of 480 fish each, to be maintained for about 10 years without re-introduction, with replacement broodstock generated on-site at two-yearly intervals in accordance with WorldFish GIFT rotational-cohort cyclic mating scheme protocols.
Multiplier hatchery	Fingerling production target will be 200,000 per year initially of approx. 1-inch size fish, increasing to 1 million fingerlings per year within 5 years.

3.1.3 Technical design features of each section

A - Quarantine facility

SPC recommends the construction of an aerated static-water tank system enclosed in a weatherproof structure, using 4 x approx. 1000 L rectangular cement tanks and a 2000 L sump tank, which can be managed with partial water exchange of about 20% daily. Drained water will be chlorinated and held in an external enclosed 5000 L tank for 24 hours, before discharge into an earthen soak-pit.

A static tank system with partial water exchange is selected because, although the use of a shared water recirculation system is permissible, it is not advisable, as it may facilitate the spread of pathogens between tanks.

The quarantine system should not be located at the same site as the breeding nucleus centre. It should be constructed at either the biosecurity compound at Henderson Field, or at the MFMR aquaculture complex at Aruligo.

General requirements of the quarantine facility

- Access should be through property owned or leased on a long-term basis by the operator and should be available to quarantine officers during normal business hours and at such time as aquatic animals are entering or leaving the facility.
- The quarantine facility should be located within a single operational entity, if possible. It should be structurally physically separated from all other operations and is dedicated solely to the holding of the shipment.
- It should not share a building having areas that are used for different purposes and should not allow access to other buildings or activities.
- It should not to be used for any purpose, whatsoever, other than as a place for quarantine.
- It should be weatherproof and maintained in a state of good repair.
- It should be a secure, lockable building that is surrounded by a lockable person-proof security fence.
- The holding capacity should be commensurate with the proposed quantities of the species of aquatic animal for which a permit is granted.
- Provision must be made for the growth and maturation of the original parent stock and the holding of all F1 and subsequent generations as required.
- The quarantine facility should be equipped for the sterilisation of all equipment that comes in contact with aquatic animals or tank water during the quarantine period.
- It should also be equipped with back-up systems for essential components (e.g. electricity, water circulation, aeration, temperature control, filtration) to maintain biosecurity and the health of stocks in the case of electrical or mechanical failure.

The quarantine facility should comply with the specific construction and equipment requirements listed below.

a) Windows should be screened to prevent the entry of insects.

b) Floor and walls should be constructed of concrete, tiles or other impervious material to enable hose down and disinfection with retention of all wastewater. The floor should be sufficiently smooth and with sufficient slope to drain into an enclosed holding tank.

c) Floor to wall junctions and all gaps and cracks in the walls, floor and ceiling should be effectively sealed, such that the quarantine area is capable of containing all leaks and floods that might occur.

d) Lighting should be of sufficient intensity to allow proper inspection of all aquatic animals.

e) Floor drainage with an insertable plug or other mechanism to prevent the accidental escape of aquatic animals or uncontrolled release of water should be installed. Drainage should be to an approved holding tank. The holding tank should be of suitable size to contain the total volume of all tanks used for the holding of aquatic animals.

f) Doors should be equipped with self-closing mechanisms to ensure that they remain closed after entry, or there should be a self-closing insect-proof screen door installed.

g) Access to the quarantine facility should only be through a personnel entrance leading to a separate outer change room, provided with facilities for staff and quarantine officers to wash their hands and change outer clothing prior to entering or leaving the quarantine area.

h) A footbath containing disinfectant should be placed at the entrance door to the quarantine facility.

i) All holding tanks for aquatic animals should:

- be identified with permanent numbers so that individual tank records can be correlated with them;
- be fitted with lids or other approved coverings so as to prevent transmission of pathogens between adjacent tanks due to splash from the aeration/filter system, and to prevent the escape of aquatic animals;
- have water intake lines equipped with automatic shut-off valves;
- be arranged in a manner that permits ready access for inspection purposes, including a minimum width of 75 cm for corridors between rows of tanks or tanks and walls;
- other than the aquatic animals, contain only sterilisable materials that do not interfere with inspection;
- have at least the front transparent to provide good visibility of their contents, and be stacked for adequate viewing; and
- have their own set of equipment – nets, buckets, beakers and other items associated with the tank use – to ensure that none are shared between tanks.

j) As all aquatic animals within the facility should be considered to have the same quarantine status, the use of a shared water recirculation system is permissible but not advisable, as it may facilitate the spread of pathogens between tanks.

k) All entry and exit points to the quarantine facility should prominently display a permanently affixed quarantine sign that states: Quarantine Area–Authorised Persons Only. Such signs should be highly visible.

l) A suitable wash-up trough should be located in the quarantine area for the cleaning and disinfecting of equipment. An approved disinfectant should be available at the wash-up trough.

m) A designated refrigerator or freezer should be provided solely for the storage and preservation of dead aquatic animals. The refrigerator or freezer should be clearly identified as being for quarantine use only and it should be lockable and located within the quarantine area.

n) Equipment necessary to carry out the disinfection of all wastewater (both the overseas transport water and all domestic water used in the quarantine facility) should be supplied.

o) Secure storage facilities for food used for aquatic animals should be provided such that contamination or infestation by pests is prevented.

p) A fully stocked first-aid cabinet should be provided and maintained.

q) Amenities that should be provided for use by quarantine officers include access to a desk and chair, a telephone with a direct outside line, toilet facilities, hand-washing facilities (within the quarantine area), a hygienic means of drying hands, and suitable arrangements for daily cleaning of amenities.

B - Breeding nucleus centre

Four HDPE-lined or cement-lined ponds, with cement preferred but dependent upon budget, of dimensions 25 x 15 m (375 m^2), will be dedicated to maintenance of the nucleus broodstock.

Each pond can hold three 12 x 5 m hapa nets.

There will be one pond per family of brood stock nucleus fish. Each family of brood stock fish (1,080 fish in total) will be held in these two replicate hapa nets per pond, with each hapa net holding 360 fish (180 males, and 180 females).

Surplus fish from hapa stocking, and any escapements from the hapa, will thus be retained in the pond without the possibility of mingling with fish from any other family.

Security fencing and bird netting will surround the brood stock nucleus ponds. Bird netting will also stop people throwing fishing lines over the fence to catch fish from ponds.

Tilapia pond construction, Solomon Islands

C - Multiplier hatchery

Systems proposed for breeding and rearing of swim-up fry are listed below.

a) Hapa-in-pond breeding system – This uses the same four 25 x 15 m ponds that hold the nucleus broodstock, using these same broodstock fish in three 12 x 5 m hapa per pond (combined capacity of 2,160 female and 2,160 male fish at 1:1 sex ratio) to produce an estimated 6 million fry per year if using an incubator system, or about 4 million fry per year if collecting swim-up fry from hapa.

b) Cement-tank breeding system – This requires 10 tanks of approx. 5 x 2 m, for 3 x 2 m hapa-in-tank system with aeration and stocked at six fish per m^2. These will hold a combined capacity of 240 female and 120 male fish at 2:1 sex ratio, sufficient for theoretical production target of up to 1 million fry per year if using incubator system (less, if fry are collected from hapa at the swim-up stage).

c) Incubator breeding system – This uses 12 trays and an egg-wash station.

More than one type of breeding system is proposed, for three reasons:

- each system will provide a back-up to the other;
- these systems are not expensive to build or operate; and
- addition of a tank system provides scope for other work to be conducted at the facility apart from tilapia (for example, trials on domestication of any suitable indigenous freshwater fish, or for staff or student research projects).

Two systems are proposed for nursing swim-up fry to fingerlings:

- stage 1 nursery/MT nursery – one pond of 25 x 15 m with up to twelve A-net nursery hapa of 2 x 3 m (max. capacity 20,000 fry per hapa); and
- stage 2 advanced nursery – one pond of 25 x 15 m with up to twelve B-net advanced nursery hapa of 2.5 x 4 m (capacity 10,000–5,000 fingerlings per hapa).

Back-up nursery and grow-out ponds – four additional "spare" ponds of 25 x 15 m for dry-out and preparation while the other two ponds are in use, or for grow-out of fish for the station's use (open days, community training, ministerial visits, etc.), or in case something goes wrong with the other brood stock nucleus or nursery ponds.

Purging and packing shed – two cement tanks of 1.5 x 3 x 0.8 m each, with aeration, under a roofed area.

D - Educational facility

Tilapia monoculture production pond: one pond of approximate 15 x 10 m for monoculture grow-out, and for demonstration of integrated agro-aquaculture with vegetable gardens.

The educational facility shall be at a separate public area of the fenced site to facilitate easy access by secondary or tertiary students, community trainees, or the public. It could be combined with a community training hatchery space and have a reception area with aquaculture displays (aquarium, posters, etc). The high-security quarantine, broodstock nucleus and multiplier hatchery facilities will be cordoned off from this public area of the facility, with admittance by authorised personnel only.

Total pond requirements: ten ponds of 25 x 15 m (inside fenced area) and one pond of 15 x 10 m plus hatchery-training cement tanks in a public reception area.

3.1.4 Evaluation of production capacity

A - Quarantine system

The quarantine facility shall be capable of holding sufficient fingerlings to stock the broodstock holding capacity of the breeding nucleus centre, which is four ponds of 25 x 15 m that can be stocked with up to 1000 adult fish per pond.

If four families of fish are introduced for implementation of a cyclic mating scheme for periodic replacement of broodstock, four quarantine tanks capable of holding 2000 fish fingerlings each for two weeks will be sufficient.

B - Breeding nucleus centre

Four HDPE-lined or cement-lined earthen ponds (depending on cost) of 25 x 15 m (375m^2) each, one for each of the four fish families introduced, will be sufficient to hold three replicate batches per family, with 360 fish in each batch, in three 12 x 5 m hapa nets per pond (representing 180 m^2 or 48% of the pond area, and thus in accordance with AIT guidelines). At this stock density, aeration of the pond water will not be necessary. Some surplus fish can be stocked in the pond itself, as an insurance against theft or escapement of fish from the hapa.

C - Multiplier hatchery

Two main systems are proposed for breeding and rearing of swim-up fry:

a. (i) Cement-tank swim-up fry collection system, from 10 tanks of approximately 5 x 2 m, for 3 x 2 m hapa-in-tank system with aeration, with a combined capacity of 240 female and 180 male fish. This is sufficient for a theoretical production target of 1 million fry per year, if combined with the use of an egg incubator system. If operated without egg incubation, 600,000 fry per year will be possible, and;

   (ii) Hapa-in-pond breeding system, using four 25 x 15 ponds with three 12 x 5 m hapa per pond. This has a combined capacity of 2,160 female and 2,160 male fish at a 1:1 sex ratio giving a total brood stock nucleus of 4,320 fish, sufficient for a theoretical production target of 6 million fry per year if using an egg incubator system, or 4 million per year without an incubator.

b. Incubator breeding system using 12 trays and an egg-wash station. This system provides the greatest output of fingerlings per egg clutch, if well managed. Egg collection from fish: (i) in hapa in ponds; and (ii) in hapa in cement tanks, and incubation of those eggs in jars, should achieve a combined production of 5.4 million fry per year (source: AIT Tilapia Hatchery Planner spreadsheet).

The main system proposed for nursing swim-up fry to fingerlings is a hapa-in-pond method consisting of:

a. Stage 1 Nursery/MT Nursery – one pond of 25 x 15 m with up to twelve A-net nursery hapa of 2 x 3 m (max. capacity 20,000 fry per hapa)

b. Stage 2 Advanced Nursery – one pond of 25 x 15 m with up to twelve B-net advanced nursery hapa of 2.5 x 4 m (capacity 10,000–5,000 fingerlings per hapa).

There is enough space in these two ponds, plus any of the other four "spare" ponds, for sufficient hapa to rear these fry to fingerlings. On average, to reach a production target of 1 million fingerlings per year there should be around 80,000 fingerlings produced per month.

D - Educational facility

Because these are training facilities, they have no specific production targets and simply need to be large enough to realistically demonstrate the husbandry methods. A 15 x 10 m pond will be sufficient for training in pond management methods.

4. Management and administration protocol

This section provides a general description about the broodstock management protocols recommended by WorldFish to institutions that receive GIFT tilapia.

The purpose of describing the recommended WorldFish practice in this report is to illustrate the reasons behind the design, layout and scale (size) of the facilities that are recommended for construction at the MFMR aquaculture complex, Aruligo.

Other protocols will need to be developed for day-to-day operations and fish husbandry, and a maintenance schedule for the plant and equipment. These protocols need to be tailored to the facility and equipment as it appears when completed, so will be developed at that time.

4.1. Principles of broodstock management policy

WFC sets out some guiding principles for broodstock management in hatcheries, which are summarised here. At national level, there are two types of hatcheries:

- a national breeding nucleus centre, operated by MFMR of SIG; and
- multiplier hatcheries, operated by the private sector, NGOs, communities, and educational institutions.

Laboratory technician, Ministry of Fisheries and Marine Resources

The function of the breeding nucleus centre is to periodically receive an improved fish strain (at approximately 10-year intervals), maintain the quality of these fish for as long as possible, and regularly disseminate offspring to multiplier hatcheries and grow-out farmers.

The centre will operate with the intention of generating its own replacement broodstock. However, its functions will not include implementation of a programme of further genetic improvement, because this rests with WorldFish Center in Malaysia.

The multiplier hatcheries will operate without having to breed their own replacement brood stock. When quality declines, they will receive replacement broodstock from the breeding nucleus centre.

To establish and maintain a successful national tilapia-breeding programme firstly requires a founder population that has a high genetic diversity to begin with and, secondly, requires that alleles are not subsequently lost from the gene pool of the breeding population.

4.2. The guiding principles for the breeding nucleus centre are shown below.

Objective	Guiding principle
Maintaining broodstock quantity	The number of broodstock in the hatchery at any particular time will be maintained according to the planned output of fingerlings to farmers and private multiplier hatcheries.
Reducing inbreeding and loss of alleles	When breeding fish to replace the current generation of broodstock, steps are taken in the breeding nucleus centre to slow down the rate of inbreeding and prevent loss of alleles from one generation to the next. For example: (i) ensure that close relatives are not mated by implementing a cohort breeding design; (ii) maintain a minimum effective population size (see below); and (iii) use a 1:1 sex ratio.
Maintaining quality and quantity of the breeding nucleus	The national hatchery will generate a surplus of fish beyond those needed to maintain the quality and quantity of the breeding nucleus, and for dissemination to production farmers and private multiplier hatcheries. This surplus may be either offspring of the breeding nucleus, or redundant parents that have been replaced by a new generation.
Replacement of old broodstock	Some inbreeding will occur, but adoption of the steps (i)–(iii) in 2) above will reduce inbreeding to a level at which any effects should not be noticeable until after 5–10 years. A new GIFT introduction to Solomon Islands can then be made from WorldFish in Malaysia (or from any Pacific regional GIFT hub that is established), and the old GIFT broodstock can be discarded.

5. Definitions

Cohort breeding design – introduce four unrelated groups of fish, keep them clearly separated (e.g. in four separate ponds), and inter-breed them by a cyclic mating scheme (Ponzoni et al. 2012) to avoid inbreeding. The strategy is to mate fish that do not share a common grandparent, to avoid mating of relatives.

Effective population size – ensure that replacement broodstock are the offspring of a minimum of 50 pairs of parents. For example, combining 120 males with 120 females should ensure that at least 50 different male-female pairs do breed.

Sex ratio – a male to female ratio of 1:1 results in the lowest rate of inbreeding (in contrast with multiplier hatcheries, which typically use from 1:2 up to 1:5 ratios of males to females).

6. Procedure to breed replacement broodstock

1. After completion of the post-introduction quarantine period and transfer of imported fingerlings to the breeding nucleus centre, grow-out the four families in this first cohort of fish (each family in one 10 x 2 m cement tank or 12 x 5 m hapa) up to a size where they can be sexed. This size is approx. 60–70 g and will be reached after about three months, depending on feeding and temperature. Alternatively, one can wait until the eggs or swim-up fry first appear, and then sex the fish.

2. Segregate the two sexes (M and F) in each family into two separate 12 x 5 m hapa. This requires set-up of eight hapa in total – there will be two hapa in each of the four broodstock ponds. In case of fish escapement from out of hapa into the ponds, and in order to avoid mingling of fish families, do not put more than one family of fish into each brood stock pond.

3. On-grow the segregated M and F fish until sexual maturity (which takes four to five months in total) in the eight 12 x 5 m hapa.

4. The target of breeding from this first-introduction of tilapia fish is to obtain and maintain a breeding nucleus of no less than 1,080 breeding-size fish per family, for stocking of 360 fish into each 12 x 5 m hapa and with three replicate hapa for each cohort.

5. Surplus fingerlings from this first breeding can be used to stock cement tanks or other ponds, or can be given out to farmers for pond stocking.

6. To obtain a new generation of nucleus broodstock, we apply the "odd generation" cyclic mating scheme, whereby all males from Cohort 1 are moved to join the females of Cohort 2, all males from Cohort 2 join the females of Cohort 3, males from Cohort 3 join the females of Cohort 4, and males from Cohort 4 join the females of Cohort 1. We can use three 12 x 5 m hapa per family and stock them with fish taken from the two hapa of segregated M and F fish for each family. For example, 180 males from Family 1 are added to 180 females from family 2 into one 12 x 5 m hapa in Pond 2, and so on. Keep a careful logbook record of which males have been added to which females in which hapa.

7. Collect up to 10,000 fry per hapa. Transfer these to twelve 3 x 2 m Nursery A-net hapa and/or hapa-in-tanks and rear them for three to four weeks, with a target to obtain about 5000 fingerlings per hapa. Do this during the season when egg production is high and survival of fry is good (if there is a distinct season).

8. Transfer the fingerlings into Advanced Nursery 4x2.5m B-net hapa and grow them up to 3g size or bigger.

9. The parents are now surplus, and can be discarded from the four nucleus broodstock ponds or used for multiplier hatchery functions. Any free-range fish of that same generation in the broodstock ponds can also be discarded at this time, by draining the pond and refilling.

10. Choose randomly 2000 fish per family for grow-out in the brood stock nucleus ponds. Transfer the four families of fingerlings into the twelve 12 x 5 m hapa set up in the four ponds formerly occupied by their parents, once they have completed advanced nursery. Grow these offspring, stocked at around 600 fingerlings per hapa, to juvenile size on a daily feed ration (DFR) of 4% body weight per day.

11. Select (e.g. by size grading) the best 400 males and the best 400 females from the 600 juvenile fish in each of the twelve hapa, and discard the rest.

12. Once the new generation of fish has reached breedable size, switch to 1.0% DFR daily, in order to maintain these fish within the ideal brood stock size range of less than 300 g for at least 1.5–2 years. Adjust their numbers to 360 fish per hapa (180 males and 180 females) by moving any surplus fish to the hapa-in-tank breeding system. Use the fish in both systems for multiplier hatchery purposes, by collecting swim-up fry weekly and growing them out in nursery hapa in another pond or tank.

13. After 1½ years the quality of eggs will deteriorate, so produce a new broodstock generation every 12 to 18 months, or when broodstock fish exceed 300 g size. Generate the second generation of replacement broodstock by applying the "even generation" mating scheme, whereby all males selected from Cohort 1 are paired with all females from Cohort 3, and all males from Cohort 2 are paired with all with females from Cohort 4.

14. Repeat steps 3–8 above, and so on, with an interval of about 1.0–1.5 years between each mating to produce a replacement broodstock generation and pairing males with females according to the alternating "odd" and "even" phases of the rotational cohort breeding design.

15. If these steps are followed, GIFT broodstock from a single introduction could be made to last for 10 years without the need for re-introduction. After eight or nine generations, we can think about replacing all broodstock with a new introduction from Malaysia. Fin clips taken at four yearly intervals can be tested for inbreeding and relatedness, etc, to review the broodstock status.

16. Hapa are changed weekly after each egg collection. A cement floor of the pond (or liner), not clay, extends the period of the hapa staying clean to two weeks. Removing fish faeces strings by scoop net daily also keeps the hapa cleaner for longer.

Summary of key steps

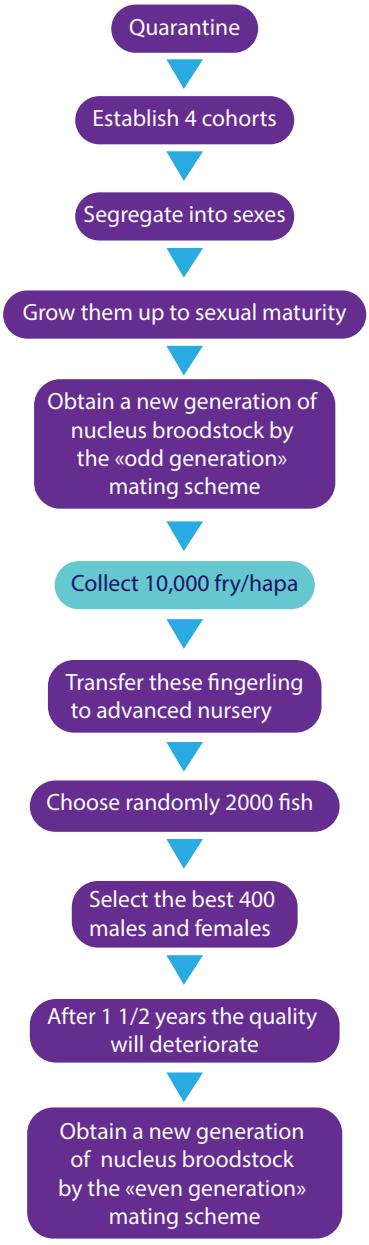

Figure 1. Odd generation mechanism

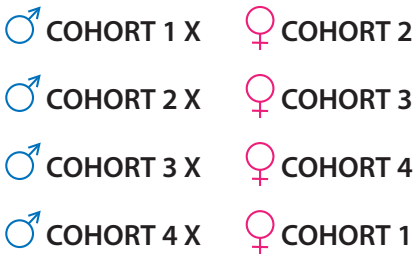

Figure 2. Even generation mechanism

Tilapia farming pond, Solomon Islands

Annex 1: Diseases to be absent in introduced GIFT tilapia stock

Bacterial diseases

- *Streptococcus agalactie*
- *Streptococcus iniae* and related species
- Motile Aeromonas Septicemia (MAS): *Aeromonas hydrophyla* and related species
- *Edwarsiella tarda* and related species
- *Flavobacterium columnare*
- *Vibrio anguillarum* and related species

Parasitic diseases

- *Ichthyophthirius multifiliis*
- *Trichodina* sp. and related protozoa.
- *Dactylogyrus* sp.
- *Gyrodactylus* sp.

Fungal diseases

- *Saprolegnia* sp.

Viral diseases

- Tilapia lake virus (TiLV)

Annex 2: General quarantine protocol - Infrastructure and operations

1. Period of quarantine

The period of holding the introduced or transferred specimens in the quarantine facility will depend on the various factors: species to be introduced, life cycle to be introduced, pathogens that could be introduced and spread with the stock (among these pathogens – pathogens not considered further and pathogens for further consideration) and other possible imported stock hitch-hikers.

One of the most relevant points in order to define the required – more or less conservative – quarantine period is the possibility of introduction of pathogens that could be vertically transmitted (by one generation to the next one), or "hidden" pathogens, which could have long incubation periods or cause sub-clinical infections. According to these factors, either the imported stock or the following generations (F1, F2 and so on) would be released after the quarantine process, where testing and monitoring of pathogens for further consideration will be carried out, as described below.

In all cases, once the competent authority is satisfied that the introduced stock, the F1 or a subsequent generation, is safe for limited release, the specimens could be released. In the case of vertically spread pathogens, it is advisable to maintain the parent stock at the facility. Once the F1 has been tested, the parent stock should be destroyed and the quarantine facility thoroughly disinfected. An application to introduce or transfer aquatic animals entails a commitment to maintain the animals under conditions of strict quarantine, sometimes for a number of years. The quarantine period will need to take into account the life history of the aquatic animal being introduced or transferred. If a pathogen or infectious disease is detected at any point while the imported aquatic animals and their progeny are under quarantine, the supervising quarantine officer may order treatment and further testing. If the disease is of a serious and/or untreatable nature, destruction of all aquatic animals held in the facility should be ordered and complete disinfection of the building, water and all equipment should be done before permission to restock is granted.

2. Standards of construction

2.1. Location of quarantine facilities

It is always advisable to avoid locating quarantine areas in the vicinity of private or government fish hatcheries, aquaculture facilities, watercourses or areas subject to frequent flooding. In cases when the quarantine area is located in the vicinity of another aquaculture facility, water disinfection and filtration protocols, as described below, for inlet and outlet should be followed very strictly.

2.2. General requirements

a. Access to the quarantine facility should be through property owned or leased on a long-term basis by the operator and should be available to quarantine officers during normal business hours and at such time that aquatic animals are entering or leaving the facility.

b. The quarantine facility should be located within a single operational entity, if possible. It should be **structurally physically separated** from all other operations and is dedicated solely to the holding of the shipment.

c. **It should not share a building having areas that are used for different purposes and should not be used to access other buildings or activities.**

d. The quarantine facility should not be used for any other purpose than as a place for the performance of quarantine.

e. The quarantine facility should be weatherproof and maintained in a state of good repair.

f. The quarantine facility should be a secure, lockable building that is surrounded by a lockable person-proof security fence.

g. The holding capacity of the quarantine facility should be commensurate with the proposed quantities of the species of aquatic animal for which a permit is granted.

h. Provision must be made for the growth and maturation of the original parent stock and the holding of all F1 and subsequent generations, as required.

i. The quarantine facility should be equipped for the sterilisation of all equipment that comes in contact with aquatic animals or **tank water during the quarantine period.**

j. **The quarantine facility should be equipped with back-up systems for essential components** (e.g. electricity, water circulation, aeration, temperature control, filtration) to maintain biosecurity and the health of stocks in the case of electrical or mechanical failure.

2.3. Specific construction and equipment requirements

The quarantine facility should comply with the specific construction and equipment requirements listed below.

a. Windows should be screened to prevent the entry of insects.

b. **Floor and walls should be constructed of concrete, tiles or other impervious material to enable hose down and disinfection with retention of all wastewater.** The floor should be sufficiently smooth and with sufficient slope to drain to an enclosed holding tank.

c. Floor to wall junctions and all gaps and cracks in the walls, floor and ceiling should be effectively sealed such that the quarantine area is capable of containing all leaks and floods that might occur.

d. Lighting should be of sufficient intensity to allow proper inspection of all aquatic animals.

e. Floor drainage with an insertable plug or other mechanism to prevent the accidental escape of aquatic animals or uncontrolled release of water should be installed. Drainage should be to an approved holding tank. The holding tank should be of suitable size to contain the total volume of all tanks used for the holding of aquatic animals.

f. Doors should be equipped with self-closing mechanisms to ensure that they remain closed after entry, or there should be a self-closing insect-proof screen door installed.

g. **Access to the quarantine facility should only be through a personnel entrance leading to a separate outer change room** provided with facilities for staff and quarantine officers to wash their hands and change outer clothing prior to entering or leaving the quarantine area.

h. **A footbath containing disinfectant should be placed at the entrance door to the quarantine facility.**

i. **All holding tanks for aquatic animals should:**

- be identified with permanent numbers so that individual tank records can be correlated with them;
- be fitted with lids or other approved coverings so as to prevent transmission of pathogens between adjacent tanks due to splash from the aeration/filter system, and to prevent the escape of aquatic animals;
- have water intake lines equipped with automatic shut-off valves;
- be arranged in a manner that permits ready access for inspection purposes, including a minimum width of 75 cm for corridors between rows of tanks or tanks and walls;
- other than the aquatic animals, contain only sterilisable materials that do not interfere with inspection;
- have at least the front transparent to provide good visibility of their contents, and be stacked for adequate viewing; and
- have their own set of equipment – nets, buckets, beakers and other items associated with the tank use, to ensure that none are shared between tanks.

j. As all aquatic animals within the facility should be considered to have the same quarantine status, the use of a shared water recirculation system is permissible **but not advisable**, as it may facilitate the spread of pathogens between tanks.

k. All entry and exit points to the quarantine facility should prominently display a permanently affixed, quarantine sign that states **"Quarantine Area–Authorised Persons Only"**. Such signs should be highly visible.

l. A suitable **wash-up trough should be located in the quarantine area for the cleaning and disinfecting of equipment.** An approved disinfectant should be available at the wash-up trough.

m. A designated refrigerator or freezer should be provided solely for the storage and preservation of dead aquatic animals. The refrigerator or freezer should be clearly identified as being for quarantine use only, be lockable and located within the quarantine area.

n. **Equipment necessary to carry out the disinfection of all wastewater** (both the overseas transport water and all domestic water used in the quarantine facility) should be supplied.

o. Secure storage facilities for food used for aquatic animals should be provided, such that contamination or infestation by pests is prevented.

p. A fully stocked first-aid cabinet should be provided and maintained.

q. Amenities that should be provided for use by quarantine officers include access to a desk and chair, a telephone with a direct outside line, toilet facilities, hand-washing facilities (within the quarantine area), a hygienic means of drying hands, and suitable arrangements for daily cleaning of amenities.

3. Standards of operation

3.1. Influent water

All influent water entering the quarantine facility should be from an approved water source certified to be free of biological material, including any possible infective agents.

Alternatively, water from other sources may be used but it should **be filtered** to remove suspended matter and then sterilised, using a method approved by the competent authority before being used in the quarantine facility.

3.2. Wastewater sterilisation and disposal

All wastewater discharged from the quarantine facility should be appropriately sterilised. Sterilised wastewater should not be discharged directly into natural waterways. Disposal of wastewater should also conform to any state and local government requirements. **Wastewater should be sterilised in accordance with one of the following methods.**

3.2.1. Chlorination

a. All water should pass through an approved filter capable of removing suspended organic material prior to hypochlorite treatment.

b. All water should pass to a retention vessel where sufficient hypochlorite is be added to achieve a minimum concentration of 200 parts per million (ppm)

c. Before the treatment period commences, the chlorinated effluent should be brought to a pH between 5.0 and 7.0.

d. Following addition of hypochlorite, wastewater should be agitated for at least 10 min to ensure thorough mixing of hypochlorite.

e. After a retention period of not less than 1 h, the chlorine concentration is measured using an approved method (e.g. commercially available chlorine test kit). Tanks not achieving a minimum chlorine concentration of 200 ppm

f. The chlorine in the wastewater should be neutralised by adding sodium thiosulphate at a rate of 1.25 g (2.5 ml of 50 percent sodium thiosulphate solution) per l of treated wastewater, then, agitated for not less than 10 min before discharge.

g. Chlorination records should be maintained noting: the amount of compound added, the volume of effluent, the time that treatment period commenced, the pH at commencement of the treatment period, the 1 hr post-treatment concentration, the amount of sodium thiosulphate added to achieve neutralisation and the of residual chlorine concentration at discharge.

h. Chlorinated water should not be discharged directly into adjacent waterways.

3.2.2. Heat treatment

Prior to discharge, wastewater shall be heated to at least 85° C for a minimum of 30 minutes. Water heating units should be approved by the competent authority and be fitted with temperature and flow recorders.

3.2.3. Ultraviolet (UV) light radiation

As particles in the water may shade pathogens from the effects of UV light, all water to be treated should pass through an approved filter capable of removing suspended organic material prior to irradiation.

Commercial UV water treatment units operating in the spectral range of 190–280 nm (254 nm recommended) delivering doses of at least 130 mWs/cm^2 are required. As UV bulbs will burn long after their effectiveness has waned, the burning time of the UV lamp should be monitored, and the lamp replaced according to the manufacturer's specifications.

3.3. Disinfection of equipment

Before removal from the quarantine area, and before any restocking, **all tanks and tank equipment must be thoroughly cleaned and disinfected with**:

- hypochlorite solution at 200 ppm concentration for 5 minutes; or
- an approved iodophores solution containing iodine at 0.5% available iodine for 5 minutes; or
- by another disinfection procedure approved by the supervising quarantine officer.

If possible, filter material should be disposed of by autoclaving, followed by incineration or deep burial.

3.4. Disposal of dead aquatic animals

Dead aquatic animals should be disposed of only as directed by the competent authority. Aquatic animals **that have died while under quarantine should held in an approved freezer or** an approved refrigerator, or they should be preserved using another method as specified by the authority (or other officer in charge) until removed for laboratory examination or released for disposal by the supervising quarantine officer. Upon approval, dead aquatic animals should be disposed of by sterilisation, using an approved autoclave, followed by incineration or deep burial.

3.5. Disposal of packing materials

All containers (bags, boxes and cartons) used to hold aquatic animals during transit should be disinfected using the methods of disinfection specified under Disinfection of equipment and then disposed of by incineration, deep burial or another method approved by the supervising quarantine officer.

4. Work practices

4.1. Cleanliness and sanitation

- The quarantine facility and holding tanks should be kept clean at all times.
- **Adequate cleaning facilities** (e.g. pressurised water supplies, brooms, shovels) should be provided to enable maintenance of appropriate standards of hygiene.
- No animals other than aquatic animals and live food for aquatic animals should be permitted in the quarantine area.
- All feeds used within the quarantine facility should have prior approval of the supervising quarantine officer and be of assured sanitary condition.
- Live food should not be used unless no other food is acceptable to the animals under quarantine.
- Live food should be certified to the specifications set by the competent authority to ensure their freedom from potential disease agents.
- **Equipment used in the handling of aquatic animals and tank cleaning and maintenance should not be shared between tanks.**
- **A separate set of equipment (nets, cleaning equipment, etc.) should be kept for each tank or series of tanks operated on an individual water filtration system.**
- Where several tanks are linked by a shared water recirculation system, a single set of equipment can be used for all tanks within the shared system.
- All nets and other equipment should be regularly disinfected by an approved method of disinfection. Equipment and other material should not be removed from the quarantine area while the shipment is under quarantine conditions.
- In exceptional circumstances and with the written approval of the supervising quarantine officer and his/her verification that proper disinfection has been accomplished, a request to remove specific items of equipment may be granted.
- All footwear and protective clothing used in the quarantine area should be restricted to this site.
- The operator should provide protective clothing to staff and visitors to use in the facility.
- Protective clothing should be kept inside the quarantine area (street footwear should left outside the quarantine area and within the changing area).
- Cloth protective clothing that should be routinely washed may be removed from the quarantine area after washing for the purpose of drying.
- **A footbath containing hypochlorite, Betadine or another approved disinfectant should be maintained at the entrance of the quarantine area proper. The bath should be routinely replenished for adequate disinfection and a record of bath maintenance maintained.**
- All wastewater disposals should meet any state and local government requirements, be done by an approved method, and should not flow directly into natural waterways.

- All filter material should be disinfected by autoclaving or another method approved by the supervising quarantine officer prior to removal from the quarantine facility and then disposed of by incineration or deep burial.
- Staff and visitors who have had contact with water or aquatic animals should wash their hands and forearms with soap and water prior to exiting the quarantine facility.

4.2. Handling of aquatic animals

- Upon arrival of a shipment of aquatic animals at the approved port of entry, and following verification of the accuracy of details of the shipment and its preliminary inspection and clearance by customs officers, the shipment should be resealed by the supervising quarantine officer with an approved tamper-proof seal and then transferred to the custody of the operator, who should guarantee the secure transport of the aquatic animals, under quarantine conditions, to the quarantine facility.
- Upon their arrival at the quarantine facility, the integrity of the seal should be verified by the supervising quarantine officer, the seal removed and the animals transferred to new water.
- The overseas water should be subjected to an approved disinfection treatment.
- In the event that a shipment of imported aquatic animals is incorrectly represented in any manner, the shipment may be destroyed under supervision of the quarantine officer.
- A standard tank record sheet should be maintained for each tank.
- Periodically throughout the day, the operator should check all aquatic animals for signs of illness and abnormal behaviour.
- All dead aquatic animals should be held for inspection by a quarantine officer.
- Any equipment that has been in contact with dead aquatic animals should be disinfected before re-use.
- The use of any drug or chemical to treat aquatic animals should have prior approval and be recorded on tank record sheets.
- The operator should ensure that no aquatic animals leave the quarantine area under any circumstances without the approval of the supervising quarantine officer.
- On approval by the competent authority, the introduced stock (parental), the F1 or subsequent generation aquatic animals may be released from the quarantine facility for limited trials in aquaculture facilities or for stocking in enclosed water bodies. The competent authority may specify the precise conditions, period and any further risk management measures under which the aquatic animals are to be maintained.
- All original stock and any F1 or subsequent generation aquatic animals not approved for release from quarantine should remain under quarantine conditions.
- When determined by the competent authority or at the request of the operator, the operation of the quarantine facility may be terminated under the direct supervision of the supervising quarantine officer.
- In which case, all remaining aquatic animals, including all original parent stock, should be humanely killed by a method approved by the supervising quarantine officer, tested for pathogens if required, appropriately sterilised and then disposed of by incineration or deep burial.
- The facility and all tanks and equipment should be thoroughly cleaned and disinfected using approved disinfectants, as well as all filters, clothing and other similar materials.

4.3. Occurrence of an outbreak of a serious exotic disease

If a serious exotic disease is diagnosed, the operator should be immediately notified. In such cases, the supervising quarantine officer or other representative of the authority may direct the management of disease control. Disease control measures may include the extension of quarantine, treatment and/or the destruction of stock.

Measures to be taken are likely to include:

- treatment and/or destruction of stock from infected tanks or of all aquatic animals present in the facility at the time of the outbreak, and their sanitary treatment, removal and incineration;
- decontamination of the interior of the facility, all tanks and equipment, and all waters present in the facility at the time of the outbreak; and
- approval of the competent authority prior to the reuse of the facility.

5. Record keeping requirements

5.1. Summary records

A complete history of the stock of aquatic animals contained in the quarantine facility should be maintained. The operator should, for auditing purposes, maintain all documentation (shipping bills, health certificates, biosecurity clearance, etc.) and records for a minimum period of 36 months after closure of the quarantine facility, during which time they will, upon request, be readily made available to a quarantine officer.

The following summary information concerning the quarantined stock should be recorded:

- overseas supplier, country of origin and waybill;
- date of arrival of parent stock;
- date/s of release of stock, F1 or subsequent generation from quarantine;
- total number of animals in original shipment/s and total mortalities in each shipment upon arrival;
- original number of animals stocked in each tank;
- details of any clinical signs of disease and number of affected individuals, by tank;
- details of any mortalities, by tank;
- details of any health certificates;
- details of any diagnostic tests and examinations; and
- details of any F1 progeny produced (date and number) and their corresponding transfer tank number.

For parent stock, and for any F1 or subsequent generation aquatic animals that for any reason have not been approved for release from quarantine upon termination of the quarantine license: number and size of aquatic animals destroyed, date and method of destruction and disposal and signature of the supervising quarantine officer.

For F1 or subsequent generation aquatic animals, if approved for limited release from quarantine: number and size of aquatic animals released, date of release, destination, summary of any risk management measures or restrictions to be employed and signature of the supervising quarantine officer.

5.2. Tank record sheets

A **corresponding approved tank record sheet** should be maintained for each holding tank and must be kept up to date at all times. Tank record sheets should be retained for a minimum of 36 months following release from quarantine of the portion of the shipment held in the specific tank, or their destruction.

This sheet should display the following information if possible:

- tank number;
- number of aquatic animals in the tank;
- exporter identification details, including country of export;
- importer's name;
- date of arrival;
- shipment or airway bill number;
- number of aquatic animals dead on arrival;
- details of any observed disease conditions and number of sick aquatic animals;
- daily record of number of aquatic animal deaths in the tank;
- details of any prophylactic or therapeutic treatments given;
- disposal details;
- disinfection details; and
- details of any F1 progeny produced (date and number) and their corresponding transfer tank number, if any.

5.3. Operations and entry logbooks

- Details of wastewater treatment (including chlorination records); filter cleaning, replacement or disposal; internal audit; and general maintenance should be recorded in an operations logbook.
- A separate entry logbook should be used to record details of the entry and exit of authorised personnel into the quarantine facility.

6. Auditing

- The operator should undertake systematic periodic internal audits to ensure that the standards for the operation of the quarantine facility as in the relevant legislation are maintained and to identify and correct any deficiencies.
- The operator should record in the logbook any variations from the prescribed criteria encountered and the corrective measures taken.
- Periodic external audits of the quarantine facility should be conducted by the supervising quarantine officer or other approved personnel to verify the security and proper functioning of the facility.

7. Security

- Control and security of the quarantine facility is of the utmost importance and is the responsibility of the operator.
- The quarantine facility and its perimeter fencing should be securely locked when the facility is not in active use or when unattended.
- Increased security after working hours should be considered to prevent unauthorised entry and theft, particularly where valuable broodstock are being held.
- Procedures should be adopted to ensure that access to the premises is limited to authorised persons only.
- The entry of staff into the quarantine facility should be restricted to the minimum required to perform necessary maintenance and observation of the quarantined animals.
- A list of authorised staff should be provided to the supervising quarantine officer by the operator. Except in an emergency, no other persons should enter the quarantine facility.
- A logbook of all entry and exit into and out of the quarantine facility should be maintained. All personnel entering the facility should be required to enter the following information:
    - name of authorised person;
    - date of entry/exit;
    - time of entry;
    - reason for entry;
    - time of exit; and
    - signature at exit.

Signature at exit indicates that the exiting staff member has confirmed that the quarantine facility was in proper order at the time of his/her exit and that the premises have been left in a secure manner. The operator should ensure that all staff conform to these requirements and should verify the accuracy of record keeping on a weekly basis. The logbook should be made available for examination by the supervising quarantine officer upon request.

8. Contingency plans

The operator should develop a contingency plan addressing actions to be taken in the event of on-site emergencies that may arise, such as fire, flood, electrical failure or breakdown of essential equipment (aerators pumps, etc.). In the case of emergency, the supervising quarantine officer should be notified as soon as possible.

Annex 3: Other risk management measures complementary to quarantine

1. Introduction

Quarantine should be seen as one of a wide range of risk management measures that can be applied, either alone or in combination, to reduce the risks posed by aquatic animal pathogens. The decision whether or not to require quarantine or other biosecurity measures should be done on a case-by-case basis and determined by a risk analysis. Some of the other complementary approaches that can be applied and provides some references that can be consulted for further information are provided below. Risk reduction measures are subdivided into pre-border and post-border measures.

2. Pre-border measures

Pre-border measures are often critically dependent on the inspection, certification and compliance regime of the exporting country and are most effective when undertaken as a cooperative undertaking by the competent authorities of the importing and exporting countries.

- **Certification of production source**

The inspection, testing and certification of hatcheries and other aquaculture production facilities as free from specific pathogens is a highly effective method to assure freedom from many serious diseases.

- **Use of specific pathogen free (SPF) stocks**

The pathogen for which freedom is certified varies between SPF production facilities and species. There is also no universally accepted standard (e.g. type, number and frequency of diagnostic testing that must be performed) as to the criteria that must be met for a production facility to achieve SPF production status.

- **Zoning**

Sourcing stock from production facilities located in disease-free zones is another highly effective method to assure that the aquatic animals being moved are free from certain serious pathogens. Such a system is currently in place in the European Union.

- **Restrictions on life cycle stages**

Juvenile stages, especially fertilised eggs, generally carry fewer subclinical infections than do adult animals.

Restricting importations to surface-disinfected fertilised eggs is often an effective way to prevent the movement of parasites, most bacteria and some viruses.

- **Lists of approved species**

Allowing importation only of certain pre-approved "lower risk" species is an effective means to reduce the likelihood of pathogen introduction. Such lists should be country-specific as determined by risk analysis, taking into consideration the various national factors, including possible end uses.

- **Lists of approved exporting countries**

Importing countries may wish to establish lists of exporting countries that have met pre-set risk management conditions and thus can be pre-approved as lower risk sources for certain types of aquatic animals. Such conditions might include:

  - presence of disease surveillance, monitoring and reporting programmes;
  - existence of zoning programmes;
  - existence of production facility health certification programmes;
  - existence of standard operating procedures or better management practices (BMPs) for production facilities and exporters; and
  - existence of contingency plans for serious disease outbreaks.

- **On-site inspection of exporting facilities**

For movements of "high risk" species, the competent authority of the importing country may wish to make on-site visits to proposed hatchery or other production facilities to verify the biosecurity measures that are in place to support claims of health status.

- **Evaluation of competent authorities**

In cases where, as part of a risk assessment, the competent authority of an importing country has uncertainty regarding the zoo-sanitary measures used by a potential exporting country, an evaluation of the authority may help to relieve any specific concerns.

- **International and other health certificates**
    - Requiring international health certificates for specific OIE-listed diseases of concern to the importing country can provide a high level of assurance that consignments are free of the specified diseases.
    - It should be noted that importing countries should not require certification for diseases that are not relevant to their country situation and/or the species of aquatic animal being moved.
    - Other types of health certificates are of limited value and must be individually evaluated, based on the reliability of the diagnostic test(s) performed, the sampling regime, etc.
    - Health certificates based on visual inspection for gross signs of pathology/or general "healthiness" have little value in preventing the international spread of transboundary aquatic animal diseases (TAADS).
- **Pre-border quarantine and temporary holding**
    - Risks to the importing country posed by "high risk" species can be reduced by conducting quarantine and disease testing of the stock/consignment or aquatic animals to be imported in the exporting country, or in a third country having appropriate quarantine capacity.
    - Pre-border quarantine holding of "lower risk" aquatic animals in the exporting country can also allow time for any diseases or infections to become evident.
    - In quarantine situations involving "high risk" species, the use of co-habitation experiments in which key native species are held in contact with the exotic species or effluent waters from the quarantine holding tank can be performed to investigate pathogen presence and the susceptibility of native species.
    - Placing quarantined animals under increased stress may also assist in the overt expression of subclinical infections.
- **Pre-shipment treatment**
    - In some cases, the use of pre-shipment treatments can reduce the risk of pathogen transfer.
    - The surface disinfection of eggs using iodophores, for example, is one such treatment.
    - However, treatment of external parasites and bacterial infections may only reduce infection levels, removing the clinical signs of disease but not eradicating the pathogen(s).
- **Inspection, certification and compliance audits**

Establishing auditing procedures to verify that exporters, importers, competent authorities and private contracting agencies are strictly adhering to specified protocols and requirements should be considered.

3. Post-border measures

Complementary post-border risk management measures include the following.

- **Restrictions on initial use**

Placing restrictions on the initial use of introduced or transferred aquatic animals provides the opportunity to detect any introduced diseases prior to the animals' general release into the natural environment and increases the opportunity for control and eradication.

- **Monitoring programmes**

Inclusion of a disease surveillance component within monitoring programmes for introduced or transferred aquatic animal species can be used to confirm that serious diseases have not been spread to new environments and, in the case where serious exotic pathogens have escaped detection in quarantine, will help minimise their impacts by allowing containment or eradication programmes to be initiated at an early stage.

- **Contingency planning**

All proposals for introductions and transfers should include planning for actions to be taken in case animals or pathogens escape from quarantine or a serious pathogen fails to be detected during quarantine and is released into aquaculture facilities or the natural environment.

Produced by the Pacific Community (SPC)
Pacific Community
B.P. D5 - 98848 Noumea Cedex , New Caledonia
Telephone: + 687 26 20 00
Emai l: spc@spc.int
Website: www.spc.int