

Country Report - Singapore

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Abstract

The aquaculture industry produces about 10 % of Singapore's annual local fish consumption. By 2030, the country's goal is for the agri-food industry to produce 30 % of Singapore's nutritional needs. In order to achieve this, the Marine Aquaculture Centre (MAC) spearheaded several research and development programmes such as the broodstock development of Asian seabass and large-scale fry production technology. MAC also provides technical support to local farms to adopt sustainable farming practices and technology. In 2019, the Singapore Food Agency (SFA) was formed to oversee all matters pertaining to food supply and safety, including seafood production from aquaculture. The National Centre for Food Safety (NCFS) of SFA and Centre for Animal and Veterinary Services (CAVS) under National Parks Board (NParks) provides support via their diagnostic and testing capabilities in the areas of food safety and animal health, respectively.

Based on the national surveillance program conducted by the SFA and NParks, the commonly reported diseases are viral, bacterial or parasitic infections. These include Benedeniosis, Big-Belly (BB) Disease Syndrome, infections with *Streptococcus iniae* and *Tenacibaculum maritimum*, *Norcardiosis*, Viral Nervous Necrosis (VNN), and Infectious Spleen and Kidney Necrosis Virus (ISKNV). With the aim to control and manage the aquatic diseases in Singapore, control measures for major pathogens in fin fishes and crustaceans are being implemented. In addition, Aquatic Animal Health Professionals (AAHP) should undergo trainings in aquaculture farm biosecurity.

Status of aquaculture in the country

Singapore is a small country state (land area of 719.9 km²) with a demographic profile of 5.6 million in population (Yearbook of statistics Singapore, 2018). Aquaculture in Singapore consists of both the food and ornamental fish industry. As of 2017, there are 117 coastal fish farms, 9 land-based food fish farms and 60 ornamental aquarium fish farms licensed by the former Agri-Food & Veterinary Authority (AVA).

The food fish aquaculture industry produces about 10 % of Singapore's annual local fish consumption. We aim to develop the capability & capacity of our agri-food industry to produce 30 % of Singapore's nutritional needs by 2030.

The Singapore Food Agency (SFA) was formed as a new statutory board under the Ministry of the Environment and Water Resources on 1 April 2019. The SFA brings together food-related functions carried out by the former Agri-Food & Veterinary

Authority of Singapore, the National Environment Agency and the Health Sciences Authority.

Culture systems and extent of culture

Marine food fish are cultured on mainly offshore coastal fish farms located along the Johor Straits. Most coastal farms adopt shallow wooden-caged designs, and the nets typically measure 3 x 3 x 2.5 or 5 x 3 x 2.5 meters. Some have longer, extended nets to facilitate maintenance – this allows different portions of the net to be regularly raised for drying out, thus reducing fouling by marine organisms. Some coastal farms along the Johor Straits adopted closed containment systems, which separate the water where the fish are kept from the water in the natural environment. These can be tanks placed in barges or wooden platforms. Seawater is treated before entering the system and then discharged without being reused. During adverse environmental conditions (e.g., harmful algae bloom), the system can be operated in a recirculation mode which the water from the containment system is treated and reused. There is also one open-sea farm off the Southern Islands of Singapore

using high-density polyethylene (HDPE) circular floating cages. As for land-based fish farms, most farms use traditional culture systems such as mud-based ponds, concrete tanks and fibreglass/ glass tanks, while some farms use multi-storey Recirculating Aquaculture Systems (RAS) to produce fish and shrimp.

Species farmed and production trends

The floating farms in Singapore culture a variety of high-value food finfish for local consumption and for export purposes. The main species of marine food finfish cultured are the Asian sea bass (*Lates calcarifer*), groupers (*Epinephelus* spp.), milkfish (*Chanos chanos*), mullet (*Mugil cephalus*), long dorsal fin pompano (*Trachinotus blochii*), snappers (*Lutjanus* spp.), four finger threadfin (*Eleutheronema tetradactylum*) and golden trevally (*Gnathanodon speciosus*). The fish are purchased as fry from either local hatcheries or imported from neighbouring countries.

Ornamental fish produced in Singapore are solely freshwater species. This includes the live-bearers: Guppy, Platy, Swordtail and

Table 1. Farm production of food fish and aquarium fish for the last 7 years

Year	2011	2012	2013	2014	2015	2016	2017
Food Fish (tonnes)	5,094	5,127	5,864	5,639	6,540	6,086	5,916
Aquarium Fish (mil pcs)	110	106	114	109	77	77	73

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Source: <https://www.singstat.gov.sg/>

Molly; and the egg-laying species: Dragon Fish, Goldfish, Cichlid, Angelfish, Gourami and Tetra.

Research and development

The aquaculture in Singapore is supported by a vibrant research and education ecosystem, including polytechnics, universities, private sector/research institutes and government organisations. These Institutes of Higher Learning (IHLs) and entities are crucial in the development of key competencies in the area of aquaculture genetics, nutrition, health and systems. Hence it is important to deepen our local research capabilities.

SFA's Marine Aquaculture Centre (MAC) is located on St John's Island in the open southern waters of Singapore and was established in 2003 by the former AVA to spearhead tropical aquaculture technology development for large scale hatcheries. Their R&D programmes focus on these areas:

Asian Sea bass

Since its setup, MAC has focused on genetics and broodstock development. Through its partnership with Temasek Life Sciences Laboratory (TLL) on Asian sea bass selective breeding programme, genetically superior Asian seabass lines that are able to produce seabass fry that grow at least 30 % faster than unselected seabass fry have been developed. The breeding programme with TLL utilises aquaculture genomic tools for more accurate selection of superior individuals without the use of genetic modification.

Large-scale fry production technology

MAC also undertakes R&D in large-scale hatchery production technology to ensure the long-term sustainable supply of marine fish fry. To date, MAC has successfully transformed hatchery production from an extensive outdoor pond system which requires large footprint and is vulnerable to weather changes to an intensive indoor closed-loop production system which allows large-scale production on a smaller footprint, enables the control of diseases and minimises waste discharges. This has led to 10x improvement in Asian sea bass fry survival and 100x intensification over the prevalent outdoor pond system. Hatchery protocols for other key marine fish species such as snapper, pompano and grouper have also been developed. Indoor hatchery production has since been adopted by our local hatcheries & nurseries.

Growing SG's aquaculture research ecosystem

MAC welcomes research institutes and IHLs to conduct collaborative R&D projects by contributing our expertise in the areas of fish husbandry such as breeding and live feed and hatchery production. MAC also provides shared facilities such as replicated tank systems for research and incubator space for test-bedding and commercialisation of R&D results. MAC also makes available key biological materials such as eggs, larvae, rotifers and microalgae for aquaculture research. These inputs of husbandry-related expertise, shared facilities and ease of access to biological materials will enable researchers in Singapore to conduct aquaculture R&D and to facilitate the translation.

Others

Besides R&D work, MAC also provides technical support to local farms to adopt sustainable farming practices and technology. Furthermore, MAC also hosts learning journeys for schools, conducts practical sessions and mentors interns from polytechnics and universities.

Country aquatic animal health infrastructure

The Singapore Food Agency (SFA) was formed on 1 April 2019, under the Ministry of the Environment and Water Resources (MEWR) to oversee food safety and security. Concurrently, all animal health-related services were transferred to the Animal & veterinary Service (AVS) of the National Parks Board. The SFA is the national authority responsible for all matters pertaining to food supply and safety in Singapore, including seafood production from aquaculture. The management of aquatic animal health cuts across several departments in the SFA.

SFA inspection offices conduct regular inspections of the aquaculture farms, which consist of land and coastal farms. Inspections are conducted to check for compliance with licensing conditions, respond to alerts and to take enforcement action for non-compliances. The Veterinary Public Health Department (VPHD) coordinates the Disease Investigation Team (consisting of veterinarians and specialist inspectors), which is first-responder for investigation and clinical diagnosis of animal diseases detected at the aquaculture farms.

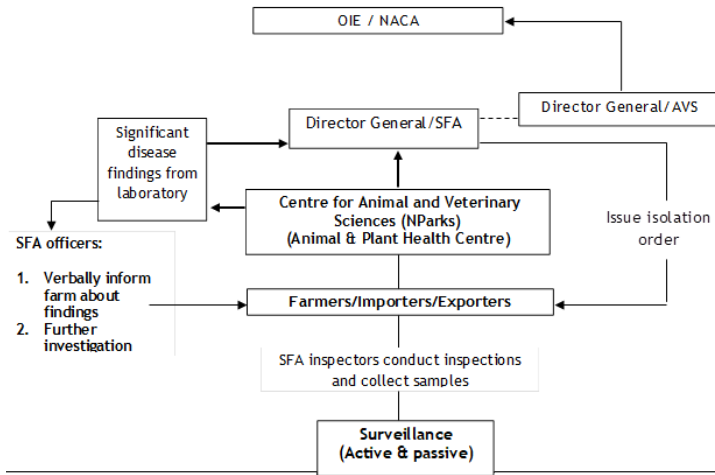
Samples are also routinely collected as part of surveillance programmes – market-size food fish, feed, oyster, biotoxin (for Harmful Algal Bloom), imported food fish fingerlings. The National Centre for Food Safety (NCFS) of SFA and Centre for Animal and Veterinary Services (CAVS) under National Parks Board (NParks) provides support via their diagnostic and testing capabilities in the areas of food safety and animal health, respectively. Aquaculture extension services are provided by extension staff under the Urban Food Solutions Division.

Disease monitoring reporting system

The national list of notifiable aquatic animal diseases relevant to aquaculture animals are Epizootic Ulcerative Syndrome (EUS), Koi herpes virus (KHV), Red Seabream Iridovirus (RSIV), Spring Viraemia of Carp Virus (SVCV) and White spot syndrome virus (WSSV). It is a legal requirement to notify AVS (NParks) if a notifiable or significant disease is suspected. Disease cards and posters are distributed to exporters and farmers for reference to increase their awareness and recognition of notifiable aquatic animal diseases.

For reports of fish kills or suspected or confirmed disease cases, the SFA will activate the Contingency Plan & Eradication Programme, which would include carrying out site investigation and taking samples for laboratory testing, before determining a suitable course of action based on the findings. Quarantine and suspension of movement may be imposed on the premise or area until

Aquatic Animal Disease Reporting



confirmation of disease following which total eradication of affected fish stock and disinfection of premises concerned will be carried out.

Commonly reported diseases/ impact of diseases on production

SFA and NParks implement national surveillance programs for significant viral diseases of food and ornamental fish respectively. Based on the information derived from these surveillance programs, government veterinarians, surveillance staff and extension personnel work closely with the aquaculture industry to control and manage aquatic diseases in Singapore.

Susceptible species are routinely collected for the following diseases:

- a. Epizootic Ulcerative Syndrome (EUS)
- b. Koi herpesvirus (KHV)
- c. Spring Viraemia of Carp (SVC)
- d. *Aeromonas salmonicida*

- e. Iridoviruses (ISKNV & RSIV)
- f. White spot syndrome virus (WSSV) for crustaceans.

In addition, samples will be taken for disease diagnosis should there be any diseased fish observed during surveillance of the aquaculture premises.

For OIE-notifiable diseases (i.e. KHV, WSSV), premises will be imposed with an isolation order, with compulsory culling of the affected batch and further investigation to ensure that other batches of aquatic animals in the premise are free from infection. In the case of non-OIE notifiable diseases, there is no regulatory requirement of compulsory culling. However, in most cases, operators will choose to voluntarily cull the batch to minimise disease spread.

Viral, bacterial or parasitic infections are common production diseases detected in marine fish in Singapore. These include Benedeniosis, Big-Belly (BB) Disease Syndrome, infections with *Streptococcus iniae* and *Tenacibaculum maritimum*,

Table 2. Control mechanisms for major pathogens

Major pathogens	Control measures
Finfish	
Megalocytiavirus – Infectious Spleen and Kidney Necrosis Virus (ISKNV)	Stock vaccinated fish only. Recommend to cull diseased and potentially infected fish. Activation of heat shock proteins as part of disease management.
Megalocytiavirus – Red Seabream Iridovirus (RSIV)	Stock vaccinated fish only. Cull diseased fish and vaccinate clinically healthy fish.
Singapore Grouper Iridovirus	Exclusion of virus via screening of incoming stock. Recommend to cull diseased and potentially infected fish.
Viral Nervous Necrosis Virus (VNNV)	Stock vaccinated fish or exclusion of virus via screening of incoming stock.
Koi Herpesvirus (KHV)	Cull diseased and infected fish.
Scale Drop Disease Virus	Exclusion of virus via screening of incoming stock.
<i>Lates calcarifer</i> Herpesvirus	Exclusion of virus via screening of incoming stock.
Big Belly Bacterial Disease	Pathogen exclusion. Raise early life stages of susceptible fish species, in low salinity RAS. Antibiotic treatment ineffective over several batches.
Streptococcosis	Stock vaccinated fish only, or Treatment with a suitable oral, in-feed antibiotic. Monitor for development of antibiotic resistance.
Vibriosis	Stock vaccinated fish only, or Treatment with a suitable oral, in-feed antibiotic. Monitor for development of antibiotic resistance.
Crustacean	
White Spot Syndrome Virus (WSSV)	Stock clean, disease-free crustaceans. Production in closed systems with high biosecurity. In event of detection, cull all diseased and infected shrimp.

Norcardiosis, Viral Nervous Necrosis (VNN), and Infectious spleen and kidney Necrosis virus (ISKNV).

Observation of clinical signs and gross external pathology of disease ornamental and food fin fish by the extension officers and inspectors are used as the first line in the detection of diseased fish. With a clinically normal population of fish, 30 pieces of fish are sampled each time per batch in order to achieve 95 % confidence in detection, assuming 10 % prevalence of the pathogen. When investigating a disease outbreak in a population of fish, minimum of 5–10 pieces of fish are collected from both moribund/affected and clinically normal fish.

R&D capability/initiatives

Singapore is conducting a carrying-capacity survey for its farm sites, with the aim of stipulating a production limit for farms so that they do not exceed the carrying capacity of a particular geographical area.

This is intended to reduce adverse effects on water quality and the ecosystem.

The hydrodynamics of Singapore's waters are also being studied to identify hydrodynamically connected farm sites, to facilitate designation of farming areas and planning disease response.

Training needs

Training of Aquatic Animal Health Professionals for the aquaculture farms

SFA recognises the need for Aquatic Animal Health Professionals (AAHP) to develop, implement and review the biosecurity plans for the aquaculture farms. AAHPs are required to have aquaculture qualifications (eg. aquaculturists, aquatic veterinarians) and undergo further training in aquaculture farm biosecurity. SFA is working with institutions of learning to implement capability-building programmes to develop a pool of AAHPs in Singapore.

References

SFA website: <http://www.sfa.gov.sg/>

SFA Annual report 2017/2018: <http://www.sfa.gov.sg/docs/default-source/publication/annual-report/ava-ar-2017-18.pdf>

Yearbook of Statistics Singapore 2018: https://www.singstat.gov.sg/-/media/files/publications/reference/yearbook_2018/yos2018.pdf

<https://www.sfa.gov.sg/food-farming/aquaculture-services/marine-aquaculture-centre>

SFA Organisational Chart wef 1 Apr 2019

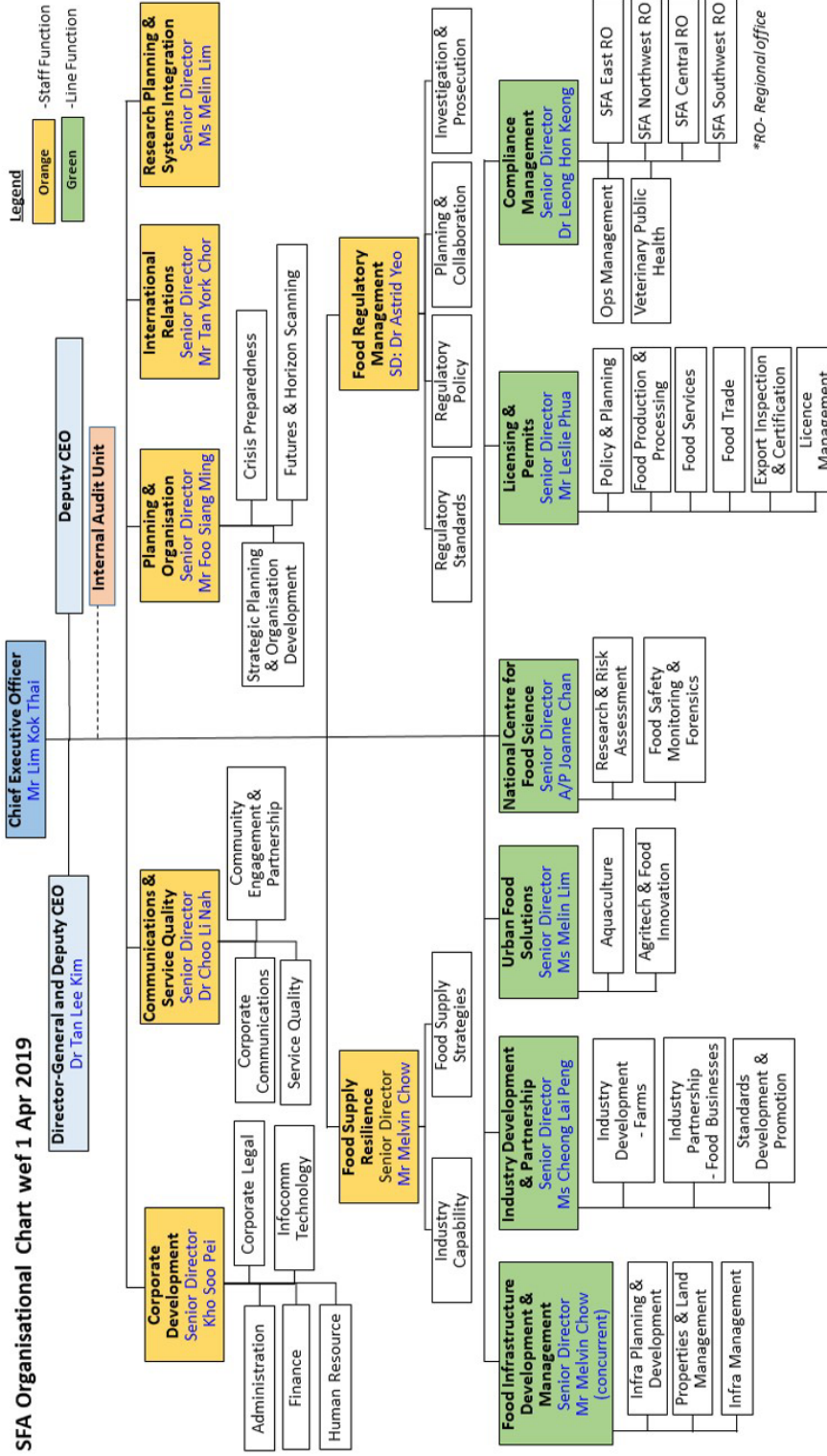


Figure 1. The Singapore Food Agency organizational chart