ASEAN
Good Aquaculture Practices for Food Fish

Trainers' Guide

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Acronyms

AADCP II	ASEAN-Australia Development Cooperation Program Phase II
AMS	ASEAN Member States
ASC	Aquaculture Stewardship Council
ASEAN	Association of Southeast Asian Nations
DO	Dissolved Oxygen
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agriculture Organization
FCR	Feed Conversion Ratio
GAqP	Good Aquaculture Practices
ILO	International Labour Organization
MRL	Maximum Residue Level
OECD	Organisation for Economic Co-operation and Development
OIE	World Organisation for Animal health
PDR	People's Democratic Republic
PPT	PowerPoint
SEAFDEC	Southeast Asian Fisheries Development Center
ToT	Training of Trainers
USA	United States of America
WHO	World Health Organisation

Introduction

LEARNING OBJECTIVES

- Understanding of the composition and mandate of ASEAN
- Describe the status if aquaculture in Southeast Asia and its challenges
- Define Good Aquaculture Practices (GAqP) and the 4 GAqP aspects

The Southeast Asian region is characterised by a heavy dependence on fisheries as a contributor to national and regional social and economic development. Aquaculture and the production of food fish for local consumption and exports continue to increase in importance to the economies of Southeast Asian countries. Four out of the ten largest aquaculture-producing countries are located in Southeast Asia. As the Association of Southeast Asian Nations (ASEAN) progresses to a single economy it is essential that uniform guidelines and standards on sustainable aquaculture are introduced across its member states.

ASEAN

The ASEAN was established on 8 August 1967 in Bangkok, Thailand, with the signing of the ASEAN Declaration (Bangkok Declaration). ASEAN comprises of 10 countries, namely Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam. The establishment of the ASEAN Economic community in 2015 was a major milestone in the regional economic agenda in ASEAN, which offers opportunities in its huge market.

The goal of the ASEAN Community is to improve the lives of Southeast Asia peoples through economic and cultural development, social progress, regional peace and security, collaboration, mutual assistance in training and research, improvement of living standards, promotion of Southeast Asian studies and cooperation with regional and international organizations. ASEAN recognises the importance of ensuring the safety of its citizens from challenges and threats such as climate change, pandemics, natural disasters and transnational crimes. It offers new opportunities to the region and the world for an atmosphere of peace and stability, of bigger, more open and rules-based market for business, of better health and education, and of sustainable development.

The ASEAN Member States (AMS) are legally bonded though the ASEAN Charter. The ASEAN Charter provides a legal status and institutional framework for ASEAN. It also codifies ASEAN norms, rules and values; sets clear targets for ASEAN; and presents accountability and compliance.

Aquaculture in Southeast Asia

Asia accounts for about 89% of the world aquaculture production. Southeast Asia is second after East Asia, in aquaculture production, with Indonesia, Viet Nam, Myanmar and Thailand in the top 10 of major aquaculture producers in the world (FAO 2018). Total production of the Southeast Asian region in 2016 was 11.8 million tons (excluding aquatic plants) of which 5 million tons was produced by Indonesia, 3.6 million tons by Viet Nam. Thailand and Myanmar both produced approximately 1

million tons and the Philippines follows with 0.8 million tons (FAO 2018). The remaining countries together account for 0.4 million tons.

The importance of the aquaculture sector in Southeast Asia is not limited to the high contribution to the world aquaculture production. Aquaculture also plays an important role in food security providing income and livelihood for rural communities. For example, over 90% of the aquaculture production in the Philippines, Myanmar and Indonesia is consumed locally (Belton et al. 2018). Southeast Asian countries have a high per capita consumption of fish, which serves as the major source of animal protein (Hishamunda et al. 2009). As such, fish plays an essential role in the diets of hundreds of millions of consumers, many of them poor and malnourished (Thilsted et al. 2016). Ensuring food security and maintaining these consumption levels requires a continuous expansion of aquaculture production, as capture fisheries will not be able to supply the increasing demand.

Aquaculture production covers several environments: freshwater, marine and brackish water (SEAFDEC 2017). Most of the aquaculture production is finfish production, predominantly from inland aquaculture. Inland culture of finfish in Myanmar for example accounts for almost 95% of its production. In Vietnam and Indonesia, over half of the aquaculture production comes from inland finfish culture. In the Philippines, the majority of finfish production comes from marine aquaculture (FAO 2018). The major fish species cultured are tilapia, carp, catfish and milkfish (Hishamunda et al. 2009), with tilapia providing the highest production (SEAFDEC 2017).

Challenges of the aquaculture sector in Southeast Asia

The rapid growth of aquaculture over the last decades is a result of diversification in cultured species, increased levels of intensification (OECD-FAO 2017), the implementation of technical innovations often accompanied by higher stocking densities (SEAFDEC 2017) and institutional support from development aid agencies and local governments. This rapid growth and intensification of the sector have resulted among others in issues in disease management, land availability, and environmental impacts, especially in the countries in the region with the highest production; Indonesia, Viet Nam and Thailand (OECD-FAO 2017). Main challengers identified by AMS are diseases, low seed quality, fishmeal dependence, lack of traceability and increasing climate change impacts.

Disease management

The intensification of fish farming operations has resulted in the proliferation of diseases along the cultured stock. As a result, antibiotics and other chemicals are being used more extensively. The excessive use of antibiotics and chemicals in turn has adverse effects on human health, and therefore, stricter regulations are being developed and implemented by governments. These regulations specifically include strict food safety requirements, which can be hard for farmers to implement, especially for small-scale farmers that have a lack of knowledge and capacity on the topic as well as limited financial capacity.

Low seed quality

Another challenge is the lack of high-quality seed despite the efforts of genetic programs to improve seed quality and solutions to improve survival, nutrition, disease management, and avoid inbreeding in hatcheries (SEAFDEC 2017). The use of low-quality seed results in an increased susceptibility to diseases, reduced farm performance and higher production costs. Causes for the low quality of seed stock include a lack of regulations, insufficient larval rearing protocols, lack of biosecurity in hatcheries, low quality feeds and improper broodstock management.

Fish meal dependence

Fish meal is the main source of protein in the production of aquaculture feeds. Although the percentage of fish meal used in commercial pellet feeds is decreasing, the total amount of fish meal used continues to increase due to the increase in total aquaculture production (SEAFDEC 2017). The use of commercial fish feeds varies between the countries in the region, depending on the intensity of the aquaculture sector in the country. However, it is expected the countries with smaller aquaculture production may intensify development of their aquaculture sector in the future. Therefore, it is expected that the use of commercial fish feeds will keep increasing, putting more pressure on wild fisheries.

Lack of traceability

Traceability is key to assure the food safety and quality of aquaculture products. With the globalisation of aquaculture markets and consumer preferences to be informed about the source and quality of their seafood purchases, traceability of aquaculture commodities has become an essential element of the value chain organisation. Traceability records are used to prove compliance with food safety, biosecurity and regulations throughout the supply chain.

ASEAN has developed *Regional Guidelines on Traceability System for Aquaculture Products in the ASEAN Region*. Some of the AMS have started to implement traceability systems in order to be able to export their products to markets like the EU, USA and Japan, which have set stringent regulatory requirements. However, most AMS still have issues regarding traceability. Some countries lack the necessary legal framework to enforce traceability. Second, the aquaculture sector in the region comprises of many small-scale operators that do not have the financial and human resources to maintain a traceability system. There is also a lack of awareness and knowledge of the importance and benefits of improving traceability.

Climate change

The region is very vulnerable to extreme weather events such as drought, typhoons and floods. Models predict a higher frequency of these events due to climate change resulting in a higher vulnerability. Southeast Asia is also highly impacted by a rise in seawater temperature, which is expected to result in a severe production drop in the coming decades. Philippines, Myanmar, Vietnam are amongst the most vulnerable countries to climate change. Measures to mitigate and adapt to climate change should be implemented to cope with the changing environment.

Good Aquaculture Practices

To prevent or minimise the risks for farmers that come with these challenges, Good Aquaculture Practices (GAqP) have been developed. GAqP are a series of considerations, procedures and protocols designed to foster efficient and responsible aquaculture and minimise their negative impact on the environment, while also addressing social responsibility, animal welfare, food safety and traceability. To harmonise existing GAqP guidelines and standards of AMS, ASEAN has developed *ASEAN Guidelines on Good Aquaculture Practices for Food Fish* which look at four aspects affecting production, namely: (i) food safety; (ii) animal health and welfare; (iii) environmental integrity; and, (iv) socio-economic responsibility. It must be stressed that these guidelines are not mandatory for farmers to implement until adopted by the legislation of the respective AMS.

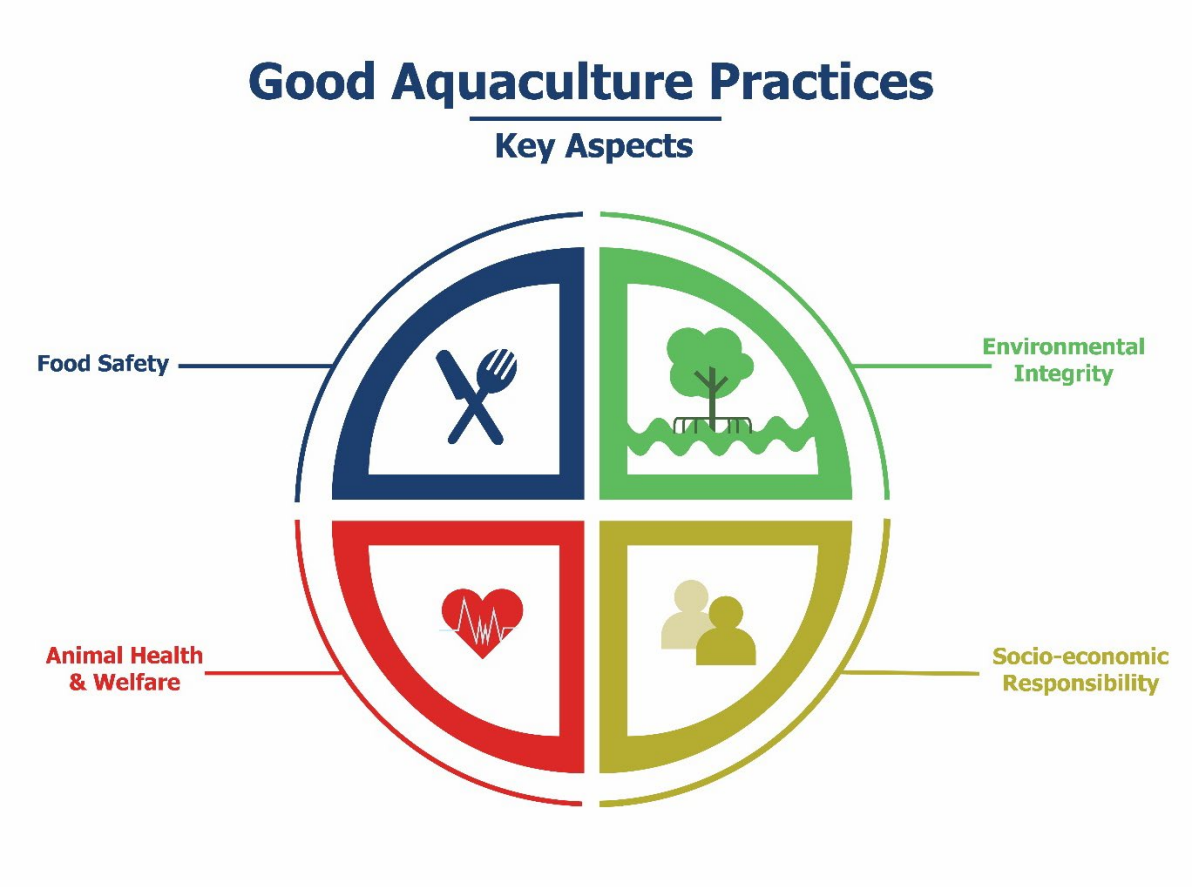

Figure 1: The four key aspects of ASEAN Good Aquaculture Practices

The 4 ASEAN GAqP aspects

Food safety and quality

Fish farmers must make sure that their products are safe to eat and are of high quality. Food safety is defined by the Codex Alimentarius General Principles of Food Hygiene as 'Assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use'. Food quality comprises of different factors that make food acceptable for consumers such as appearance, texture and flavour.

Food safety and quality can be compromised by food safety hazards. To ensure food safety, all food producers, processors, distributors etc. should control all major potential hazards. A food safety hazard is 'a biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect'. Examples of different hazards are provided in table 1.

Table 1: Potential food safety hazards

Type of hazard	Substances
Biological	Parasites (worms, protozoans) Viruses Fungi (mycotoxins) Bacteria (e.g. *E. coli* and *Salmonella*)
Chemical	Veterinary drugs (antibiotics, food additives) Heavy metals Insecticides, herbicides, fungicides etc. Natural toxins (e.g. biotoxins)
Physical	Metal Glass Bone Other hard or sharp objects

These substances can contaminate the fish during different stages of the supply chain. The residues of some of these contaminants can remain present in the tissue of the cultured fish and present a health concern to both the cultured fish and consumers.

Some biological contaminants are not harmful to humans and others may cause spoilage but are not directly harmful. However, there are numerous bacteria and other pathogens that cause diseases in animals or humans. Chemical contaminants come from chemicals such as veterinary drugs or food additives used in aquaculture. Other chemicals that can be present in production areas and a source of contamination are pesticide residues, heavy metals, detergents and disinfectants. Physical hazards include any potentially harmful extraneous matter that are normally not found in food. These can cause harm and injuries to consumers, but are mostly not life threatening.

Fish quality can be reduced through contamination during production, processing and handling, but fish also naturally start decomposing as soon as they are slaughtered. Fish spoilage can also be caused by environmental aspects such as temperature, humidity and light. The main factor that causes fish spoilage is temperature since bacteria grow rapidly between 4 and 60 °C, which is also called the danger zone. When a fish is spoiled it can be identified by a change in colour or texture or a bad odour or taste. Eventually the quality of the fish reduces to the point that the fish is unsuitable to eat and can cause food poisoning.

Implementing GAqP on food safety will prevent contaminating fish with pathogens or other hazards, reduce spoilage, and thus ensure safe and protected fish products.

Animal health and welfare

Diseases can affect growth rates and can cause high mortalities, resulting in reduced farm performance and serious losses for the farmer. Healthy fish have ample resistance against diseases and are to a certain extent able to adapt to environmental changes. Although, knowledge and technology to support fish health are constantly improving, diseases in aquaculture production remain a major issue.

Diseases occur when there is a presence of pathogens in the culture environment, low resistance of fish and/or unfavourable water quality (Idowu et al. 2017). There are two categories of diseases, infectious and non-infectious. Infectious diseases are caused by pathogenic organisms e.g. parasites, bacteria, viruses or fungi. Non-infectious diseases are caused by non-living factors such as environmental issues (e.g. low water quality, pollution) or nutritional deficiencies (Idowu et al. 2017).

GAqP on fish health focus on both disease prevention, and improved diagnostics and treatment procedures.

Fish welfare should be considered during all production and harvesting processes. Welfare focuses on the way fish are cared for without compromising their quality of life and without causing unnecessary suffering. Eventually, reduced fish welfare will result in a lower production and higher costs. Factors that contribute to the welfare of fish are stocking density, nutrition, water quality, equipment and handling (Ashley 2007). Welfare should also be considered during live transportation of fish as outlined in the *Standard Operating Procedures for Responsible Movement of Live Aquatic Animals for ASEAN*. Adopting GAqP on fish welfare will also positively impact fish health through the reduction of stress, thus reducing the susceptibility of the cultured fish to diseases.

Ensuring the health and welfare of the fish will result in a better quality of the fish products as excessive exposure to stress causes the quality of the tissue of the fish to decline. Also, for some consumers, animal welfare is an important aspect when selecting fish products.

Environmental integrity

Environmental issues can affect aquaculture farms, but the farms also have an impact on the environment. Aquaculture heavily relies on environmental goods and services like land, water, coastal ecosystems, and small pelagic fish as feed ingredients. This makes them particularly vulnerable to the pollution of available water and soil and to changes in resource availability, such as clean water, feed and feed ingredients.

Aquaculture can also cause conversion or changes in natural habitats such as mangroves and wetlands when constructing farms, biodiversity issues due to escapees when using exotic or genetically adapted species, overharvesting of wild fish for feeds, pollution due to discharge of effluent water, and the spread of aquatic animal diseases.

By implementing GAqP on environmental management, farmers can minimise and mitigate their impact on the surrounding environment. This benefits the aquaculture operations in the long term, as farm operation relies on the natural environment surrounding the farm. The environmental aspects of GAqP play an important a role in different stages and activities of the farm, including site selection, design and construction, operation, post-harvest management and staff training.

Socio-economic responsibility

Farmers should take into consideration the importance of corporate social responsibility and social welfare. Socio-economic responsibility includes adhering to labour rights, gender equity, and rights on land and water use.

One of the main social issues in the aquaculture sector is conflict over land, water and other resource use. Small-scale farmers may find difficulties in obtaining rights to land use when facing competition from large land developers. The aquaculture sector also has to compete with other sectors over the use of land and the access and use of public water bodies. Water use can also cause issues for farmers when competing with other water users. When effluent water from farms is not treated, it can pollute public water bodies; and since fresh water is becoming increasingly scarce, this can cause serious social conflicts. Marine aquaculture may interfere with navigation, fishing, and recreational use (Boyd et al. 2008). GAqP include measures to avoid conflict situations and to keep good relations with the surrounding community.

Farmers also have responsibilities to their workers by following the national rules and regulations in line with the International Labour Organization (ILO) Convention. International labour standards have

been developed by the ILO as a legal instrument to set out basic principles and rights at work. Subjects covered in their standards include forced and child labour, equality, wages, working time, safety and health, staff training and social security.

Women play a large role in the aquaculture sector in most Southeast Asian countries. Gender equity is a human right that provide gains in health, education, food security, employment and livelihoods. Farmers need to ensure to adhere to treat women and men equally, according to their respective needs.

GAqP on social responsibility should be implemented at all stages of aquaculture planning, development and operation. This will ensure rural development, enhanced benefits and equity in local communities, thereby reducing extreme poverty and improving food security.

Benefits of implementing GAqP for farmers

Even though implementation of GAqP will require some time and financial investment of the farmer, a lot of benefits can be incurred.

Implementing GAqP measures on food safety reduces production risks for farmers and thus improves farm performance on the long term. Also, by having sufficient food safety measures in place farmers will have access to buyers that are willing to pay a premium for higher quality fish (like supermarkets and high-end restaurants).

Ensuring the health and welfare of fish results in a lower occurrence of diseases and thus increases the survival rate of the fish and the overall quality of the harvested crop. This in turn results in a higher income for farmers. Consumers that find animal welfare important are also willing to pay a premium price.

Implementing GAqP measures on environmental management benefits the aquaculture operation in the long term, as farm operation relies on the natural environment surrounding the farm. For example, safeguarding the mangroves around the farm will protect the farm infrastructure and fish in the pond during a large storm. By not polluting the environment of the farm, the area will stay clean and free of pathogens, thus reducing the occurrence of diseases on the farm. Reducing risks always results in a better income for the farmer.

GAqP measures on social responsibility ensure rural development, enhanced benefits and equity in local communities, thereby reducing extreme poverty and improving food security. By helping the local community, they will in turn have more appreciation for the farm operations resulting in fewer local conflicts. Also, by keeping your employees happy they will in turn keep the fish happy, again resulting in better financial returns for the farmer.

About the training course

To harmonise existing GAqP guidelines and standards of AMS, ASEAN, with the support of the ASEAN Australia Development Cooperation Program Phase II (AADCP II), developed *ASEAN Guidelines on Good Aquaculture Practices for Food Fish* in 2015, which addressed four areas affecting production, hereinafter referred to as key GAqP aspects, namely:

1. Food safety
2. Animal health and welfare
3. Environmental integrity
4. Socio-economic responsibility

These ASEAN GAqP Guidelines address distinct issues on ensuring safety and quality of food fish during on-farm and post-production processes, enhancing environmental integrity of aqua farm operations, and contributing to socioeconomic sustainability. The guidelines cover all types of aquaculture (inland and marine) that produce fish for human consumption, including both hatcheries and grow-out farms.

In order to operationalise the ASEAN GAqP Guidelines at both national and regional levels, promoting better understanding by capacitating AMS towards effective implementation of these guidelines, is crucial. ASEAN, in partnership with AADCP II, has initiated a project to support the development of a training program and training materials for aquaculture extension workers. The training materials were tested in a pilot training course held in Penang, Malaysia on February 3-6, 2020 with representatives from all 10 AMS in attendance and was subsequently refined.

This Trainer's Guide is intended to support AMS in delivering effective Training of Trainers (ToT) programs for aquaculture extension workers and trainers that will further contribute to better understanding and utilisation of ASEAN GAqP. To complement this Trainers' Guide, a set of PowerPoint presentations is available covering the introduction, 12 teaching modules and a module on teaching methods for trainers to be used during the training course. References in the text to the *ASEAN Guidelines on Good Aquaculture Practices for Food Fish* are indicated in blue and with an [(A)]. All measures outlined in the previous guidelines are included in this Trainer's Guide and the accompanying PowerPoint presentations.

Course objectives

At the end of the course, trainees are expected to:

- Understand the basic principles of food safety and quality, animal health and welfare, environmental integrity and socio-economic responsibility.
- Be familiar with the ASEAN Good Aquaculture Practices related to the four (4) key GAqP aspects.
- Understand the main ASEAN GAqP compliance needs.
- Be able to lead and conduct national GAqP training courses for farmers and other aquaculture operators.

How to use this Trainers' Guide?

This Trainers' Guide should be used in conjunction with the PowerPoint presentations of this course. It provides background information on the GAqP topics, a detailed flight plan, and teaching notes with suggested exercises and activities. The guide is divided into 12 teaching modules that are categorised in 3 main sections; farm preparation, farm management and other standalone topics:

Farm preparation:

1. Site selection, farm lay-out and design

Farm Management:

2. General hygiene practices
3. Water quality management
4. Feed management
5. Management of chemicals and veterinary drugs
6. Fish health and disease management
7. Harvest and post-harvest management
8. Staff and community relations
9. Record keeping and documentation

Stand-alone modules:

10. Legislation and compliance
11. Financial management and marketing
12. Climate change adaptation and mitigation

The four (4) key GAqP aspects are cross cutting throughout the teaching modules. These are indicated for the individual GAqP with the following symbols:

Food safety

Environmental integrity

Animal health and welfare

Socio-economic responsibility

Each of the teaching modules in this guide follows a similar structure that consists of an introduction to the module followed by the relevant GAqP measures. Each GAqP contains background information for the trainer to help understand and thereafter explain the GAqP to the trainees. At the end of each module, a trainer aid is included with web links to useful videos, examples of good and bad practices and questions that the trainer can use throughout the module to promote interaction with the trainees and to clarify the GAqP through examples. It is recommended, however, to add additional videos and examples from the respective AMS for contextualisation and better understanding. Finally, suggestions for practical activities are included that can be carried out with the trainees in order to further improve their understanding of the training content. Depending on the level of the trainees, their interests and the available timeframe for each presentation, the trainer is free to make a selection of training aids. If the trainer has other training aids, specifically aids tailored to the country or to specific needs of the country, these can also be used.

Beside the 12 teaching modules, this Trainers' Guide also includes a module on teaching methods that outlines guidelines for the trainer to organise and facilitate an effective training course while maximizing the learning value of the trainees.

The trainer is advised to go through this entire Trainers' Guide and PowerPoint presentations. The trainer should also prepare the guiding questions, good and bad examples, and exercises. He/she can add additional examples, questions and exercises tailored to the country. Some activities also need materials that should be prepared.

Training schedule

A total of 4 days is envisioned for each training course with an optional fifth day for a farm visit. Each day is divided into a morning and afternoon block with a lunch break in between. The morning and afternoon block both have a short coffee break as well. The training aids for each module and activity are specified in the last column.

Table 2: Training course schedule

GAqP TRAINING - COURSE SCHEDULE			
Course day		**Lecture modules and activities**	**Training aids**
Day 1	**Morning 9.00 - 12.00**	Introduction ASEAN	PowerPoint
		Course outline and goals	PowerPoint
		Coffee break	
		Introduction trainees and sharing of experiences	Ball with questions
		ASEAN GAqP and the 4 main aspects	PowerPoint + video
	Afternoon 13.30 - 17.00	**Module 1:** Site selection, farm lay-out and design	PowerPoint + video
		Coffee break	
		Module 2: General hygiene practices	PowerPoint
		Recapitulation Day 1,questions & discussion	Whiteboard
Day 2	**Morning 9.00 - 12.00**	Course outline Day 2	PowerPoint
		Module 3: Water quality management	PowerPoint, water samples and pH test kit + video
		Coffee break	
		Module 4: Feed management	PowerPoint + video
		Questions & discussion	Whiteboard
	Afternoon 13.30 - 17.00	**Module 5:** Management of chemicals and veterinary drugs	PowerPoint
		Coffee break	
		Module 6: Fish health and disease management	PowerPoint + video
		Recapitulation Day 2,questions & discussion	Whiteboard
Day 3	**Morning 9.00 - 12.00**	Course outline Day 3	PowerPoint + video
		Module 7: Harvest and post-harvest management	PowerPoint + video
		Coffee break	
		Module 8: Staff and community relations	PowerPoint
		Questions & discussion	Whiteboard

	Afternoon 13.30 - 17.00	**Module 9:** Record keeping and traceability	PowerPoint + video
		Coffee break	
		Module 10: Legislation and compliance	PowerPoint
		Recapitulation Day 3,questions & discussion	Whiteboard
Day 4	**Morning 9.00 - 12.00**	Course outline Day 4 **Module 11:** Financial management and marketing	PowerPoint + Whiteboard
		Module 12: Climate change adaptation and mitigation	PowerPoint
		Coffee break	
		Recapitulation ASEAN GAqP	PowerPoint
		Questions & discussion	Whiteboard
	Afternoon 13.30 - 17.00	Teaching methods	PowerPoint + video
		Coffee break	
		Recapitulation Day 4,questions & discussion	Whiteboard
		Trainee assessment (theoretical exam)	Exam
		Evaluation & feedback	Evaluation forms
Day 5 (Optional)	**Morning 9.00 - 14.00**	Field visit to a fish farm (excursion and practical training)	Transport, water quality tests
		Recapitulation Day 5, questions & discussion	

Farm Preparation

Teaching Module 1: Site selection, farm lay-out and design

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Site selection criteria
- Layout and design principles

Introduction

Aquaculture facilities should be located in areas where the risk of contamination is minimal or where sources of pollution can be controlled or mitigated [(A)]. Aquaculture activities should be planned and practiced in an environmentally responsible manner in accordance with applicable national and international rules and regulations. Ensuring environmental integrity requires that environmental impacts of planning, development and operational practices of aquaculture activities be addressed [(A)].

Implementing GAqP on site selection, layout and design reduces the risk of pollution and also minimises negative environmental impacts from the construction and future operation of the farm, while simultaneously ensuring the site is suited for the selected culture species. It is recommended to ask the local competent authorities for permission, advice and recommendations when starting the site selection process for a new farm, especially for larger projects.

Good Aquaculture Practices

Site selection

1. *The climate and environmental parameters should be suitable for the selected production system*

For all aquaculture systems, climate (yearly rainfall, minimum and maximum temperature) and environmental conditions (soil, air and water) should be considered.

The site should have clean air, water and soil that is not polluted by natural or manmade chemicals. For example, a farm site next to or downstream from a large factory or city could contain chemicals in the air, soil or water that can accumulate in the tissue of the fish that is being cultured. In case of cage farming in rivers or coastal areas, a site should be selected that is free from upstream pollution from waste from large cities or industries.

When dealing with pond operations, it is important that the soil in the selected area can hold water to minimise water seepage. While clay soils hold water well, sandy soils are difficult to seal and will slowly but surely fully drain. Proper testing needs to be done before the start of the project to ensure the soil type is appropriate. If the soil is inappropriate for pond farming, concrete ponds or polyethylene pond liners can be considered.

When selecting a site to install a cage or pen system, it is important to first evaluate if the site is suitable for this purpose. Examine if the water depth and current is appropriate throughout the year and make sure the area is protected against high waves and extreme tide fluctuations. Cages and pens

should be placed in an area, which has suitable water parameters and is of sufficient quality for the farmed species.

2. *Sufficient clean water should be available year-round*

Water is indispensable for any aquaculture operation to fill ponds and tanks and replace losses from evaporation, as well as for cleaning and sanitation, and thus needs to be available year-round and in sufficient volume.

3. *Sites should have a slight slope*

Pond water needs to be regularly topped-up and during harvest, they often need to be fully drained. In flat areas without any slope, this would require engine driven or electrical pumps that are expensive to buy and operate. When possible, it is advised to select a site with a slight slope that will allow water to flow in and out of ponds by gravity. For farms with indoor hatcheries and nurseries, a similar approach can be taken by installing a large reservoir or header tank in the section of the site with the highest elevation. Making use of gravity gives farmers the opportunity to save a considerable amount of electricity and time while also reducing their reliance on fossil fuels.

4. *The site should have access to the market and other supply chain actors*

Farms often require a large amount of feeds and other inputs like fingerlings and pond additives such as probiotics and fertilisers. Sufficient labourers willing to work in the farm also need to be available and the farm should have the necessary infrastructure such as access to electricity and a road network. Farmers likewise need customers to buy their harvested produce. It is thus important to take these factors into consideration when selecting a new farming site and to make sure that inputs are locally available and that a local market or buyers are present. This in turn will also reduce transportation costs and improve farm performance. A reduced transportation time also reduces the chances of contamination of the transported fish. When transporting and selling live fish, like fry and fingerlings, minimising transportation time benefits the health of the fish and will reduce costs considerably.

5. *Environmental damage should be prevented*

New farms should never be sited in environmentally sensitive wetlands or mangrove areas because the farm activities most likely will have a significant negative impact on these ecosystems and the plants and animals they contain. For example, trees would need to be cut to make space for buildings and ponds, and pond effluents (wastewater) are full of nutrients that cause eutrophication of wetlands and often result in algae blooms. Cage operations should also be located at a sufficient distance from ecologically important ecosystems such as coral reefs and sea grass beds.

6. *Environmental Impact Assessment should be conducted if required by national law and according to national legislation, prior to approval of establishment of aquaculture facilities/farms* [(A)]

To make sure all site selection criteria have been properly evaluated, especially when dealing with larger farms, it is recommended to conduct an official Environmental Impact Assessment (EIA). Such an assessment is normally conducted by an external company and assures the farm owner that a suitable site has been selected that will have minimal negative impacts on the surrounding natural environment. An EIA is also of use in demonstrating compliance to the competent authorities and to international certification labels like ASC or Global GAP.

7. *Extreme weather events due to climate change should be taken into consideration and planned for*

The effects of climate change include the increased occurrence of extreme weather events, such as excessive rains, flooding and big storms. These need to be taken into consideration during the design

and planning stage to avoid massive destruction of farm infrastructure and fish losses during such events. In practical terms, this means that farm buildings should be located in areas that are free of flooding, pond dikes need to be made stronger and higher, and sufficient drainage canals need to be connected to drain water in case of flooding. In areas that are prone to typhoons, sufficient distance from the seashore should be kept to preserve the operational infrastructure; mangroves should be left intact and should be replanted to buffer against the impact of storms. Cages should only be installed in areas that are protected from strong waves and structures should be strong enough to withstand extreme weather events.

Farm layout and design

8. *The layout and design of the farm should allow for easy cleaning and sanitizing*

To minimise the spread of contaminants and pathogens, it is important that the layout of the farm and the design of different farm structures allow for easy cleaning and sanitizing. This can for example be accomplished by ensuring that floors and walls in hatchery and nursery buildings are smooth and painted. This makes them easy to scrub in order to remove dirt and possible pathogens. Floors should be free from dead spots and corners should be rounded. Floor drains in strategic places will facilitate easy cleaning as well.

9. *The design should include facilities for personal hygiene*

To keep facilities clean and hygienic, sufficient facilities for personal hygiene, including toilets, footbaths and hand washing services, need to be incorporated at strategic locations in the design. Toilets should be equipped with a well-constructed septic tank or they should be connected to the sewage system.

10. *The layout should include a logical workflow and separate farm units*

To prevent employees from accidently spreading pathogens to different fishponds or other units of the farm, known as cross-contamination, the layout should incorporate a logical workflow. For this purpose, it is also important to clearly separate different farm units like the hatchery, nursery, and grow-out ponds and to restrict the flow of workers to different areas of the farm. Finally, each pond and tank should have their individual in- and outlets.

11. *Staff housing should be strategically placed*

If the farm provides staff housing on the premises, some precautions should be made as staff could accidently contaminate the cultured stock during off-work hours. It is important to separate staff housing, including an area to prepare and eat foods, from other farm units. There should also be a separated area where people can smoke.

12. *The layout should include separate storage facilities for feeds and chemicals*

Feed and chemicals should be stored indoors or sheltered locations for feed. Storage facilities should be kept separated from farm units and positioned in a suited location in the design. These measures will also help to maintain the quality of the feeds and chemicals.

13. *The layout should cater for waste collection, storage and disposal facilities*

Proper waste collection, storage, and disposal is important to minimise the risk of spreading microbes and other pathogens along the farm. For this purpose, the design should include garbage bins located in strategic areas of the farm. Waste should be stored at a safe distance from the farming operations and in containers that can be closed. Waste materials should be disposed properly; either picked up by a professional company or should be brought to the designated waste disposal facility or site.

14. *The layout of the farm should allow for the restriction of access*

To reduce the spread of diseases between farms, entrance to the farm should be controlled. Facilities should have a clearly marked entrance and exit that contains a footbath and hand washing facilities for both people and their vehicles. It is recommended to place signs that notify visitors of the restricted access policy of the farm. Farms should be fenced to prevent the entry of wild animals and livestock. A visitor's log should be kept as well.

15. *The layout of the cage or pen should be designed in a way that ensures minimal physical damage to the fish and that allows for adequate cleaning and disinfection*

Cage should be designed and constructed in a way that minimises any harm to the fish during the production and harvesting processes. The materials should allow for easy cleaning and disinfection. This is achieved by for example using smooth materials and rounded corners for hatchery tanks, sorting and harvest bins, and nets.

Training aids

Videos

Site selection and pond preparation – web link: https://www.youtube.com/watch?v=WdIkQsf1F_Y

The video discusses site selection criteria for tilapia farming operations in Egypt and repeats most of the measures discussed in this Teaching Module. AMS are encouraged to utilise videos featuring their national GAqP whenever available. Giving trainees a visual overview of important criteria during site selection helps them in memorizing the content of the module and it gives the trainer the opportunity to clarify any remaining questions.

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples**.**

GAqP topic	Bad practice	Good practice
Site with suitable environmental parameters	Locating a farm next to a chemical factory that discharges pollutants in the water source will contaminate the fish and makes the produce unfit for human consumption.	A quiet location in the countryside away from factories and large-scale industries where soil, water and air are clean, is a good location for a new farm site.
Planning for climate change	Siting a new farm in a swampy area along the coast is very risky because the area will easily flood during a large storm.	Siting a new farm at a safe distance from the sea, and in an area that does not flood during heavy rains, minimises the exposure of the farm and fish to the risks from the increased occurrence of extreme weather events.
Logical workflow and separating different units	To access the hatchery, employees need to pass through the nursery first. This	Both the hatchery and nursery are located in different buildings, are managed by

	is not a logical workflow and might result in employees accidently spreading diseases from fish in the nursery to fish in hatchery.	different staff and can only be accessed by passing through a footbath and before washing your hands. Separating production units like this will prevent the spread of diseases along the farm.
Waste disposal	Locating just one garbage bin at a farm is not advisable as employees will have a hard time locating this single bin and they might decide to throw their garbage elsewhere, thereby increasing the proliferation of microbes in the farm.	Strategically positioning one garbage bin at every farm building and at every row of ponds will make it easy for employees to dispose garbage and this will minimise the proliferation of microbes in the farm.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Main source of water	A new farm is planning to fill its ponds with water directly from the public canal of the village next to the farm, is this advisable? *Possible answer:* No, this is not advisable. The farm needs to ensure the water is clean by testing. It is also recommended to screen and settle the water before using it in the ponds.
Staff housing	Where should staff housing be located? What can be done to prevent contamination between staff housing and farm units? *Possible answer:* Away from the farm. Implement biosecurity measures for staff entering the farm such as hand washing facilities and footbaths. Staff housing should be kept clean and waste should be disposed of properly.
Soil type	The soil at a particular site is very sandy and does not hold water well. What would you advise a farmer that is planning to build his farm there? *Possible answer:* Install pond liners to avoid seepage of water or use concrete tanks.
No environmental damage	A new farm is planning to treat wastewater from its ponds before releasing it to a wetland located next to the farm. Do you think the farm will pass the EIA?

	Possible answer: Yes, if the treatment is sufficient and water quality tests show that the quality is acceptable for release.
Cleaning and sanitation	A company is planning to save money by not installing footbaths and hand washing facilities at its tilapia hatchery, why is this risky? *Possible answer:* It provides a considerable risk of staff bringing pathogens into the hatchery and contaminating the fish.
Restricting access	A friendly farm owner from a nearby fish farm is planning to visit the new farming site to discuss a disease outbreak on his farm. Is this advisable? *Possible answer:* No, there is a big risk that the farm owner will transfer the disease to the visited farm. Diseased fish should be quarantined, and movement of fish should be regulated. Staff should be very cautious not to spread the disease to other farms.

Practical activities

The trainer can use the following practical activity during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Exercise: Design a farm

Instructions: Divide the trainees in smaller groups of 4-5 persons. Ask each group to design a tilapia farm that has the following specifications:

- A hatchery with egg incubation and larval rearing tanks
- A reservoir pond
- Nursery ponds
- Grow out ponds
- A feed store
- A chemical store
- A cleaning area
- A waste disposal area
- An office
- A laboratory
- Staff housing

The groups should label each of the units in their drawing. They also need to include the water flow and direction using arrows. The drawings should be presented by one of the group members and discussed with the whole group. The trainer uses the outcomes to facilitate a group discussion on the topic whereby the main GAqP measures from this module are repeated.

Farm Management

Teaching Module 2: General hygiene practices

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Cleaning and sanitation of facilities, equipment and tools
- Personal hygiene
- Waste collection and disposal
- Pond preparation
- Pest control

Introduction

General hygiene practices are preventive measures to reduce the risk of transferring and spreading contaminants and pathogens along the farm and farm stock. These contaminants and pathogens can originate from employees and be transferred to the fish, but they can also come from farm wastes, contaminated water, dirty tools, equipment and facilities that are kept in unhygienic conditions. Pathogens can also emerge without warning in a pond, tank or cage and if general hygiene practices are not sufficiently implemented at a farm, these pathogens then easily spread along the farm stock.

Contaminants and pathogens can be controlled by implementing measures that maintain the hygiene and cleanliness of resources (e.g. farm inputs and equipment) and people that enter the farm, and by keeping the farm clean and sanitized. In order to maintain hygienic conditions aquaculture facilities should be operated and maintained in ways that prevent contamination from workers, sewage, domestic animals, machinery oil or fuel and other possible sources. Waste disposal should be conducted responsibly [(A)].

These general hygiene practices also play an important role in minimising the risks of the transmission of infectious diseases along the farm stock, in later modules of this guide this will be referred to as the biosecurity of the farm.

Good Aquaculture Practices

Cleaning and sanitation of facilities, equipment and tools

1. *Farm and surrounding should be kept clean and hygienic*

To keep the farm in a hygienic condition, a systematic approach is needed that implements both cleaning and sanitation measures. Cleaning refers to the removal of dirt, soil, product scraps, blood, slime, and grease from all surfaces of the facilities, equipment and tools that are being used in the farm. Sanitizing is the killing of bacteria and other pathogens, including biological or chemical agents of disease, with the use of dedicated chemicals.

Ensuring that the farm is clean at all times is foremost achieved by implementing a proper cleaning and sanitizing program, as well as by installing sufficient waste bins, proper waste collection and disposal, and by training employees in the importance of general hygiene practices.

2. *Only clean water should be used for cleaning and sanitizing*

Unclean water is the main cause of re-contamination during cleaning and sanitizing, and farmers should only use clean water from a reliable source to clean and rinse their facilities tools and equipment.

3. *Only products approved for cleaning and sanitizing should be used and they should be used according to the specifications of the manufacturer*

Some products are not safe to use in aquaculture because their residues can remain present in the tissue of the cultured fish. Therefore, it is important to only use chemicals that have been approved for use in aquaculture activities with the purpose of producing fish for human consumption. Information on the authorised and banned chemicals per AMS can be found in the *ASEAN Guidelines for the Use of Chemicals in Aquaculture and Measures to Eliminate the Use of Harmful Chemicals* (2013).

Farmers should also follow the specifications provided by the manufacturer, especially with regards to the dosing of the products and their expiry date. Products for cleaning and sanitizing that are used at a lower dosage than recommended, or that are used beyond their expiry date, will not work efficiently and might not kill bacteria and other pathogens. On the other hand, products that are used at a dosage higher than recommended can cause permanent harm to employees and the cultured fish.

4. *Each farm department should be assigned with a different set of cleaning materials and these materials should be properly labelled*

Logically, after using cleaning materials for a full day in a farm, they will be full of dirt and are possibly covered with contaminants and pathogens. To minimise the chances that these contaminants and pathogens spread to other farm departments, farmers should use a different set of cleaning materials for each farming department. These cleaning materials should also be labelled so that employees will not mistakenly use cleaning materials from one department in another department, and so that cleaning materials are used for the right purpose. A practical tip is to colour-code cleaning materials. For example, only use blue buckets, brushes and towels in the hatchery department, while using only red materials in the nursery.

5. *Proper cleaning and sanitation procedures should be followed*

An example of proper cleaning and sanitation procedures is outlined in the following approach:

1. Before starting any cleaning and sanitation activity put on appropriate protective clothing (e.g., apron, gloves and boots)
2. Prepare cleaning tools (e.g., brooms, scrubbing brushes, shovels, water hoses, cleaning cloth, buckets, detergents, sanitizers, etc.)
3. Dismantle any processing equipment to clean it well
4. Remove all visible rubbish and place in appropriate disposal bins
5. Wipe surfaces to remove loose surface dirt
6. Rinse all surfaces of materials and equipment with clean water
7. Apply detergent to break down grease and remove stains
8. Scrub all surfaces from the top down to remove all dirt
9. Rinse off the detergent from the top down with plenty of clean water
10. Apply sanitizer to kill and reduce bacteria to a safe level
11. Rinse off sanitizer with plenty of clean water
12. Dry the materials and equipment by removing excess water that may remain behind and allow bacteria to grow

13. Properly store clean materials and equipment

6. *An area should be assigned to clean equipment and tools*

Farmers should assign a specific area where all equipment and tools are cleaned. It is advised to select a discreet area on the farm that does not need to be crossed unnecessarily by staff working in other farm departments. A clean area for drying should also be made available.

7. *Cleaning materials should be kept clean and should be stored indoors*

Pathogens, like bacteria and moulds, will continue to multiply on dirty cleaning materials. During their next use, these pathogens could consequently be transferred to other tools and equipment, and to the cultured fish. For this reason, it is important to sanitize cleaning materials well after their use. To make sure the materials stay clean afterwards, they should be stored indoors and in a suitable area that has been assigned for this purpose.

Personal hygiene

Special care on personal hygiene should be given during harvesting and post-harvesting procedures as raw materials are easily contaminated at this stage.

8. *Employees should wear suitable and clean work clothing, and personal accessories cannot be carried or worn during working hours*

Employees should wear suitable and clean work clothing at all times and personal accessories like cell phones, necklaces, rings and bracelets should be left at home or should be kept in a personal locker at the farm.

9. *Employees should regularly wash their hands with soap*

Employees should wash their hands with soap during the start of their shift, after use of the toilet, after eating, when the shift end, and whenever deemed necessary.

10. *Smoking, eating and drinking is not allowed in and around the farming facilities*

When employees eat, drink, smoke and spit, they often create unhygienic conditions. This should be avoided on the farm, and employees should only be allowed to engage in these activities in a designated area assigned for this purpose.

11. *Only healthy employees should be allowed to work at the farm*

Employees handle the cultured fish on a regular basis and they handle harvested fish before sales. To avoid transmission of pathogens, employees that are seriously ill are unfit for work and should not be allowed onto the farm. Wounds should be covered at all times with clean waterproof bandages. An employee that, for example, has an open wound could transfer bacteria from this wound onto the harvested fish. Farmers should be aware that some diseases can be transferred from employees to cultured seafood, and can then be passed to consumers. For this reason, employees with infectious diseases should not be allowed to enter the farm and all employees should undergo an annual medical check-up.

Waste collection and disposal

12. *Waste bins should be visibly placed and labelled, and waste should be collected daily*

To maintain clean and hygienic conditions on the farm, employees should be able to easily locate and recognise waste bins. These bins should be emptied daily, and should be kept in a hygienic state through regular cleaning.

13. *The temporary storage of waste on the farm should take place in a specified area assigned for this purpose*

All waste materials that are stored before disposal should be kept in a locked storage area that is accessible to authorised staff only. Doing this will also prevent animals like stray dogs and rats from roaming around the waste material.

14. *Chemical and other hazardous waste should be stored separate and under sealed conditions*

Chemical and other hazardous waste cannot be thrown into a regular waste bin since these wastes might be a health risk to employees and the cultured fish. Instead, farmers should store these wastes separately and in containers that can be sealed. Chemicals and other hazardous waste should be disposed of properly by a dedicated company that specializes in the disposal of this type of material. Storage areas should be marked with warning signs.

Pond and cage cleaning

15. *Pond bottoms should be properly cleaned and dried before use*

As a consequence of the fish farming activities bacteria, fungi and other pathogens and contaminants will accumulate on the bottom of the pond and these can be harmful to the next batch of fish that will be stocked in the pond. Drying and liming the pond in between production cycles disinfects the pond bottom and helps in the control of pests. Predatory snails that often carry parasites that can infect the fish, will also be killed in this way. This can be taken one step further by using a fallowing period during which the pond ls left dry for a period of up to 2 months. This measure is recommended once a year, or after each production cycle for cycles that take longer than one year.

16. *Pond sludge should be discarded properly*

Since the sludge from the pond bottom is full of contaminants and pathogens, it is not advisable do discard these wastes close to the farm. Instead, this pond waste should be disposed of properly and brought to a landfill, for example. Similarly, farmers should not use any sludge from the pond bottom for the repair of pond dikes.

17. *Only chemicals that have been authorised for use in aquaculture for food fish production should be used during pond preparation*

Many chemicals leave behind residues that will harm the cultured fish and potentially consumers. The competent authorities have selected and approved chemicals that are safe for the use in aquaculture for the production of food fish. It is equally important to use these chemicals according to the instructions, and specifically the dosage, provided by the manufacturer.

18. *Use of antifouling agents in marine cages should involve recognized applications of approved materials*

Marine fouling has a direct impact on fish farming practices as fish farmers need to invest substantial time and money to combat fouling (unwanted organisms on cage structures) growth. Fouling can be removed mechanically, by using high pressure washing, for example, which is not harmful for the environment if done on land and when the material is disposed of properly. There are also antifouling agents that prevent organisms to attach to the nets. In this case, only environmentally friendly and approved chemicals should be used.

Pest control

19. *Pests should be controlled*

Pests can be hazardous to food safety. They often carry diseases and can cause serious damage to farm structures, facilities and equipment. Examples of pests are rodents, cockroaches, flies and other insects. When a farmer observes a pest problem, the pest should be identified, and preventive strategies should be planned accordingly. Pest control procedures should be implemented, monitored and recorded. Regular evaluation should take place to ensure the pest control system is working.

Trainer aids

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples**.**

GAqP topic	Bad practice	Good practice
Only clean water should be used during cleaning and sanitizing	Using water from a public canal to clean your equipment is not advised, as this water is most likely full of contaminants and pathogens.	Clean water from a deep well that is regularly tested for contaminants and pathogens, is safe to use to clean equipment.
An area should be assigned to clean equipment and tools	A small hatchery decides to use the staff kitchen to clean hatchery buckets and filters. This is not advisable since there is a big risk of contamination.	A hatchery has a separate cleaning area in the corner of its farm. The area is only used to clean equipment and tools at the hatchery. By doing this, the hatchery minimises the risks of contamination.
Employees should regularly wash their hands with soap	Several nursery employees do not use disinfectant to clean their hands because they do not like the smell of the disinfectant. This is not advisable since these workers might spread diseases along different tanks in the nursery.	All nursery employees wash their hands regularly with disinfectant. By doing this they minimise the risk of contaminating their fish and they minimise the risk of spreading pathogens along the cultured stock in other departments.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Waste storage	A small farm has difficulty finding a place to properly store its waste before disposal. One employee proposes to store the waste in a waste bin inside the storage room for feeds. Is this a good idea? And what would you recommend? *Possible answer:* This is not advisable; waste can contain pathogens that can be transferred to the feeds. The waste should be kept in a separate location on the farm and this location should only be accessible by authorised staff.
Employee health	An employee has told his manager that he has been infected with hepatitis, a highly infectious disease. What actions should the farm management take? And how could the farm management assist the employee with this difficult situation? *Possible answer:* The employee should not be allowed to come to work. The farm management should advise the employee to seek treatment. If necessary, the farm management should help the employee gain access to medical assistance. When the employee is no longer infectious, he can return to work.
Pond preparation	The owner of a fishpond is observing many snails during pond preparation. He is looking for an environmentally friendly way to remove these snails. What would be a suitable solution? *Possible answer:* The pond should be drained, and proper drying and liming procedures should be applied to eliminate the snails and any eggs they have deposited in the pond.
Restricting access	A group of school children would like to visit the farm, what measures with regards to general hygiene practices should be taken? Are there any areas where they should not be allowed access? *Possible answer:* In case of large farms, the children should be asked if they have visited another livestock or fish farm in the past 24 hours. If yes, as a precaution, they should not be allowed to enter the farm since it can never be ensured that that farm was clean. The remaining children should wash their hands, and pass a footbath, before entering the farm. Children should be instructed not to touch anything. Vulnerable areas like hatcheries should not be accessed.
Pest control	What kind of tools can be used for pest control? *Possible answers:* Rodent traps, sticky insect trap to catch flies and, electric insect killers.

Practical activities

The trainer can use the following practical activities during or at the end of the module to promote interaction with the trainees and to further enhance the learning value of the trainees through practical examples.

Group discussion: Pond preparation

The trainer can use the following scenario to engage in a group discussion with the trainees:

The owner of a fish pond is trying to dry his pond bottom during the dry season, but for unclear reasons the pond does not dry. What could be a reason for the pond bottom not drying up properly? And what could be a suitable solution?

Possible answers:

- The pond might not dry up because the pond is shaded by surrounding vegetation, or because it still raining despite it being the dry season. Another possible cause is that groundwater is seeping into the pond.

Possible solutions:

- Some of the vegetation along the pond might need to be trimmed to bring more sunlight into the pond.
- In case there are still regular rains during the dry season, it might be impossible to dry the pond. Instead it would be recommended to use a heavy liming procedure to kill pathogens and snails in the pond.

The farmer also discovered that two (2) big mangrove crabs made holes in his pond wall. What materials can he best use to fix his pond wall?

Possible solution:

- Important is that the farmer should never use pond sludge from the pond bottom to repair the pond wall. Instead, the farmer should look for clean uncontaminated soil with the same profile as the soil in the pond walls, and use this instead.

Exercise: Spreading of disease

This exercise shows how fast an infectious disease can be spread especially when animals are contained in closed spaces.

The trainer first explains the exercise to the trainees: At first, all trainees close their eyes and the trainer picks one trainee from the group that will be infected with a disease by shaking his/her hand. Then all trainees can open their eyes and will start to mingle. When they meet, they should shake each other's hand. The trainee that is infected must squeeze when shaking hands with another trainee. Now this trainee is also infected and in turn must squeeze when shaking hands from now on. And so on. This should be done for 30 seconds.

After the game ends, the trainer asks the trainees who is infected with the disease, which will be most, or possibly all, of the trainees.

The trainer can then use this as an example why hand washing is so important as well as footbaths in hatcheries.

Teaching Module 3: Water quality management

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Water quality parameters and monitoring
- Effluent management

Introduction

Water is a vital resource for aquaculture farmers and many parameters, including temperature, level of Dissolved Oxygen (DO), pH, ammonia, nitrates and the amount of solids, have an influence on the general wellbeing and health of the cultured fish. By testing these parameters, the farmer can get a clear indication of the water quality and suitability for the cultured fish. These test results also provide information about the on-going nutrient and waste cycle in ponds, as several of these parameters are interlinked. Additionally, incoming water is often infected with contaminants and pathogens that could harm the cultured stock and potentially consumers, making water management an important but complex topic.

Farmers should make sure that the incoming water at a farm is of sufficient quality for the production of fish that is safe for human consumption [(A)] and suitable for the cultured species. If needed, farmers should adopt measures to further improve the quality of incoming water and to maintain the quality during storage. Measures should be adopted to promote efficient water management and use, as well as proper management of wastewater (effluents) to reduce the impact of the farming operation on surrounding terrestrial and aquatic resources and environments [(A)].

Good Aquaculture Practices

Water quality parameters & monitoring

1. *Incoming water should be of sufficient quality and volume throughout the year*

A source of water should be selected that is located at a sufficient distance from major polluting sources. Farmers should take into consideration that many water resources decline in quality during the dry season. While polluting sources continue to pollute the water at a similar rate during the dry season, the amount of water available in which this pollution is diluted has declined, resulting in a decline of overall water quality. To prevent this from impacting the fish farm, water usage should be properly planned ahead, and incoming water sources should be selected that provide clean water throughout the year. Incoming water quality (ground water, surface water or marine water) should always be tested before use.

2. *Incoming water should be properly screened and settled before use*

Incoming water often contains a large number of small solid particles that can have an influence on the water quality and turbidity. Incoming water often brings in animals like snails and predatory fish. By screening intake water, these animals are prevented from entering the farm. By giving the incoming water time to settle in a designated pond, most solid particles will sink to the bottom, thereby significantly improving the quality of the water for use in the culture ponds or tanks. If after this

process the water is still not suitable to be used, it should be thoroughly filtered, using for example a sand filter or bed filter. Unsuitable water should be discarded.

3. *Only designated ponds and appropriate tanks can be used as storage reservoirs*

After incoming water has been screened and settled, it should be stored properly to prevent re-contamination from external sources. For this reason, settling ponds cannot be used as reservoir. Instead, designated reservoirs are recommended for this purpose, preferably with a liner in place to avoid contamination from the soil or ground water. For hatcheries and nurseries, it is recommended to use large concrete tanks as reservoirs. These tanks should be covered and protected from insects and pests. Staff access to reservoirs should be limited.

4. *Water quality of intake and culture water should be regularly tested*

After screening and settling, the incoming water needs to be tested to make sure it meets national criteria and the required parameters for the cultured species [(A)]. Parameters that should be tested include DO level, temperature, pH, and ammonia levels. What is often forgotten by farmers is that these parameters should be within the range of the water in which the fish are kept, as for example sudden changes in temperature and pH will shock the fish, and can result in mass-mortality.

Since water quality within aquaculture ponds or tanks strongly influences the health of the fish and consequently, the success or failure of a fish farming operation, pond water should be regularly tested. Marine and freshwater farms operating cages or pens should also monitor the water quality. When a parameter is outside of the optimal range, mitigating measures should be taken.

5. *Testing equipment should be regularly calibrated and validated, and should only be operated by qualified employees*

If the equipment for testing is not reliable, or if the employees that have to use the testing equipment and read the results are unfamiliar with this task, the testing results are unreliable. It is thus important to calibrate testing equipment regularly. To further verify the reliable of the company's equipment and testing procedures, it is recommended to also regularly perform water quality analysis through an external laboratory, these results can be compared to the internal results of the farm. Only employees that have been trained in applying the proper procedures should be allowed to perform water testing procedures and interpret results.

6. *Water resources should be used efficiently*

Around the globe, freshwater resources are becoming an increasingly limited resource and no water should be wasted or unnecessarily polluted during production.

Effluent management

7. *Effluent water should be of sufficient quality to minimise impact on the surrounding environment*

Untreated wastewater is full of organic materials (e.g., uneaten feeds, faeces etc.) and pathogens. When this water is released untreated into public canals or other waterways, it will contaminate these public aquatic resources and degrade the surrounding ecosystem. This would also have serious negative consequences on nearby villages and neighbouring farms as pathogens rapidly spread.

Farmers should avoid this by making sure all outgoing wastewater has been settled and screened before release. When deemed necessary it should be filtered as well. The quality of the wastewater

should be verified by testing to ensure it meets national criteria from the competent authorities before discharging. Depending on the local rules and regulations, wastewater might only be released with permission from the local authorities. In some places, wastewater may only be released during a certain time of the year, and in a coordinated manner to avoid cross contamination between farms.

8. *Wastewater should not be released into sensitive natural habitats or protected areas*

Mangroves play an important role as fish nurseries, nutrient recyclers, carbon sink and as buffers against waves and storms. Natural wetlands are an important refuge for birds and other wildlife. Both of these habitats provide resources that are important to local communities. They also play a critical role in absorbing excessive water during heavy rains, thereby preventing flooding in surrounding areas. Polluting these areas through the release of wastewater that contains excessive organic materials and other contaminants (such as antibiotics, and disinfectants) results in eutrophication. This in turn affects the local species composition and productivity, thereby reducing the benefits for local communities.

9. *Saline wastewater should not be discharged in areas where public freshwater resources and groundwater resources could be contaminated*

When pumping brackish and marine water land inwards, and discharging it at a later stage as wastewater, public freshwater resources are affected. Currently only 3% of all the water on our planet is freshwater and the salt contained in the wastewater will make the freshwater unusable. This should be prevented, and farmers should never discharge brackish or marine waters in areas where public freshwater resources and groundwater resources could potentially be contaminated.

Training aids

Videos

Water management – web link: https://www.youtube.com/watch?v=fo9Ap7hgnFQ

The video discusses water management principles for tilapia farming operations in Egypt and repeats most of the GAqP discussed in this Teaching Module. Giving trainees a visual overview of important criteria during site selection helps them in memorizing the content of the module and it gives the trainer the opportunity to clarify any remaining questions.

Water quality measurements – web link: https://www.youtube.com/watch?v=tV8nNNBFX9E

The video discusses the importance of taking water quality measurements, it also explains the basic water parameters, and basic sampling procedures used in tilapia farming operations in Egypt are demonstrated. This video gives trainees a visual overview of basic procedures that can be used for future reference.

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Bad practice	Good practice
Incoming water	Using untreated water from a public canal in which other farms are discharging their wastewater is not advisable. This water is most likely full of	Farms should separate intake and outlet canals, and only use clean water from canals or wells. To limit the chances of contaminants and pathogens

	pathogens and other contaminates that will cause harm to the cultured fish.	causing harm to the farmed fish, it is also advised to screen and settle all incoming water.
Water testing	A hatchery uses water from a local spring that looks and does not smell bad. Since the water looks so clean the hatchery does not test the water. This is risky since the water quality cannot be verified through visual inspection only.	A hatchery owner uses a local spring for his incoming water and he tests this weekly. By doing this he can assure the water is of sufficient quality and he can continue to assure to health of his cultured fish.
Wastewater	A farm is located next to a large area of coastal mangroves. The farm discharges its untreated wastewater directly into the mangroves. This is not advisable since it will most likely cause eutrophication in the mangrove area and disturb this sensitive habitat.	A farm settles and screens all wastewater before discharge, so that most pollutants are removed from the water. The farm owner also tests the quality of the water before discharging it. He then discharges the water in a public canal meant for wastewater and with approval from the local authorities. By doing so, he minimises the negative impact of his waste water on the surrounding environment and on public aquatic resources used by the neighbouring community.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Incoming water	A land-based farm located near the coast is planning to culture groupers. The farm is investigating if the local waters are of sufficient quality to use and meet the parameters required for this species. How should the farmer proceed? *Possible answer:* The farm should first contact experts at the country's competent authority to ask about the exact requirements for the grouper species he is planning to culture. He can then continue to investigate the local water parameters using quality equipment, or he can hire a professional laboratory to help him with the matter. If the results match the requirements of the species, the farm can continue with planning his project.

Water testing	Two neighbouring farms both daily test the temperature, salinity and ammonia levels of the incoming water for their backyard prawn hatcheries. Each uses their own testing equipment and although they use the same water resource, the test results are very different. What can have happened? *Possible answer:* The testing equipment is not functioning properly and most likely one of the farm owners has not calibrated his testing equipment.
Water storage	Why should settling ponds not be used for water storage? *Possible answer:* Settling ponds are used to settle the water, and to let possible contaminants sink to the bottom of the pond. By storing the water for longer periods of time in these settling ponds, the water might be re-contaminated by the contaminants at the bottom of the pond.
Effluent water	What can a farmer do to ensure that the effluent water from ponds is of sufficient quality to release in the river? *Possible answers*: Settle and screen the water, check water quality before releasing, responsible use of feeds and fertilisers, avoid erosion of pond embankment (vegetation, no livestock on farms, do not use pond sediment for pond repair), reduce water exchange as much as possible, provide storage for overflow during heavy rain.

Practical activities

The trainer can use the following practical activities during or at the end of the module to promote interaction with the trainees and to further enhance the learning value of the trainees through practical examples.

Group discussion: Testing water parameters

This practical activity focuses on letting trainees share their own procedures for the testing of water parameters. The practices that are shared are then used as a starting point for the development of a set of best practices to test water parameters, with which all trainees agree. These best practices can be best written down on the whiteboard in the classroom.

Guidelines for the discussion:

Intensity: Water quality parameters are ideally monitored every day in the morning, at a similar hour. This is done because many parameters tend to change once the pond or tank heats up during the day.

Equipment: Testing equipment should be from a reliable manufacturer. Please note that such equipment is not necessarily expensive, simple dripping test kits or test strips from reliable manufacturers can for example be bought for $US 5 to 10 per kit.

The following water quality parameters are recommended to be monitored, and should be discussed with the trainees:

The *temperature* determines the level of activity in the fish. For the optimum growth of most species in Southeast Asia a range of 24°C to 32°C is recommended. The temperature can be measured using a handheld thermometer.

The *Dissolved Oxygen (DO)* level in the water is critical to support life, and becomes especially important when working with higher stocking densities. A level of between 5.0 to 8.0 milligrams per litre (mg/L) is recommended. Normally, a digital meter with a DO sensor is used to measure this parameter. Alternatively, manual test kits are also available for measuring DO.

The *pH* is influenced by many factors and although most fish can survive a wide range in pH, it is recommended to keep the culture environment within a range of pH 6 to 8. The pH can be measured using pH strips that are readily available and inexpensive.

Water transparency gives an indication of the amount of suspended solids in the water column. The level of transparency influences pH and ammonia levels, but also tells you something about the amount of available algae for the cultured stock. The water transparency can be measured using a so-called Secchi Disk. It is recommended to measure the transparency in the shadow, and as a general rule of thumb to maintain a transparency of 20 – 30 centimetres throughout the water column.

Ammonia can be toxic to the fish and high ammonia levels normally indicated large amount of organic materials, like uneaten feeds and faeces are decomposing at the bottom of the tank or pond. Ammonia is present in two forms, un-ionised NH_3 which is highly toxic, while ionised NH_4+ is less toxic. Above concentration of 0.1 – 0.2 mg/L ammonia can already become toxic. Ammonia can be measured using a simple dripping test kit or by using test strips.

The trainer then asks the trainees what to do when a water quality parameter is outside of its optimal range in tank and pond systems. The trainer can use the table (for tilapia species) below for guidance.

Observation	Possible measures
High temperature (>32°C)	• Exchange water
Low dissolved oxygen (<3.5 ppm AM, <5ppm PM)	• Increase water exchange • Stop feeding until corrected • Watch for symptoms of parasites/disease • Increase aeration (or beating/stirring of water-moving water increases DO)
Low pH (<6)	• Add alkaline buffer (sodium bicarbonate, lime) • Reduce feeding rate • Check ammonia concentration
High ammonia (TAN >0.25 mg/l) or pH higher than 9	• Exchange water • Reduce feeding rate • Watch for symptoms of parasites/diseases
Transparency too low (<30cm)	• Exchange culture water • Reduce feeding rate • Watch for symptoms of parasites/diseases
Dark green or dark brown colour	• Exchange water • Reduce feeding rate • Measure DO

Exercise: Testing pH in water

For this exercise a pH test kit is required plus a few water samples (for example from the tap, and if possible, from a fish pond). The trainer should demonstrate the procedure of the test following the instructions provided by the manufacturer. After the demonstration by the trainer, a couple of trainees can carry out the test as well. A good question to start further discussion with the trainees, is to ask them if the test always generated the same results.

Teaching Module 4: Feed management

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Origin and quality of feed and feed additives
- On-farm feed production
- Feeding practices
- Feed storage

Introduction

Feeds can be contaminated through contaminated feed ingredients, or by external contaminants when feeds are stored inappropriately or for too long. Common feed contaminants include veterinary drug residues, heavy metals (like mercury and lead), chemicals used for cleaning and pest control, pathogens like salmonellae, and toxins such as aflatoxins and mycotoxins. These contaminants negatively affect the health and wellbeing of the cultured fish, and many of these contaminants can also pass along the food chain and cause harm to consumers.

The quality of the feed plays an important role in ensuring optimal growth rates and in determining the quality and food safety of the produced fish. The quality of the feed can be assured and maintained by paying close attention to the origin of the feed and feed ingredients, and by following appropriate storage and feeding protocols.

Good aquaculture Practices

Origin and quality of feed and feed additives

1. *Aquaculture operations should use feeds and feed additives that do not contain unsafe levels of biological, chemical and physical contaminants or other adulterated substances* [(A)]

Farmers should only acquire feeds and feed additives from reliable producers and suppliers that are able to guarantee the quality of feed. For this purpose, it is recommended that farmers only acquire feed and feed additives from commercial feed producers that have been registered and approved by the competent authority [(A)].

2. *All feeds should be properly labelled following requirements set by the competent authorities*

To be able to verify if farms use commercial feeds that have been approved by the competent authority, all feeds should be properly labelled. The label should include details on the composition of the feed, batch number, recommended storage conditions, expiry date, feeding rates, and other necessary guidance in an adequate language. The label should also include the name and contact details of the manufacturer, so that the feeds can easily be traced back to the source.

3. *Fresh and frozen fish should only be used if in an adequate state of freshness*

Fresh or frozen fish or trash fish are used by some farmers to feed broodstock that are not weaned on pelleted feeds, and to boost the health of broodstock during egg maturation. When fish are no longer fresh, they start decomposing. The bacteria responsible for decomposition can harm the wellbeing of the broodstock and can indirectly also reduce the quality of the maturing eggs. To maintain the health of the broodstock, it is important to assess the quality of the acquired fresh and frozen fish, and to only use fish that is of sufficient quality.

On-farm feed production

4. *Only approved feed ingredients should be used*

All ingredients that are used for the preparation and manufacturing of feed on the farm must be free from prohibited substances [(A)]. Farms that engage in on-farm feed production should take extra care that the ingredients they use are of sufficient quality, have been approved by the competent authorities for the use in aquaculture feeds, and have been purchased from a reliable supplier. Farmers should always be able to trace these ingredients one step back in the supply chain, to their supplier.

5. *The preparation area for on farm feed production should be kept clean*

An area should be assigned for feed production and mixing. To prevent cross-contamination this area should be solely used for this purpose and should be kept clean at all times. The area should also be protected from entry of pests (e.g. rodents or insects).

6. *When using fish silage and offal as feed or feed ingredients these should be properly prepared and thoroughly cooked first*

Fish offal and silage are often used as feed ingredients and to feed broodstock. To assure the quality of these body innards and body parts, these should always be cooked thoroughly before being used as feed.

Feeding methods

7. *Feeding practices need to be in place that take into consideration the efficient use of resources*

To maximise feeding efficiency, feeding practices should take into consideration a large number of factors that determine how much feed is being fed, how often the stock is fed, and at what time during the day. Factors that need to be considered include the cultured species, the life stage and age of the cultured fish, water quality parameters, and weather conditions. Feeding practices should also target optimal Feed Conversion Ratio's (FCR) for the specific species. The feeding method can also influence feed efficiency and targeted feeding at routine intervals and fixed positions in a cage, pond or tank is advised. Together, these practices reduce the amount of feed needed per production cycle, ensuing in less pollution in the ponds or tanks, and lower feed expenses for the farmer.

8. *Feeding practices should not compromise the quality of the culture water or sediment*

To maintain the health of the culture fish, feeding practices should not compromise the quality of the culture water or sediment. Feeds should be used responsibly to minimise their adverse impacts on the environment [(A)]. The daily feed requirements should be calculated depending on the feed

specifications, cultured species, biomass and size of the fish to ensure the right amount of feed is used. It is recommended to feed smaller amounts multiple times a day, versus a large amount of feeds once a day. Late afternoon feeding without the support of additional aeration is not recommended, as it will decrease the DO levels of the water.

9. *When using medicated feeds, their application should be outlined in the farms feeding procedures*

The use of medicated feeds requires expert supervision and monitoring of the stock, because potential residues of veterinary drugs can remain present in the tissue of the cultured fish. As such, the use of medicated feeds, and their application, should be outlined in the written feeding procedures of the farm.

Feed storage

10. *Feeds should be stored in a way that does not compromise their quality*

Foremost, feeds should be stored indoors in a designated area. In this area the feeds should be stored in a way that allows sufficient ventilation between the bags of feeds, this prevents the spread of moulds. This approach also allows for easy inspection so that employees can easily inspect the status of the stored feeds. Feeds should never be stored directly on the floor or in direct contact with the walls.

Feeds should be stored in such a way that makes the use of the "First In, First Out" system possible. This can be achieved by sorting bags according to their expiry date, and by arranging the labels of bags uniformly on one side. Doing this enables employees to easily check the expiry date and first use feeds that expire first.

11. *Different feeds should be allocated in separate sections of the storage area*

Allocating different feeds in separate sections of the area designated for feed storage helps employees in quickly allocating the right feed type and feed size. Doing this also minimises the time employees spent in the storage room, and contributes to keeping the room clean and hygienic. When storing medicated feeds in the same room, these should be stored separately as well. Medicated feeds should also be clearly marked to avoid employees mistakenly using medicated feeds to feed healthy fish.

12. *Fresh and frozen fish for feeding purposes should be stored under appropriate conditions*

Frozen or fresh feeds should always be kept under appropriate conditions to prevent spoilage. As such, frozen fish should be stored in a freezer for short and long periods, while fresh fish should be stored in a refrigerator, but for a short period only. This should always be done under hygienic conditions, properly bagging the fish in small volumes.

Training aids

Videos

Fish feeding – web link: https://www.youtube.com/watch?v=nafty5ajgQs

The video discusses feeding practices for tilapia farming operations in ponds and repeats most of the content presented in GAqP 7 of this Teaching Module. Giving trainees a visual overview of important

aspects of feeding practices helps them in memorizing the content of the module and it gives the trainer the opportunity to clarify any remaining questions.

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples**.**

GAqP topic	Bad practice	Good practice
Feed origin	A farmer has been offered local pellet feeds for an excellent price. These feeds come in professionally looking bags, but without any label. It is not advisable to acquire and use such feeds since their origin cannot be verified. The farmer will also not know which ingredients have been used in the production of this feed. He thus cannot be sure if the feeds are appropriate for the species he is culturing. The farmer also does not have information on the recommended FCR and feeding protocols, nor does he know when the feeds will expire.	A farmer buys pelleted feeds from a local feed manufacturer that is registered with the competent authorities. The bags with feed contain a label that indicates the composition of the feed, batch number, recommended storage conditions, expiry date, feeding rate, the name and contact details of the manufacturer, and other necessary guidance in an adequate language. The farmer now has all the required information that he needs to feed his fish in a responsible way.
Feeding practices	A farmer was sick for one week and he has been unable to feed his fish. Since fish look very hungry the farmer decides to feed the volume of feed he normally uses in 5 days, in one time. This is not advisable as the fish won't be able to eat all this feed in one time. Instead the feeds will sink to the bottom of the pond and deteriorate the water quality. This in turn might harm the health of the cultured fish.	A farmer was sick for one week and he has been unable to feed his fish. Since his fish look very hungry, he decides to give his fish a little bit of extra feed, every day for a period of 4 days. By following this systematic approach, the farmer makes sure all the feeds will be eaten by the fish and the water quality will not deteriorate.
Feed storage	A sea bass farm uses 3 sizes of pellets from one brand during the nursery stage. The feed storage room of the company	A sea bass farm uses 3 sizes of pellets from one brand during the nursery stage. The feed storage room of the company

	is badly organised and bags with different sizes of feeds are all mixed. This is not advisable as staff will easily grab a bag with the wrong feed size. Feeding a wrong pellet size will decrease the feeding efficiency of the farm and will result in higher costs for the farm owner.	is well organised; bags are sorted in 3 piles, one pile for each pellet size. This practice ensures employees will not easily make a mistake when selecting the appropriate pellet size, this in turn ensures that the feeding efficiency is maintained.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Fresh and frozen fish	Why is it important to only use fresh fish for feeding purposes? *Possible answer:* Older fish that are decomposing are full of bacteria and possibly other pathogens. These bacteria and other pathogens will reduce the health of the broodstock.
Feed storage	Why is ventilation important for the storage of feeds? *Possible answer*: One of the main reasons for declining feed quality during storage is insufficient ventilation. This results in the growth of fungi and moulds. Some of these moulds produce toxic substances called *mycotoxins*. These *mycotoxins* harm the wellbeing of fish, stun their growth, and can cause mass mortality.
Feeding practices	What is wrong with excessive feeding? *Possible answer:* Feeds that are not consumed by the fish will end up on the bottom of the pond or tank. Feeds contain many nutrients and when left uneaten start decomposing. When these nutrients are dissolved into the water column, they act in a very similar way as fertilisers. This process of decomposition requires oxygen, thereby making less oxygen available for the fish, it also increases the level of ammonia. For these reasons it is very important to implement appropriate feeding protocols and to calculate daily feed requirements correctly.

Practical activities

The trainer can use the following practical activities during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Group discussion: Verifying feeding practices

Farmers often developed their own unique feeding practices based on experience and advice from other local farmers. However, to maximise feeding efficiency, and to ensure the efficient use of resources, more uniform and well deliberated feeding practices are needed.

The goal of this activity is to engage in a group discussion with the trainees on developing a feeding protocol for a species that is commonly farmed in their area (e.g. carp, tilapia or pangasius). Once the species has been selected, trainees need to give inputs on elements that they would include in the written feeding practices for this species. The answers should be written down on the whiteboard.

Once the answers have been given, the trainer compares the results on the board with the list of factors that should be considered in the development of appropriate feeding practices. The list of factors that should at the very minimum have been considered includes: the type of feed and feeding instructions from the manufacturer, the cultured species, the life stage and age of the cultured fish, water quality factors and weather conditions. These feeding practices should also target optimal Feed Conversion Ratio's (FCR) for the specific species and the type of feeds used. The use of feeding systems and tools, like automatic feeders and feeding trays, should also be discussed.

The trainer then continues discussing potential differences in the outcomes and why certain factors were not considered. Ultimately, the goal is that all trainees understand and agree that all these factors should be considered and incorporated in the written feeding practices of the farm.

Exercise: Calculating feed quantity

In this exercise, the trainees will learn how to calculate the amount of feed needed per feeding for a certain pond or cage. The amount of feed is calculated as follows:

- *Calculate biomass*: Multiply the average body weight of fish (acquired through sampling) by the number of fish in the pond or cage
- *Daily feed needed*: Multiply the total biomass in Kilogram by the daily feeding rate (for grow out this usually is 3%, for hatcheries and nurseries this is much higher, up to 10-15%)
- *Amount of feed per feeding*: Divide the daily feed requirement by the amount of feedings per day.

The trainer then presents a simple case study to the trainees, and ask them to calculate the amount of feed per feeding time:

Average body weight of fish: 100 gram
Number of fish: 500 pieces
Daily feeding rate: 3%
Number of feedings per day: 3

Answer:
Average body weight sampling of fish: 100 gram Number of fish: 500 Pieces
100 gram x 500 pieces = 50,000 gram /1,000 = 50 Kilogram
3.0% = 0.03 50 Kilogram x 0.03= 1.5 Kilogram
Amount per feeding: 1.5/ 3 = 0.5 Kilogram

Teaching Module 5: Management of chemicals and veterinary drugs

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- The use of chemicals and veterinary drugs
- Storage and transport

Introduction

Many chemicals and veterinary drugs can permanently accumulate in fish tissue and present a potential health hazard to both the cultured fish and consumers. Substances that permanently accumulate are therefore not allowed to be used in the aquaculture production of food fish. Even when using legally allowed veterinary drugs and chemicals, these still can negatively affect the health and wellbeing of the cultured fish and the consumer if used, stored, or transported incorrectly. Therefore, these activities should follow strict practices in accordance with applicable national legislation or relevant international agreements that ensure effectiveness for animal health, while also taking the safety of the public and the protection of the environment into consideration. As such feed additives, chemicals, veterinary drugs should be used responsibly to minimise their adverse impacts on the environment [(A)].

Good Aquaculture Practices

The use of chemicals and veterinary drugs

1. *All veterinary drugs and chemicals for use in aquaculture should comply with national regulations and international guidelines. If veterinary drugs and chemical treatment is necessary, only registered veterinary drugs and chemicals should be used and the instruction on the manufacturers label should always be followed* [(A)]

It is important that farmers only acquire veterinary drugs and chemicals that have been authorised for use in the production of food fish. In case the cultured fish are planned to be exported, the veterinary drugs and chemicals allowed for usage in aquaculture also depend on the country where they fish will be exported to. The instructions provided by the manufacturer should always be followed. Special focus needs to be given to accurate dosing, as low dosing could render the treatment useless, while excessive dosing will result in higher residue levels and can potentially harm the cultured fish. The expiry date of the product should be checked as well, as active substances might become less effective after their expiry date has passed.

Substances of which the residues are only present temporarily are normally allowed for use in aquaculture. The time for the residue to withdraw from the tissue of the treated or exposed fish is called the withdrawal time. Manufacturers specify official withdrawals times for individual substances, and these can be found on the label of the product. The withdrawal period is set so that it is long enough to ensure that medicinal residues in the tissue of the fish are below the maximum limit. Fish should not be harvested before this official withdrawal time has passed.

Withdrawal time and Maximum Residue Levels (MRLs) are the two most commonly used "rules" for safe usage of chemical substances. MRLs specify the maximum levels of specific residues that can be present in the fish when harvested and sold. Fish that have been treated with veterinary drugs, or that are known to have been exposed to chemicals that could leave behind residues, should always be tested to check for MRLs before harvest. If the tested fish exceed these MRLs, they cannot be harvested or sold, and the farmer should wait until the residues have withdrawn further.

2. *All veterinary drugs, medicated feeds, and other chemicals should be clearly labelled*

To make sure farmers are able to use veterinary drugs and other chemicals correctly, it is important that the labelling on these products is complete and presented in an adequate language. At the very minimum the label should include clear information on the name of the product, active substances, target animal species, storage conditions, prescribed dosage, route of administration, expiration date and withdrawal periods. The name and contact details of the producer should also be included, so that the substance can be traced back to the producer.

3. *Farmers should never use veterinary drugs prophylactically*

Farmers should not add veterinary drugs, including antibiotics, to the feed or to their ponds or tanks in an effort to keep their healthy fish disease free. This practice is referred to as the prophylactic use of veterinary drugs. Farmers often believe that by using these veterinary drugs prophylactically, the proliferation and spread of diseases will be minimised, while actually the opposite is true. When farmers regularly apply small dosages of veterinary drugs through feed or to the culture water, the bacteria that are present in this water get used to these veterinary drugs, and become immune to the effects of these drugs. We refer to such bacteria as antibiotic resistant bacteria.

When fish are infected with resistant bacteria, they cannot be treated with regular veterinary drugs and antibiotics. Worse, these resistant bacteria can also make humans sick. Humans infected with antibiotic resistant bacteria are also resistant to any treatment. Because of inappropriate and excessive use of antibiotics in Asia, a new strain of tuberculosis is now quickly spreading across the continent, this strain of tuberculosis cannot be treated. As such farmers should never use veterinary drugs prophylactically.

4. *Veterinary drugs and chemicals should only be administered by authorised staff or qualified fish health experts*

Since the administration of veterinary drugs needs expertise, only authorised staff that have been trained properly can administer these drugs and be responsible for the monitoring of the recovery process. If veterinary drugs require a prescription, e.g. antibiotics in most AMS, these should only be administered under adequate supervision by a qualitied fish health expert.

Storage and transport

5. *Veterinary drugs and chemicals should be properly stored and transported*

Since veterinary drugs and chemicals can become less effective and inactive as a result of inappropriate storage conditions, farmers should always follow the storage instructions specified by the manufacturer on the label. Many veterinary drugs, for example, need to be stored under refrigerated or in dark conditions, if these requirements are not met the substance quickly becomes ineffective. The same is applicable to transport conditions, and these should always be executed conforming the instructions of the manufacturer.

Training aids

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Bad practice	Good practice
Origin of veterinary drugs	A farmer from the Philippines is in the possession of a bottle of veterinary drugs from Thailand. He was told that this medicine is very effective against fin rot but the instructions on the label are in the Thai language. The farmer should not use this veterinary drug since he is not able to read the Thai language. Thus, he cannot follow the instructions provided by the manufacturer. Neither does he know if the veterinary drugs have been approved in the Philippines for the use in aquaculture of food fish.	A farmer from the Philippines has a list with all the veterinary drugs approved for the use in aquaculture for food fish in the Philippines from the competent authority. He has selected the appropriate veterinary drug to treat fin rot from the list and has contacted an approved supplier. The supplier provided him with a bottle of this drug and the label contains clear instructions in English and Tagalog. Now the farmer can safely treat his fish against fin rot, without worrying about any negative effect that the drug might have on his fish or consumers.
Prophylactic use of drugs	A farmer has a large crop of fish and they only need to grow two more weeks before harvesting. The farmer is worried that his crop might become sick and he decides to daily add some antibiotics to his pond, in the hope of preventing this from happening. The farmer should never do this as he is actually promoting the development of antibiotic resistant bacteria that might harm both his current and future crops. Also, by using veterinary drugs just before harvesting, the fish might contain high levels of residues from the antibiotic treatment.	A farmer has a large crop of fish and they only need to grow two more weeks before harvesting. The farmer is worried his crop might become diseased and decides to strictly follow the biosecurity protocol of his farm to minimise the changes of a disease outbreak. Among others, he carefully monitors and controls the quality of the incoming water used in his ponds, he minimises access of visitors to his farm, and he uses high quality feeds with vitamins to keep his stock strong and healthy. He also monitors his stock on a daily basis so he can

		take appropriate actions when needed.
Storage of veterinary drugs	A farmer has bought an authorised veterinary drug to treat fungi on his mullets. The instructions provided by the manufacturer state that this veterinary drug should be stored in a refrigerator at all times. However, the farms' refrigerator is broken and instead he decided to store the medicine in a shaded room in his house. The farmer should not do this as the effectiveness of the veterinary drugs is most likely reduced by storing it inappropriately. It might even be possible that the veterinary drugs is no longer useable.	A farmer has bought an authorised veterinary drug to treat fungi on his mullets. The instructions provided by the manufacturer state that this veterinary drug should be stored in a refrigerator at all times. The refrigerator of the farmer is broken, and he stores the drugs in the refrigerator of his neighbour instead. He makes sure he follows the instructions of the manufacturer. By doing this, the farmer ensures that the quality and effectiveness of the veterinary drug is maintained. When treating the infected stock, he has a good chance his fish will recover.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Authorization of veterinary drugs	Why is it important that the competent authority gives permission for veterinary drugs to be used in the production of food fish? *Possible answer:* Most veterinary drugs and chemicals leave behind residues in the tissue of fish exposed to these substances. These residues can be harmful to both the cultured fish and consumers, and their use needs to be controlled by the competent authority.
Administered by authorised staff	To prevent mistakes, veterinary drugs should only be administered by authorised staff. What kind of mistakes could possible occur during the administration of veterinary drugs? *Possible answer:* The dosage of a veterinary drugs is almost always dependent on the weight of the fish and should be carefully calculated. The mode of administration is also important since some drugs are mixed with feeds, while other needs to be injected into the tissue of the fish, or added to the culture water. Thorough understanding and experience in these

	topics are needed to prevent mistakes and to maximise the efficiency of the treatment procedure.
Storage and transport	Why can veterinary drugs become unusable if stored wrongly? *Possible answer:* Many veterinary drugs contain active ingredients that can spoil, similarly to the spoilage of fresh foods. To maximise the shell life of such veterinary drugs, these should be stored properly.

Practical activities

The trainer can use the following practical activities during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Group discussion: Labelling of veterinary drugs

This discussion focuses on the importance of following the label and information provided by the manufacturer. It is advised that the trainer keeps this discussion during the presentation on the management of veterinary drugs and chemicals, and before the slide on the importance of labelling.

Farmers often value past experiences with veterinary drugs, and advice from befriended farmers, over the instructions provided by the manufacturer. As such the trainer starts out with asking the trainees why they believe it is important to follow the label of the manufacturer? Or do they maybe find it more important to follow advice from befriended farmers? The trainer then continues with asking the trainees what information should exactly be recorded on the label, and on other instructions provided by the manufacturer? The answers given by the trainees are then recorded on the whiteboard.

The trainer continues with presenting the PowerPoint slide on the reasons for labelling, and the exact information that should be included on the label. Differences between the answers on the whiteboard, and the reasons provided in presentation slide are then discussed. Ultimately the goal is that all trainees understand, and agree, that all the mentioned data elements should be included on the label, and most important that these instructions are adhered to by farmers.

Exercise: Labelling

For this exercise the trainer should divide the group into small groups of 4-5 trainees. Each group is asked to design a label for a veterinary drug of their choice. The label can be for a fictional medicine and the group can come up with a name, and what disease it treats. The label should include all the required information that the trainees have learned during this Teaching Module.

When all groups are finished with the design of their label, they will be asked to swop labels with other groups and review the work of their colleagues.

The trainer should check if the labels contain the name of the product, active substances, target animal species, storage conditions, prescribed dosage, route of administration, expiration date and withdrawal periods. The name and contact details of the producer should also be included.

Once the labels are reviewed, the results are discussed with the whole group and relevant feedback is discussed.

Teaching Module 6: Fish health and disease management

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Species selection
- Layout and design principles
- Broodstock
- Seed stock
- Health management
- Disease management
- Handling of mortalities

Introduction

Farms often struggle with combatting diseases as this requires an integrated approach, meaning that all farm activities have an impact on the health and wellbeing of the cultured fish. Ensuring that the cultured fish remain healthy requires the implementation of GAqP along all steps of the farming process, and in all farm departments. This starts with proper site selection, acquiring strong and healthy seed stock and broodstock, and also includes using quality feed and appropriate feeding protocols during the grow-out stage, avoiding high stocking densities, and implementing strong biosecurity protocols across the farm.

It is recommended that farmers take into consideration that aquatic animal health management programs should take place in accordance with the relevant provisions in the OIE Aquatic Animal Health Code. This will prevent the introduction or transfer of diseases and infectious agents pathogenic to aquatic animals, while avoiding unwarranted sanitary measures [(A)].

This Teaching Module focuses on the direct measures that are needed to maintain the health of the fish, including proper monitoring and control, and measures that need to be taken when a disease has been diagnosed positively for a particular pathogen.

Good Aquaculture Practices

Species selection

1. *Select the right species for the farm*

When selecting a species for culture, environmental preferences of the species, growth rates and market demand should all be taken into account. If the environment is not suitable for the species,

this can have repercussion on the health of the fish. While a lack of market demand will result in low prices or with harvested fish that cannot be sold.

2. *Prioritize the culture of native species*

In case of escapee events, the farming of non-native species can have a considerable impact on natural ecosystems. Exotic species often outcompete or eat local species, which has resulted in the past in the extinction of native species. Hybridization with native species can also occur and this results in changes in the genetic structure of native populations. Exotic species should only be used when they pose and acceptable level of risk to the natural environment, biodiversity and ecosystem health. Where genetic material of an aquatic organism has been altered in a way that does not occur naturally, science-based risk assessment should be used to address possible risks on a case-by-case basis [(A)].

3. *Implement measures to avoid escapees*

To prevent escapees, farm structures should be checked regularly. Screens and barriers should be installed where escape risks are most likely to occur, such as nets at water in- and outlets. These screens and barriers should be regularly monitored and maintained.

Broodstock

4. *Broodstock should be healthy and from a reliable and authorised source*

Selecting healthy and strong breeders plays an important role in producing high-quality eggs and healthy and strong fry. Also, the source of broodstock should be such that it reduces the risk of carryover of potential human health hazards into the growing stocks [(A)]. All broodstock should come from an authorised source, and the hatchery should keep the contact details of the supplier for traceability purposes. The sourcing of wild breeders should not have any negative affect on wild populations, and wild breeders should have been caught with permission from the competent authority, using legal fishing methods only.

5. *New broodstock should first undergo a health assessment and should thereafter be quarantined*

Although new breeders might look healthy, this can only be verified by taking blood samples and samples of faeces, which then should be submitted to a certified laboratory for testing. New breeders should always be quarantined first in order to minimise the risk of cross-contamination. Only after the new breeders have acclimatised well, and all test results have come back negative, they can be transferred to the main section of the hatchery. It also recommended to give all new breeders individual tags for monitoring purposes.

Seed stock

6. *Seed should be healthy and should come from a reliable and authorised source* [(A)]

Farmers should focus on acquiring strong and healthy seed stock. These will grow faster and fewer fish are likely to succumb to diseases. The source of seed for culture (e.g. eggs, larvae, post larvae, fry, or fingerlings) should be such that it reduces the risk of carryover of potential human health hazards into the growing stocks [(A)], and farmers should only source seed stock from approved hatcheries and nurseries. It is also recommended to request a health certificate for the seed stock, and this health certificate should come from a reliable laboratory that has been authorized by the competent authority to perform these services.

Where possible, hatchery produced seed should be used [(A)]. It is recommended to avoid the use of wild seed stock as these could carry diseases, and because it is difficult to achieve uniform growth rates from wild seed. Also, many wild stocks are overfished, and sourcing wild seed would increase the pressure on these wild stocks. When wild seeds are used, they should be collected using responsible practices and, whenever applicable, in accordance with national laws and regulations.

7. *The use of hormones in seed stock should be carefully evaluated*

Farmers often treat seed stock from species like tilapia with hormones to encourage sex change. They do this because monosex male populations of these species attain better growth rates. An increasing number of scientists however believe, that treating fry and fingerlings with hormones, permanently damages their immune system (Ela 2018). This makes the fish, for their remaining life, more susceptible to diseases. As such, farmers should avoid the use of hormones, and instead use techniques like genetic selection or manual sorting, to achieve monosex populations of culture stock.

Health management

8. *Appropriate culture procedures should be implemented that safeguard the health and wellbeing of the cultured fish*

At all production stages, a culture environment should be maintained that is suitable for the cultured species. Doing this, also reduces the risks of introducing and spreading diseases along the culture stock. Management practices should be introduced to reduce the likelihood of disease transmission within and between aquaculture facilities and natural aquatic fauna, and reduce stress on animals for the purpose of optimizing health [(A)].

Farming protocols should optimise the utilization of resources by maximizing growth rates and survival rates. However, this should be done in a way that does not compromise health and welfare aspects. Focus should be on minimising stress experienced by the cultured stock. Stress can be caused by many factors including for example, high stocking densities, inappropriate water parameters, irregular feeding or low quality of the feed.

Another important way to reduce stress during culture is the regular sorting of fish, and separating fish that are too small or too big. Big fish outcompete smaller fish during feeding, causing stress to the smaller individuals. Bigger fish might also actively hunt the smaller fish, resulting in even more stress, and lowering the performance of the farm.

9. *Disease prevention through vaccination is recommended*

To keep fish healthy, vaccination should be considered. For many common diseases, including fin rot and Viral Nervous Necrosis (VNN), vaccines are available. These vaccines are injected or given orally and make the fish immune to the particular disease they are vaccinated for. Sometimes fry and fingerlings are already vaccinated at the hatchery, but often this is only done in larger fish (e.g. those that weigh 25 – 50 gram).

10. *Fish health and welfare should be closely monitored*

Routine monitoring of stock and environmental conditions should be carried out for early detection of fish health problems [(A)]. For this purpose, staff should be familiar with symptoms of common diseases for the species cultured. The best way to determine if the cultured fish are diseased or stressed is through regular monitoring and recording. Farmers should continuously record variables such as growth rates, survival rates, and the overall appearance and behaviour of the fish. Learning to recognise if the fish are behaving in a healthy and normal way, or if they are behaving abnormally and

are stressed or diseased, is key. Signs to look for include unusual behaviour of the fish (like swimming in circles, or floating upside down), physical damages, spots or swellings on the body. Healthy fish tend to swim actively and have a strong appetite. Proper monitoring also requires the regular sampling of fish, as many signs are best observed out of the water.

Disease management

11. *A systematic disease management policy and sufficient biosecurity measures should be in place to limit the manifestation and spread of diseases*

Besides proper health management, the proliferation and spread of diseases on a farm can be controlled through the implementation of a systematic disease management policy and by implementing sufficient biosecurity measures.

Once a disease has been diagnosed in some of the cultured fish, it is important to halt the disease and to try to restore the health of the affected fish. Simultaneously, the farmer should focus on controlling the spread of this disease among the remaining farm stock. To prevent diseases from spreading, diseased fish should always be kept in a separate quarantine area. This can be in separate ponds, or in cages located at a sufficient distance from the healthy stock. In situations where fish cannot be moved, the affected area needs to be sealed off and staff should be made aware of the disease outbreak. They should also be made aware of the location of the quarantined area, so that they do not accidentally contribute to spreading the disease further. Access to these areas should be limited to senior staff assigned to monitoring the diseased stock.

Disease treatments have been discussed in the previous module, but what is important to remember is to always use veterinary drugs according to the instructions provided by the manufacturer. Diseased fish, and those under treatment, should not be harvested or sold. Treated fish that no longer show signs of disease should be tested for MRLs before harvesting.

Fish that died during a disease outbreak, and fish that are too sick to recover (moribund), should be disposed of immediately. In case of a large disease outbreak with mass mortalities, the relevant authorities should be notified.

Handling of mortalities

12. *Dead and moribund fish should be handled and disposed of in a sanitary way*

The collection and disposal of dead and moribund fish should be handled properly, following appropriate hygiene procedures. There should be a designated storage area for dead fish before final disposal, and it should be possible to close this area off. In the event of a large disease outbreak with mass mortality, it is important to coordinate the collection and disposal of dead fish with the competent authority.

Training aids

Videos

Fish health care – web link: https://www.youtube.com/watch?v=Hxfc-NJfwWg

The video discusses measures to maintain and monitor fish health in tilapia farming operations and repeats most of the measures discussed in this Teaching Module under GAqP 8, 9, 10 and 11. Giving trainees a visual overview of the main measures on fish health helps them in memorizing the content of the module and it gives the trainer the opportunity to clarify any remaining questions.

Pond stocking - web link: https://www.youtube.com/watch?v=xmySy_TqlBA

This instructional video introduces the best practices for introducing fish seed into aquaculture ponds.

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Bad practice	Good practice
Seed stock	Collecting wild seed stock is not advisable since wild seed often contain pathogens. It is also more difficult to attain a uniform growth rate with wild stock. Wild seed stock tends to have very variable ages, and most likely originate from different parents, or even different localities. Lastly, seed stock of many species is overfished, and collecting wild seed would increase the pressure on their population further.	Buying hatchery bred seed stock from a registered hatchery is recommended. Hatcheries often provide farmers with a health certificate from a certified laboratory. Seed stock from a hatchery comes from uniform parent stock that have been selected for their favourable farming traits. The seed stock is of the same age, resulting in better and more uniform growth rates.
Broodstock	Buying large breeders that have been illegally caught with cyanide is not advisable. Illegal fishing methods, like the use of cyanide, are very destructive and will have permanent negative health effect on the broodstock. Most likely the breeders will die within a few days. Fishermen that are using illegal fishing methods should also not be rewarded for their practices.	Selecting some fast-growing fish from the company's grow-out department, and developing these into breeders is recommended. This practice might take longer, but will ensure the hatchery will have a group of strong and healthy breeders that will produce high quality eggs.
Health management	When fish are behaving strangely and might be diseased, it is not recommended to focus on feeding them with extra feeds in the hopes of improving their health, without taking any other measures. The diseased fish will most likely infect other fish in the pond.	When fish are behaving strangely and might be diseased, they should be quarantined immediately and monitored on a daily basis. It is also advisable to contact a fish health expert for a correct diagnosis of the disease.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Hormones in seed stock	What are the alternative ways of creating monosex tilapia seed stock? *Possible answer:* For smaller farms it is very feasible to determine the sex of individual fingerlings by hand, and sort them accordingly. For larger operations genetic selection is a possibility. Several companies produce so-called YY super males, which only produce male fry.
Appropriate culture procedures	How can stress be recognised in the cultured fish? What behavioural signs do we need to look for? *Possible answer:* It is not that easy to determine stress levels in fish. The most accurate way is to take blood samples and measure the levels of stress hormones, and compare these to the base level for the species in a non-stress situation. However, most farmers will not have access to such testing procedures. Behavioural signs of stress include reduced feeding behaviour and reduced growth rates, hiding of fish in corners of the pond or cage, and less vibrant and less active fish.
Disposal of dead fish	How should farmers dispose of dead fish? *Possible answer:* For smaller farms, it is possible to burn the fish immediately or to bury them in a hole with lime that is at least 50 centimetres deep. Larger farms should dispose of dead fish by using general waste services.

Practical activities

The trainer can use the following practical activity during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Group discussion: Disease symptoms

The goal of this discussion is for trainees to share disease symptoms that they have observed in their careers as fish farmers, and to see if these can be attributed to specific diseases. The trainer starts by asking the trainees if they have encountered any signs or symptoms of disease in their farm or neighbouring farms. What specific signs and symptoms of disease have they encountered, and could these be attributed to a specific disease? The answers should be recorded on the whiteboard.

The recorded symptoms are then compared with the list of common clinical signs of pathogens below:

- Fish are not hungry, or do not eat at all
- Fish are behaving lethargic and look weak

- Lesions or haemorrhages on the body
- Rotting section on the tail and fins
- Gills are damaged, discoloured, or contain parasites
- Reduced growth rates, or fish stop growing
- Strange swimming behaviour, including swimming in circles, swimming upside-down or alternating between speeds
- Gasping
- Cloudy eyes
- Swelling of belly
- White spots on the body
- Black spots on the gills

It is very difficult to attribute these symptoms to specific diseases because most diseases manifest a similar variety of the symptoms mentioned above. The results from the trainees should also indicate this, as trainees most likely attribute similar symptoms to different diseases.

The main lesson from this exercise is that there are many symptoms to look at when determining if a fish is diseased. To determine the exact disease is difficult, and it is always advisable to contact a fish health expert or veterinarian for a proper diagnosis.

Teaching Module 7: Harvest and post-harvest management

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Use of water and ice
- Harvest equipment, methods, and handling
- Storage and transport

Introduction

Fish often become contaminated or get damaged during harvesting and post-harvesting activities, resulting in a lower price for farmers and complaints from customers. Dirty tools and equipment are sources of contaminants as well as the lack of personal hygiene during harvesting and handling.

Contaminated ice and water are also a major concern during these activities. Water is used to clean the fish after harvesting, and it is often used to prepare ice slurry to cool down the harvested fish rapidly. Ice is also used to maintain a low temperature during storage and transport.

Another issue is time-temperature control. After the fish are harvested, they need to be cooled down to a temperature below 4^0C as soon as possible, to maintain their quality and prevent spoilage. After being cooled down the fish needs to be stored and transported at a similar temperature, without any significant temperature fluctuations. This is a challenge, especially in Southeast Asia, as the climate is rather hot, and because reliable sources of electricity to power cooling equipment are often hard to find.

Since harvesting and post-harvest activities are such a major source of contamination, the following GAqP should be implemented to minimise contamination and physical damage [(A)].

Good Aquaculture Practices

Use of water and ice

1. *Only clean water and ice should be used for harvesting and post-harvesting activities*

All water and ice used during harvesting and post harvesting activities should be clean and uncontaminated. Local water sources should be tested before use, and if the water turns out to be not of sufficient quality, it should be filtered and treated first. Ice should be bought from an authorised manufacturer that uses potable water. Also, water and ice should never be re-used.

2. *Clean water and ice should be stored appropriately*

Clean water and ice should be stored appropriately. It is recommended to use closed containers to prevent contamination, and to place these in a shady area, or to store them indoors in a cooled or refrigerated room.

Harvesting area, equipment, methods, and handling

3. *Harvesting and post harvesting activities should take place in an area that is kept in clean and hygienic conditions*

It is recommended that farmers designate a particular area of the farm for harvesting and post-harvesting activities. This area should be kept in clean and hygienic conditions at all times. For this purpose, it is important that wastes are stored appropriately, for example in large plastic containers that can be closed, and collected immediately after harvesting.

4. *Harvesting area, tools and equipment should be designed, operated and maintained in ways that prevent contamination from workers, sewage/toilets, domestic animals, machinery oil/fuel and other possible sources in order to maintain hygienic conditions* (A)

For this purpose, farmers should only design facilities and acquire tools and equipment that are easy to clean and sanitize. Practically this means that farmers should only use materials with smooth surfaces, like steel tables and plastic wares. When equipment is not being used, they should be stored in a suitable indoor storage area where the materials are not exposed to dirt and potential contaminants.

5. *Appropriate harvesting of aquaculture products within the farm should be practiced to minimise contamination and physical damage* (A)

During harvesting, only healthy fish that show no sign of disease should be harvested. If fish have been previously treated with veterinary drugs, they can only be harvested after the withdrawal time has passed, and MRLs tests show satisfactory results.

When harvesting fish, these should be bled and cleaned before slaughter. During the slaughtering process, fish should be stunned first, and handled as quick and as hygienically as possible. Fish should not come in direct contact with the soil, staff should wear face masks and gloves, and all staff should wash their hands before and after handling fish. Fish that are being harvested should always be treated with respect, without compromising principles for animal welfare. After slaughter, fish should be cooled down as fast as possible to a temperature close to that of melting ice. This can be achieved by using an ice slurry, which is a mixture of ice flakes and clean water. This mixture is much colder compared to ice flakes only. It is recommended to always use a thermometer to verify the temperature. Do note that ice slurry should only be used to cool down the fish and not to storage harvested fish in.

Handling, storage and transport

6. *Appropriate post-harvest handling of aquaculture products, including storage and transport activities, should be practiced to minimise contamination and physical damage* (A)

When storing and transporting harvested fish, similar measures as those during processing need to be taken. Again, all equipment and tools used during these activities should be easy to clean and sanitize. When these materials are not being used, they should be properly stored to prevent contamination.

To maintain the quality and food safety of the fish, these need to be handled efficiently and hygienically at all times. Time-temperature control is again very important at this stage, and it should be ensured that the fish are kept close to the temperature of melting ice at all times. During storage and transport, the fish should be stored in plastic containers that allow melted ice to drain. The fish should be stored in layers and each layer should be covered with and surrounded by ice flakes. The capacity of the cooling system should never be exceeded, or the fish might warm up and spoil.

7. *Appropriate handling and transport of live fish should be practiced*

Some farmers transport live fish, for example harvest size fish for restaurants that have display aquariums or distributing fry and fingerlings to farms. When storing and transporting live fish, it is important to use clean water and to slowly bring the temperature down a few degrees to minimise stress during transport. The temperature and water quality should be closely monitored and maintained throughout the transport. Live fish should always be transported without compromising animal welfare principles. Unless the fish species is an air breather, having additional oxygen supply is important to reduce stress and mortality during transport of fish and fingerlings.

Training aids

Videos

Fish harvest and post-harvest treatment – web link:
https://www.youtube.com/watch?v=HUraP73QxHQ

The video discusses harvesting and post-harvest procedures for tilapia farming operations and discusses most of the GAqP presented in this Teaching Module. Giving trainees a visual overview of appropriate harvesting techniques and procedures helps them memorizing the content of the module and it gives the trainer the opportunity to clarify any remaining questions.

Live fish handling – web link: https://www.youtube.com/watch?v=lUviiouv9gk

The video discusses procedures for handling, transporting and stocking live seed stock for tilapia farming operations and discusses the material presented in this Teaching Module under GAqP 7. Giving trainees a visual overview of important aspects of live fish handling helps them in memorizing the content of the module and it gives the trainer the opportunity to clarify any remaining questions.

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Bad practice	Good practice
Clean water and ice	A farmer uses water from a local canal to wash his fish after harvesting. This is not advisable as the fish might be contaminated.	A farmer filters water from a local canal using a sand filter and UV installation, before using this water to clean his fish after harvesting. These measures will help preventing contamination of the harvested fish.

Appropriate harvesting	During harvesting, a farmer takes his time to catch fish from his pond individually, using a scoop net. All the fish he catches are transferred into a bucket without water, leaving the fish to jump around. Harvesting fish one by one takes up a lot of time, which will likely deteriorate the quality of the harvested fish. Storing them in a bucket without water will damage and stress the fish, deteriorating their quality even further.	During harvesting a farmer uses a wide net so he can harvest all the fish from his pond in one time. He immediately stuns and bleeds the fish so that he can continue with the slaughtering process. Using an efficient and quick approach to harvesting will minimise stress and will also ensure that the quality of the harvested fish is maintained.
Transport of live fish	Transporting live fingerling in open buckets without adding ice and without taking other measures to maintain the quality of the transport water is not advised. This will stress the fish and could possibly cause mortality as well.	Transporting live fingerlings in double-layered plastic bags with some ice and medical oxygen ensures a high survival rate and satisfied customers.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Storage of water and ice	Why is it important to store ice properly, and how can this be done best? *Possible answer:* If stored under inappropriate conditions, clean ice could become contaminated, for example with dirt and bacteria. It is best to store ice in closed containers and to store these containers in a shady area or indoors in a cooled room.
Harvesting equipment	Why is it not recommended to use wooden tools and equipment during harvesting? *Possible answer:* Wooden equipment is not easy to clean and sanitize, as small pores in the wood allow bacteria and other potential contaminants to enter. When you touch a wooden crate and move your finger along the wood it does

	not feel smooth, unlike for example a crate made of plastic, which is smooth and easy to clean.
Storing fish	How long can you store freshly harvested fish in a cooler? *Possible answer:* When fresh fish are, immediately after harvest, kept at temperatures close to the temperature of melting ice (as close to $0C^0$ as possible), it can take 14 to 21 days before the fish start spoiling. However, as higher quality fish fetch higher prices, it is best to ship out the fish from the storage are in the farm within 24 hours after harvesting, and preferably even quicker. If time-temperature control cannot be guaranteed at the site, the harvested fish should be transported immediately after cooling them down, and storing them in suitable plastic containers.

Practical activities

The trainer can use the following practical activity during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Role play: Inspection of harvested fish

This practical role-play focuses on the importance of checking if good aquaculture practices have been implemented at a farm during harvesting. This activity will help trainees remember all the necessary steps that need to be taken during harvesting activities.

The trainer starts with sketching a situation in which a fictional restaurant owner wants to visit the farm where he buys his products, so he can see the harvesting activity himself. During his visit he wants to make sure important GAqP measures are followed to ensure the quality and food safety of the harvested fish, as he only wants to sell the best fish in his restaurant.

For this activity the trainees are divided into 4 groups: 2 groups of farmers and 2 groups of restaurant owners. Each restaurant owner group will be teamed up with a farmer group.

The farmer groups then prepare the role-play sketch by writing out, and eventually playing out, all the GAqP measures that they will follow during harvesting.

The restaurant owner groups prepare the role play sketch by writing out, and eventually playing out, all the GAqP measures that they want to check at the farm.

During the role play some differences between the good aquaculture practices shown by the farm groups can be observed in comparison to the good aquaculture practices the restaurant owners was hoping to see during his inspection. The trainer continues with discussing these differences. Eventually, the group of trainees should agree on a single set of good aquaculture practices that needs to be followed during harvesting activities, and these can be recorded on the classroom whiteboard.

Teaching Module 8: Staff and community relations

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Labour conditions
- Salaries and benefits
- Equality
- Staff training
- Relations with the surrounding community

Introduction

Staff should be treated responsibly and in accordance with national labour rules and regulations and, where appropriate, relevant ILO conventions [(A)]. Farmers should take responsibility to follow regulations on land and water use and should ensure to keep good relations with surrounding communities by minimising impacts on resources shared with others. To avoid issues with human rights violations, bad labour conditions, and conflicts with surrounding communities, the following GAqP should be implemented.

Good Aquaculture Practices

Labour conditions

1. *Staff should be provided with decent working conditions for both genders* [(A)]

Safe farm work conditions must be ensured at all times, in line with the Operational Health & Safety conventions of the ILO [(A)]. A safe working environment should be provided to protect staff from sickness, diseases and injury during work. Staff should have adequate protection from noise, dust, light and exposure to hazardous chemicals. Protective gear should be provided when necessary, first aid kits should be present and accessible in the workplace, fire safety measurements should be implemented, and the farm should be insured in case of accidents. In case staff live at the farm, the provided housing should have access to a clean latrine and potable water.

2. *Child and forced labour should not be used in a manner inconsistent with ILO conventions and international standards* [(A)]

Child labour refers to work that is mentally, physically, socially, or morally dangerous and harmful to children, interferes with their schooling, and is a violation of human rights (ILO 2019). Forced labour is work performed involuntarily and under threat of a penalty. Not only is forced labour a violation of human rights, it also contributes to poverty (ILO 2019). Examples include persons that are forced to work through the use of intimidation or violence, through manipulated debt, or through the retention of identity papers. Staff should be allowed the freedom to leave the work premises at any time.

Salaries and benefits

3. *Fair wages should be ensured*

Fair compensation for work should be provided in accordance with national regulations. Wages should be paid timely, and no deductions should be made by means of punishment. Overtime should be compensated fairly or be offered voluntarily. Excessive overtime, however, should not be allowed since it can influence the staff's health and increases the chances of accidents. All staff should be given time off according to minimum legal requirements.

4. *Social security, health insurance and pension benefits should be provided*

Social security benefits should be provided to staff to ensure social needs and reduce certain life risks. Usually social security gives health protection and income security in case of illness, unemployment, maternity etc. This way the employer contributes to the general well-being of its staff, which in turn improves productivity and ensures a stable workforce.

Equality

5. *All employees should be treated equally*

Staff should not be discriminated on the basis of gender [(A)], race, or beliefs. Freedom from discrimination is necessary for staff to be able to choose their employment freely, develop their potential and receive fair compensation based on their qualifications. Workers should be treated with respect and farm owners must not engage in or permit harassment. Gender equity and social inclusion are human rights that should be adhered to by farm owners. Men and women should be given the same opportunities, treatment, and compensation.

Staff training

6. *Staff should be trained in the company's policies and procedures*

Staff should be trained on farm level hygienic practices to ensure they are aware of their roles and responsibilities in protecting aquaculture products from contamination and deterioration throughout the production cycle [(A)].

Farm staff and managers should be trained on good aquatic animal health and welfare management practices to ensure they are aware of their roles and responsibilities in maintaining aquatic animal health and welfare in Aquaculture [(A)].

Farm staff and managers should be trained in environmental management and mitigation of impact to ensure they are aware of their responsibilities in protecting the environment [(A)].

Staff should also be trained on safety and health topics. This ensures staff health and safety, and reduce the risk of accidents in the workplace. Other technical training should also be promoted to enable staff to develop skills and capabilities.

Relations with the surrounding communities

7. *Farmers should avoid conflict with surrounding communities*

During the farm preparation phase, surrounding communities should be notified about the plans of the farm and possible conflicts should be resolved first. For example, farms should no block access to fishing grounds or public water bodies. Farm operators should demonstrate equal rights on public land and water use for local communities following National Laws and Regulations [(A)].

8. *Farmers should take measures to minimise potential adverse impacts on the local community during all phases of farm operation* [(A)]

Farmers should implement sound environmental management measures that minimise their environmental impact on the surrounding environment. In case common resources are used, clear agreements should be made between users and national regulations should be followed.

Training aids

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Bad practice	Good practice
Child and forced labour	A farmer hires the neighbour's children who are 10 and 12 years old to work on the farm for work on Monday to Friday. This is a bad practice since the children will not be able to go to school when they are working at the farm.	The 15-year-old son of the farmer helps his father by working on the farm every Saturday. The farmer pays his son a fair wage for his work. This is a good practice since the son can go to school while also earning some money. Since he is 15 years old, he is allowed to work as long as it is not hazardous work.
Equal treatment of employees	A farmer has interviewed 3 candidates for a job as farm manager. There were two women and one man all equally suited for the job. The farmer chooses to hire the man because he thinks he will be a better leader because of his gender. His decision is a form of gender discrimination.	A farmer has interviewed 3 candidates for the job as farm manager. There were two women and one man all suited for the job. The farmer chooses the candidate with the most experience relative to the activities of the farm. His decision is fair.
Staff training	A farm manager attended a training course on GAqP and trained all his staff when the materials was still fresh in his mind. However, he never repeated his training. This means that new staff are not familiar with GAqP and may implement bad practices.	At a farm, all staff is regularly trained in the most important policies and procedures of the company. This means that all staff are always up to date and there is a higher chance that policies and procedures will be implemented correctly (especially when combined with controls from the farm management).

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Providing decent working conditions	In the construction phase of the farm, a lot of noise and dust is present at the workplace. What can be done to maintain suitable working conditions for the staff? *Possible answers:* Install dust curtains, provide protective equipment such as ear plugs, face masks, and eye protection. The staff should also be trained about the dangers of working on a site that is under construction.
Fair wages	How can a farmer determine a fair wage for new staff members? *Possible answer:* The farmer can ask the person what his wage was in his previous job (and a pay slip could be requested). The farmer can also take into account official minimum wages, the position of the person in the farm, and the wages of staff members in similar positions.
Discrimination	Name some examples of discrimination at work. *Possible answers:* Denied promotion due to pregnancy, bullying a gay colleague, being paid less because of a disability and not letting staff pray during work hours.
Staff training	Besides the necessary staff training on policies and procedures on the farm, what other trainings would be useful for staff to attend? *Possible answers:* First aid training, management training, specialty training and technical training.
Minimise adverse impacts	What can a farmer do when he has accidentally released polluted effluent water from ponds in the river? *Possible answers*: Immediately notify the surrounding communities and authority. Implement measures to avoid the same problem in the future. Assist the community to source clean water elsewhere.

Practical activities

The trainer can use the following practical activities during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Role playing activity: Conflict resolving

For this activity the trainer should divide the trainees in 3 groups. One group represents a fish farm that has sea cages in a local bay, the second group represents a local community that is living in the coastal area in the same bay, and the third group represents the tourism sector, which has hotels on the coast and which organises activities in the bay where the fish farm is located.

1) Ask the groups to discuss which resources they use.
2) Write down the resources of the different groups on the whiteboard.
3) Note resources that are commonly used by different groups and that can cause a potential conflict.
4) Ask each group to select a representative.
5) The representatives will discuss the use of resources and see if they can come to an agreement.
6) In case no agreement can be made, ask the whole group to provide ideas on how they think the conflict can be resolved.
7) In case an agreement is made, ask the whole group if they can come up with other examples that can cause a conflict between farmers and surrounding communities.

Group discussion: Safety hazards

For this exercise the trainer should start by asking the group what the definition of a hazard is (they should know from the introduction of the course). In this case we are not talking about food safety hazards such as bacteria, chemicals or physical hazards, but about safety hazards for the employees.

Ask the group to define the safety hazards for staff working on an aquaculture farm (e.g. electrocution, entanglement in net cages, muscle strain by carrying heavy loads, slipping on a wet surface or drowning at a fish cage) and write them on the whiteboard.

The trainer then picks the 5 most likely hazards and discusses how these could be prevented. Finally, the trainer and trainees identify the things that the farmer can do to provide safety to the staff in these cases.

Teaching Module 9: Record keeping and documentation

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Company procedures
- Record keeping

Introduction

There is a wide range of documentation that farmers need to effectively run their business such as company policies, procedures and records.

To make sure all of the GAqP are implemented correctly by farm employees, practices and methods of implementation should be written down in the form of company policies and procedures. A policy is a guiding principle, while a procedure is a series of steps to be followed to accomplish a task or goal. Policies and procedures establish the rules of conduct and outline responsibilities of staff. They are used as a reference for management and staff and should also be used for staff training.

Record keeping is necessary to verify if staff are following the company procedures and to evaluate farm performance. It is also important for the verification of GAqP compliance and traceability. Records may be kept on paper or in an electronic format. Records have to be maintained for a certain period according to international standards or national legislation. For example, data related to food safety, and animal health and movement should be recorded, kept, maintained and made accessible during culture and for at least 24 months after harvesting [(A)]. Financial records are also needed and these are covered in module 11.

The goal of traceability in the aquaculture supply chain is to ensure food safety and quality, and guarantee transparency on product information (SEAFDEC 2017). Traceability is the ability to follow the movement of food through the stages of production, processing and distribution, as defined by the Codex Alimentarius Commission (FAO/WHO 2015). Internal traceability is the ability to keep track of what happens to a product, its ingredients and packaging within the farm in order to identify sources and recipients of aquaculture products. This means that the farmer should be able to trace feeds or ingredients of feeds, veterinary drugs and chemicals, and seed stock, back to their supplier, as well as the fish produced at the farm. Traceability records include records on the treatment of fish with veterinary drugs and chemicals, records of suppliers, stocking records, and harvesting and sales records.

Good Aquaculture Practices

Company procedures

1. *Written policies and procedures should be in place and accessible to all management and staff members*

The following written policies and procedures should be in place and implemented:

- *Procedures for cleaning and sanitizing of facilities, equipment and tools*

These procedures should include sections on the cleaning and sanitizing of facilities, equipment and tools, personnel hygiene, farm hygiene and pest control.

- *Procedures on personal hygiene*

These procedures should include a section on the monitoring and control of staff health and should clearly outline in which circumstances employees are unfit to work.

- *Procedures for the collection and disposal of waste*

This policy should include a section on the collection, storage and disposal of liquid and solid wastes and should make special reference to chemicals and other hazardous materials.

- *Procedures on water quality management*

Water quality monitoring procedures should be in place, as well as required corrective actions in case parameters are outside of their optimal range.

- *Procedures for feed management*

Procedures to avoid feed contamination should be in place and these need to be in compliance with international standards and national regulations [(A)]**.** These procedures should include methods on feed management and should lay out feed storage and feeding procedures.

- *Policy in containment of fish to prevent escapees*

This policy should include measures to avoid escapees, as well as corrective actions in case events of escapees occur.

- *Policy and procedures on fish health management*

This policy should include measures on disease prevention, health monitoring, contingency plans and treatment procedures. Procedures on the monitoring, collection and disposal of mortalities should be included as well. Separate procedures for the use of veterinary drugs, feed additives and chemicals should also be available.

- *Procedures on harvesting and post-harvest management*

Procedures on harvesting and post-harvest management should include procedures on the planning of harvest, sanitation of harvest equipment, the verification of withdrawal times and MRLs, storage and transport guidelines, and the use of clean ice and water.

- *Labour policy*

The labour policy should include anti-forced labour, anti-child labour and an anti-discrimination sections and should include hiring procedures based on equal treatment. It should also provide the companies' policy on compensation, working hours and should mention the right of employees to associate. The labour policy should also include procedures on health and safety, and, if applicable, on hygiene and safety of housing for employees living at the farm site.

- *Policy on maintaining community relations*

This policy should include the farms' strategy to ensure a good relationship with surrounding communities and should outline procedures on the handling of local complaints and conflict resolution.

Roles and responsibilities of different staff members need to be specified in each policy. Mechanisms to monitor the effectiveness of each policy also need to be described, including ways to address shortcomings. The implementation of these policies and procedures should, whenever possible, be visually verifiable, meaning that an external observer should be clearly able to see that employees are following these policies.

Record keeping

2. *Records should be kept on all aspects of production and these should be stored for at least 2 years*

The following records should be kept:

- *Origin of broodstock or seed*

  Records on the origin of the broodstock or seed should be kept including details of suppliers, species, strain, age and general condition. Hatcheries must provide a health certificate with their fingerlings and these should be kept by the farmer. If transport companies and middlemen are involved, their details should be recorded as well.
- *Stocking and production*

  When stocking ponds, tanks or cages, the species or strain and their origin, quantities, and location (e.g. pond, tank or cage numbers) should be recorded. During production, mortalities (quantity, date and location), survival and growth should be recorded, including details on mass escapee events.
- *Hygiene practices*

  Records should be kept for cleaning, sanitation and maintenance of buildings, cages, tanks, ponds, equipment and machinery. Ideally cleaning check lists are used. Records on staff health (health certificates) and pest control (species, quantity, eradication method) should also be kept.
- *Water quality*

  The main water quality parameters that should be recorded are temperature, DO, pH, transparency, ammonia and salinity. Other parameters that can be included are nitrate, nitrite, chloride, hardness, and alkalinity.
- *Feed management*

  Records for incoming and outgoing feeds should include contact details of suppliers, feed type, batch numbers, expiry dates, and quantities used in each pond, tank or cage. A daily feed inputs/feeding record must be maintained.
- *Disease occurrences and use of veterinary drugs and chemicals*

  Records should be kept on general health and disease occurrences. When veterinary drugs or chemicals are used, product names, suppliers, expiry dates, batch numbers, treatment dates, dosage, withdrawal periods, MRLs, and locations of use need to be recorded.
- *Harvest and sales*

  Records for harvest and sales include species, harvest time and date, location (pond, tank or cage number), quantity, medication history, batch number, invoice numbers, buyer name and contact details, and transportation details. When fish are stored between harvest and sales, temperature records should be kept during storage. Temperature records should also be kept during transport from farm to market.
- *Environmental impact*

  Records on environmental quality on the farm should be kept of data obtained through regular monitoring [(A)]. These should include records on for example, effluent water quality, sea bottom quality for cage operations, and the occurrence of algal blooms.
- *Staff training*

  Training records on all staff trainings should be kept. These include staff names, training course name, training dates and certification numbers, if applicable.

Roles and responsibilities of different staff members need to be specified for all record keeping activities. For traceability purposes, staff that fill-out record forms should sign with their initials.

Training aids

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Bad practice	Good practice
Policies and procedures	A farm has all the necessary procedures in a folder, but the staff are not aware of the procedures since they were not trained. This means that the procedures are not implemented.	A farm has all the necessary procedures in place, and these are updated regularly. New staff are trained on all procedures, and new procedures and updates are shared with all staff. Therefore, the staff implement all policies and procedures as set out by the management.
Traceability	Harvested fish from 3 farms are transported together in one truck to the market. Crates are not labelled so the fish cannot be traced back to the farm. In case the farmer finds out there is something wrong with the fish (e.g. they are contaminated), this may result in health risks to the consumers.	Crates of fish are labelled with the company name, species, harvest date, pond number, batch number and destination. Like this, fish can easily be traced back to the producer and even to the pond they were harvested from. In case a farmer finds out there is something wrong with the harvested fish, these can be recalled from the shop or restaurant they were sold to.
Record keeping	The staff member that is responsible for monitoring the water quality notices that the pH in the pond is the same every day, so he stops measuring and just records the same value in the record book. When there is an issue with the pH this will not be detected. The staff member is also guilty of fraud.	All water quality parameters are monitored daily and the test results are recorded. The farm manager checks the results daily and takes regular control samples to check if the records are correct. This way, if something is wrong with the water quality, this will be detected and appropriate measures can be taken.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Policies and procedures	Why do policies and procedures need to be kept up to date? *Possible answer:* Old policies may fail to comply with new laws and regulations, and they may not address new systems or technologies implemented on the farm (e.g. new machines). This can result in inconsistent practices and reduced farm performance.
Traceability	Traceability records are necessary in case a recall of contaminated products is necessary. When a farmer finds out the batch of fish just sold was contaminated with *E coli*, what records does he need to take action? And what actions does he need to take? *Possible answer:* Records on harvest and sales, batch number, destination and contact details of buyers. He needs to contact the buyers to recall all the fish that has the risk of contamination. He also needs to immediately contact the competent authorities.
Record keeping	What can happen if a farm does not keep the necessary records? *Possible answers:* In case the farmer discovers his fish have been infected with dangerous bacteria sold batches cannot be recalled, and this might result in sick consumer. Fines or business closure due to violation of laws could be the result. Farmer will be unable to carry out forecasting of harvests and plan the need for supplies, this may result in reduced farm profitability.

Practical activities

The trainer can use the following practical activities during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Exercise: Procedure writing

The trainer should divide the group in smaller groups of 4-5 trainees. Each group will be given a certain task at the farm and is asked to work out a written procedure on this topic. The groups are given 15 minutes to complete the exercise. The written procedures are then presented for the whole group and feedback is provided by the trainer and the rest of the group.

Examples of farm tasks:

- Cleaning and sanitation of equipment
- Stocking of seed

- Feeding procedures
- Collection and disposal of mortalities
- Water quality monitoring

The trainer can provide the group with the following tips:

- Write actions out in the order in which they happen. Start with the first action, and end with the last action
- Avoid too many words. Just be specific enough to communicate clearly
- Use the active voice
- Use lists and bullets
- Don't be too brief, or you may give up clarity
- Explain your assumptions, and make sure your assumptions are valid
- Write at an appropriate reading level

The following video can be shown to the group before the start of the exercise:
https://www.youtube.com/watch?v=2DFFnqqbIQU

The video provides information how to write clear and accurate instructions and procedures which are essential to the world of work. Instructions tell, and frequently show, how to do something. They indicate how to perform a specific task. Everyone from the consumer to the specialist uses and relies on carefully written and designed instructions.

Exercise: Record keeping

The trainer should divide the group in smaller groups of 4-5 trainees. Each group will be given a record sheet and a topic. They are then asked to develop a form to keep records on the topic. The groups are given 20 minutes to complete the exercise. The record forms are then presented to the whole group, and feedback is provided by the trainer and de rest of the group.

Groups should work on the following forms:

- Cleaning and sanitation
- Feed management
- Water quality
- Use of chemicals
- Harvesting and sales

Example of record form on use of veterinary drugs:

Treatment date	Species	Description (Age class)	No. of stock	Location of fish	Product trade name	Dosage	Batch no.	Expiry date	Withholding period (days)	Date of MRL test

Exercise: Traceability

This exercise starts with the trainer writing down a list with fish harvested by a farmer for a restaurant in town, for example:

Pond 3: 10 Kilograms red Tilapia

Pond 4: 50 Kilograms Grass carp

Pond 10: 7 Kilograms grey Tilapia

The trainer then makes a chain of 6 selected trainees that represent the supply chain as follows:

- The farmer
- A transporter
- The middleman
- A transporter
- The restaurant owner
- A consumer in the restaurant

The trainer whispers in the ear of the farmer the information that is written on the paper. Then the farmer has to provide the information to the first transporter, the transporter to the middleman and so on. It is important that they whisper and that the others cannot hear anything. At the end of the chain, the consumer in the restaurant has to write the information that was whispered into his/her ear on another piece of paper. This is then compared to the information on the paper of the trainer. The exercise may be repeated with other trainees.

It is expected that the information will not be the same on the 2 papers. The lesson of the exercise is that It is difficult to provide the right information when it is not written down (record keeping), and when it is not well communicated to the next actor in the supply chain (traceability).

Stand-alone modules

Teaching Module 10: Legislation and compliance

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Legislation
- Standards and guidelines

Introduction

Most countries have three levels of legislation: national, regional or provincial, and local. Some countries have dedicated legislation for aquaculture, while others have incorporated sections on aquaculture in their fisheries laws. Legislation on environmental management, labour, access to land and water (zoning), food production, waste management, disease control and use of veterinary drugs are legislative topics that also apply to fish farmers. It is important that farmers are familiar with the rules and regulations on all levels related to these topics. Farmers that export their products to international markets such as the EU, the USA, or Japan, are also required to follow the legislation of the importing country.

Besides legislation there are also guidelines and standards that are of importance to farmers. While guidelines are recommended practices, standards are higher in level of authority, and are agreed measures to achieve a certain level of quality or achievement. Standards only become mandatory when they are adopted in laws and regulations.

There are different kind of guidelines and standards; private label standards such as Aquaculture Stewardship Council (ASC), Global G.A.P., and the Global Aquaculture Alliance (GAA), and regional and national standards and guidelines such as ASEAN guidelines, VIETGAP, MYGAP and IndoGAP. Private label standards have been developed for the purpose of certification. Being certified proves to buyers and consumers that the farm and products have been produced in compliance with the standard. This will benefit the farms' reputation in the market and can help in reaching new markets. The main driver behind regional and national standards and guidelines is to move the aquaculture sector in a sustainable direction, and to provide farmers with the knowledge to do so.

Good Aquaculture Practices

Legislation

1. *Farmers should comply with national and local laws and regulations applicable to the farms' activities*

Farmers should comply with national and local legislation at all stages of the farm's operation; from site selection to harvest and post-harvest management. Farms should be registered with the relevant competent authority. In case farms export their products, the rules and regulations of the country where the products are exported to, should also be adhered to. This is especially important with regards to the use of veterinary drugs and MRL's of the importing countries.

Standards and guidelines

2. *All applicable guidelines and standards provided by ASEAN and the AMS should be followed*

Even though guidelines and standards are not mandatory for farmers to follow, it is highly recommended to implement applicable guidelines and standards to ensure food safety, product quality, environmental integrity and social responsibility. Implementing GAqP also maximises farm performance, which results in a higher profitability for the farm.

Training aids

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples**.**

GAqP topic	Bad practice	Good practice
Legislation	A farmer operates without a license to undertake aquaculture activities and, thus, does not adhere to the regulations of its country. This can result in problems with surrounding communities and with the relevant authority.	A farmer is familiar with the relevant legislation in his country and has incorporated all the relevant rules and regulations into the company's written protocols and procedures. By doing this, he will avoid future problems with the authorities and surrounding communities.
Standards and guidelines	A farmer only implements GAqPs on food safety but does not follow guidelines on the environmental or social aspects. This may result in problems with employees, the authorities, and surrounding communities.	A farmer implements all the measures mentioned in the national standard on Good Aquaculture Practices, which are based on the ASEAN Guidelines on Good Aquaculture Practices for Food Fish.

Guide questions

The trainer can use the following guide questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Legislation	Why is legislation important for the aquaculture sector? *Possible answer:* Legislation supports and protects farmers. It ensures that fish production adheres to national and international standards for export and consumption. It also protects the environment and employees and ensures fish welfare and food safety.

Standards and guidelines	What are the benefits of following guidelines or standards on GAqP? *Possible answer:* Implementing GAqP has many benefits for a farmer. Among others, this reduces the farmers' exposure to food safety risks, it increases product quality, improves efficiency of farm processes and strengthens overall farm management. Implementing GAqP also ensures environmental integrity and social responsibility.

Practical activities

The trainer can use the following practical activity during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Group Discussion: Legislation in your AMS

It is recommended that the trainer familiarises him/herself with the legislation applicable in the AMS before the training course.

The trainer then asks the trainees which laws and regulations they know are applicable to fish farmers in their country. The trainer writes down the names of the relevant laws and other legal documents on the white board. The trainer continues with asking the trainees to link these documents to the different GAqP modules in this training course. The trainer can add important missing documents. Are they familiar with these rules and regulations? What knowledge is missing? Do they know where to find the information? And are there any gaps in the country's rules and regulations?

Teaching Module 11: Financial management and marketing

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics, specifically in relation to the implementation of GAqP:

- Financial management
- Marketing
- Clusters

Introduction

Financial management and marketing are essential for the success of a farm. Key aspects of financial management are ensuring that the business is financially viable, profitable, and that the cash flow of the farm is maintained. Results of financial analyses can be used to assess the performance of the farm and provides useful information when making management decisions. Financial management is also required for external reporting and tax purposes.

Marketing is the effort to identify and satisfy the needs of the buyers. There are four elements that play a role in marketing - the marketplace, product pricing, product quality, and promotion. Farmers need to ensure to have market access in terms of transport and market demand.

For small farmers, the agri-business cluster approach is recommended to reduce transportation cost and to facilitate horizontal (cooperation among farmers) and vertical integration (contract and interaction with suppliers and buyers) of the farm within the value chain.

Good Aquaculture Practices

Financial management

1. *Farmers should engage in financial planning*

In order to determine if a farm can be financially viable, a financial plan is required. The farmer should think about the source of financing (e.g. savings, loans, and investors), investment costs, operational costs, and the cash flow (movement of money). In order to calculate the investment and operational costs, a production plan should be made. This will tell the farmer when he/she needs to stock seed and how much and when he/she can harvest. Once the production volumes are determined, the farmer can make a budget to estimate expected income and costs, and finally calculate the expected profit. If a farm is not making or expected to make profit, the activities, expenses, and farming methods need to be reviewed, and a new plan should be made.

Financial planning should also be linked with marketing, as understanding market requirements and knowing market prices (and fluctuations) will help to fine tune financial planning.

2. *Adequate financial records should be kept*

In order to assess the economic performance of the farm, it is necessary to keep track of the money coming in and going out of the farm. This is done by recording all financial transactions, such as purchases of farm inputs, salaries, and sales. This activity is also called bookkeeping, and can be done

on paper or by using accounting software. All transactions should be accompanied by proof, such as purchase and sales receipts. These records need to be stored for a number of years, depending on the requirements of the AMS. Adequate records of farm performance will also facilitate producers to access loans from a financial institution.

3. *Farmers should save money*

Every business should have some money reserves in case of cash flow shortage, emergencies, or for unexpected expenses. A successful farm that is making profit can save money by setting aside some of the profit after every harvest. Savings can also be used to expand or improve the farm. Having savings can also enable a farm to have better access to loans.

Marketing

4. *Ensure that the fish products meet market requirements*

To facilitate marketing and access a higher price, it is necessary to understand the market and to know what the product requirements and specifications in terms of quality, volume and seasonality are. Understanding market supply and demand variation across the months help in designing a marketing strategy.

Selling good quality fish will help to build a reputation with buyers, which will encourage them to keep buying the product. For buyers, value for money is important; thus, a better quality fish can fetch higher prices. Farmers should ensure that their fish meets buyer requirements in terms of the size, colour and freshness. Processing and value adding can be considered to generate higher prices and provide unique products increasing the farmers' competitiveness.

5. *Ensure a market before harvest*

Fish should be available to the buyers at the right time and place. Make sure to have an agreement with buyers for the fish before harvest time so the fish can be sold on the same day. Only harvest the quantity of fish that is expected to be sold. This way, unnecessary handling and spoilage can be avoided. Arrangements with the buyer with regards to price, quantities, sizes, and logistics should be made before harvesting as well. Hence, having a written contract with the buyer is recommended. The contract should indicate the volume, price, and date of purchase/harvest of the produce. This type of contract is a form of vertical integration and helps farmers to plan the farm operation and ensure cash flow.

Clusters systems

6. *Small-scale farmers should consider operating through a cluster system approach*

By forming a collective, like a cooperative, union, or association, small-scale farmers can overcome challenges such as accessing markets and meeting market demands. Collectives can provide a consistent market supply and are in the position to negotiate better prices. Other advantages of collective collaborations are that they have a more competitive position and improved access to supplies and financial services. By combining orders from suppliers or deliveries to the market they can decrease transport costs. Forming clusters has also proven to improve yield, reduce disease occurrences and contribute to meeting food and safety requirements, as farmers can exchange individual experiences for the benefit of other members.

Training aids

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Bad practice	Good practice
Financial planning	Starting a new farm without thinking of the market or without developing any financial plan. This may result in cash flow problems at a later stage.	Making a business plan for a new farm that includes a production and financial plan. The farmer is well prepared and knows that the business can earn money.
Keep records	A farmer keeps all his receipts; however, he does not record the transactions a bookkeeping system. The farmer may fail to supply required financial data to authorities and will have no information for business planning or improvement.	All staff that handle money keep a cashbook with all their financial transactions. The bookkeeper of the company checks the cashbooks and enters the transactions into the accounting system of the farm.
Saving money	After every harvest a farmer takes his friends out for dinner and drinks. The farmer could use these earnings to save money for emergencies.	After every harvest a farmer puts a part of the money aside and deposits it to the savings account of the farm. This way he will be able to respond to emergency situations.
Meet market requirements	A farmer harvests a batch with many fish smaller than the usual market size. He decides to sell them to his long-term buyer for the same price as usual. His buyer is not happy with the fish that was delivered to his company and he decides to no longer engage in any business with the farmer.	At the request of his long-term buyer, a farmer grows his fish to 500 grams instead of the usual 350 grams. He gets a good price from the buyer and makes good profit as a result.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Financial planning	Why is financial planning important? *Possible answers:* Financial planning helps in managing farm income and expenses. It also helps the farming in reaching farm targets as financial planning helps improving the financial understanding of the farmer.
Keep records	What kind of financial transactions occur on a farm? *Possible answers:* Examples of financial transactions on farms include payments to suppliers, borrowing money and paying back loans, income from sales, payments to the tax office, salary payments to staff and payments for farm inputs like feed and fingerlings.
Save money	Why is it important for a farmer to save money? Name some example when savings can be used? *Possible answers:* Saved money can be used for emergency situations. Examples of such situations include assisting a staff member who has had an accident and his hospital bill needs to be advanced, replacing the generator breaks that cannot be repaired, but also keeping the farm running and paying staff salaries after a failed harvest.
Meet market requirements	How can a farmer find out what the market requirements are? *Possible answer:* The farmer should conduct a market survey to determine market requirements, grades of fish, and seasonal variations in market prices, supply and demand.
Ensure a market	What will happen if a farmer harvests all his fish but has not found a buyer? *Possible answers:* Most likely the fish will spoil, and the farmer will lose his harvest. Even if he finds a last-minute buyer, the farmer will most likely receive a low price, as he is in a weak position to negotiate.
Clusters	What are characteristics of clusters? *Possible answers:* Clusters are characterized by farmers with common needs and interests, the dependence between members and a similar or overlapping field of work.

Practical activities

The trainer can use the following practical activity during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Exercise: Financial planning

In this exercise the trainees are learning about the different types of costs required for an aquaculture farm.

There are 2 main types of costs:

- Investment costs (capital expenditure): Total costs made for the construction and setting up a farm. Operational cost (operational expenditure).
- Ongoing costs: Costs for running the farm. Operational costs can be divided in fixed and variable costs:
  - Fixed operational costs are expenses that do not depend on the amount of fish produced by the farm;
  - Variable operational costs are expenses that change in direct relationship to the level of production in a given production cycle.

The trainer should divide the group into small groups of 4-5 trainees and ask them to list the type of costs in each category for an aquaculture farm.

Investment Costs	Operational Costs	
	Fixed	*Variable*

Possible answers:

- Investment costs: construction of pond and infrastructure, equipment.
- Operational costs:
  - Variables costs: seasonal workers, farm inputs (e.g. lime, fertiliser, feed, fingerlings, chemicals, and veterinary drugs), electricity, fuel, salaries, losses, materials;
  - Fixed costs: permanent staff, repairs and maintenance costs, marketing expenses, travel expenses, office supplies, replacement costs (depreciation), loan costs and bank charges, business license, legal fees, certification costs and taxes.

Exercise: How is the farm performing?

In this exercise trainees learn how to calculate profit, net margins, and break-even points for a farm. These skills are necessary to determine the financial viability of a farm. First, the trainer presents a sample calculation as presented below. Once the calculation methods are clear to the trainees, the trainer should write another example on the white board, and divides the group into smaller groups of 4-5 people each to practice the calculations. The trainer should check up on the groups to see if the trainees they are doing performing the calculations correctly.

Calculating profit

Net Income or profit is calculated by deducting the total operational costs from the revenue (income from sales).

Net income = revenue - sum of cost

Example: A farm sells 4,500 kilograms of tilapia at 2.1 USD per kilogram. The total revenue is 9,450 USD. Costs include:

Cost	USD
Feed	3,500
Fingerlings	1,500
Other inputs (medicine etc.)	680
Fuel	120
Wages	500
Taxes	25
Depreciation	100
Marketing	50
Total	**6,475**

Net income: 9,450 - 6,475 = 2,975 USD

Assessing the performance of the farm

The net margin is the amount of money a farmer makes per kilogram of produced fish. This can be calculated by dividing the net income by the total volume of sold tilapia.

Net margin in USD per kg = 2,975 / 4,500 = 0.66 USD per kilogram of tilapia sold

Break-even point

The break-even point shows how much a farmer has to sell before he/she starts to make profit. In other words, this is the point at which their revenues are starting to exceed the costs of the operation. The break-even point can be calculated by dividing the total cost by the selling price per kilogram.

In this example the break-even point = 6,475 / 2.1 = 3,083 kilogram meaning that the farmer needs to sell 3, 083 kg of tilapia to recover his/her costs.

To make the most use of break-even point in this exercise, the calculation should be divided into break-even yield and break-even price. The latter is for the farmers to know that at what prices they should sell harvested fish at farm gate to gain financial benefit for that crop.

Teaching Module 12: Climate change adaptation and mitigation

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics, specifically in relation to the implementation of GAqP:

- Mitigating measures
- Adaptive measures

Introduction

The effects of climate change pose a direct threat to the aquaculture sector. Southeast Asia is increasingly vulnerable to changes like sea level rise, ocean warming, and acidification, but also from sudden impacts such as an increase in the frequency and intensity of storms and heat waves (IFAD 2015). For fish to adjust to the changing environmental conditions causes stress and ultimately leads to increased disease risks. The effects of climate change can also lead to loss of assets and reduced farm production. Extreme weather events can wipe out entire farms.

Climate change also possesses a risk for food safety and food security. Food safety can, for example, be affected by the increased proliferation of bacteria, as a direct cause of increasing temperatures. Pond farms can experience additional food safety related problems due to intrusion of polluted water after floods. Similar problems are foreseen for cage farming operations, including an increase in the intensity and duration of toxic algal blooms, and an increase in run-off of fertilisers and other pollutants. Food security will also be impacted by changes in the availability, stability, and access to food and their utilisation. For example, species distribution will change, as well as farming opportunities. Small farms are more vulnerable to climate change since they have less capacity to implement adaption measures compared to large farms.

Effects of climate change are highly unpredictable and extremely localised, complicating things further. Therefore, mitigation and adaptation measures should be adjusted to suit local circumstances. For example, mitigating measures include those actions that will reduce greenhouse emissions, while adaptation measures include those that reduce the vulnerability of the farm to the effects of climate change.

Good Aquaculture Practices

Mitigation measures

1. *Water and energy consumption should be minimised*

A number of measures can be taken to reduce the fossil fuel consumption of the farm, thus reducing greenhouse gas emissions. These include the use of efficient machinery and lighting, the use of gravity for the movement of water, and the use of renewable energy (e.g. solar, biofuel, hydro and wind energy). Water consumption can be reduced through the improvement of water use efficiency, for example by reusing water for agriculture or by using recirculating aquaculture systems.

2. *Transportation should be minimised as much as possible*

By marketing fish locally, less transportation is needed. Small-scale farms can work together through clusters to reduce the transportation footprint of supplies to the farm and of products to the market.

3. *Feed management should be optimised*

The highest impact of the aquaculture sector on climate change is attributed to feed production and the transportation of feeds and feed ingredients. Sourcing more sustainable alternative feed ingredients reduces the carbon footprint. By improving the Feed Conversion Ratio (FCR), the amount of feed needed to produce 1 kilogram of fish, less feeds will be needed. Farmers can achieve this by using high quality feeds and by implementing efficient feeding methods that minimise waste and that maximize efficiency.

4. *The production of low trophic fish species should be considered*

Low trophic fish, like herbivorous fish and fish that eat plankton, do not require feeds that contain fish meal and fish oil, and consequently their culture has a lower carbon and environmental footprint (IFAD 2014). Examples of low trophic fish species are carps, rabbit fish and tilapia.

Adaptation measures

5. *Implementation of Good Aquaculture Practices*

Implementing GAqP in all aspects of production will improve the overall resilience of the farm. Ensuring fish health through the implementation of GAqP will reduce disease risks. Environmental measures that ensure the protecting of local ecosystems will decrease the vulnerability of farms to climate change. For example, if mangroves in the farm area are protected, they will provide a barrier against storms and high waves.

6. *Integrated aquaculture should be considered*

Polyculture and integrated aquaculture are methods of raising different species within the same farming system, whereby each species utilises a distinct niche and distinct resources. Integrated aquaculture combining low-trophic fish species with rice or poultry farming does not require input of feeds and thus have a lower carbon footprint. Combining different species also diversifies the source of income and thus reduces production risks. Fresh animal manure should be dried or composted first.

7. *When selection a site climate change risks and impacts should be taken into account*

When planning a farm and selecting a site, climate change effects should be taken into consideration to avoid future risks and costs for future adaptation. For example, marine cage operations should not select a site that is unprotected from high waves or strong currents, and pond farming operations should select sites that have a low risk of flooding.

8. *Use available monitoring and early warning systems*

Farmers should be familiar with reliable sources of information on climate change and climate variability. It is important to understand and interpret the meteorological predictions such as weather forecasts well. Most AMS have national agencies in place that provide daily online weather forecasts, and which provide information on upcoming extreme weather events, like typhoons and extreme high tides. When changes in salinity, water availability and other important parameters are predicted in advance, farmers can prepare their farm to minimise losses and damage.

9. *Farmers should invest in strengthening infrastructure when needed*

To reduce impacts of climate change, farmers should invest in infrastructure improvement, like stronger net cages and stronger pond dikes. It is possible that governments, as part of their policy on

climate change, provide micro-finance schemes, insurances and loans to invest in farm infrastructure, and to take other adaptation and mitigation measures against climate change. Farmers can inquire if these options are available in their respective countries.

10. *When selecting species climate change risks and impacts should be considered*

Farmers should select species that are less sensitive to changes in the environment and less prone to diseases. Stocking larger fingerlings would shorten the farming period and would thus reduce production risks. Another solution is selective breeding with a focus on developing strains with a higher tolerance to changes in temperature, that grow faster, and which are more resilient to diseases.

Training aids

Examples of good and bad practices

The trainer can use the following examples of good and bad practices throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples**.**

GAqP topic	Bad practice	Good practice
Water consumption	Leaving the tap open in the cleaning area when not in use. This leads to unnecessary water use and costs.	Wastewater from a fish farm is reused to fertilise the neighbouring farm that grows vegetables. Like this, both farmers are saving water and costs.
Feeding	A farm uses trash fish to feed their groupers in marine cages. Trash fish has an FCR of approximately 7:1. This means that 7 kg of feed is needed to produce one kilo of fish. Pellet feeds are more efficient with and average FCR of around 1.5.	A farm buys organic pellet feeds with an FCR of 1.5:1. This has a lower impact on the environment than regular feeds. The feeds are produced from organic and sustainably sourced ingredients.
Integrated aquaculture	A farm combines chicken and fish farming. The chicken cages are on top of the pond, and the chicken are fed with hormones and antibiotics that end up in the pond water. This results in products that are not safe to eat.	The species used in a polyculture farm are carefully considered in order to reduce potential risk of disease transmission [(A)]. By using multiple species, less farm inputs are needed. However, this needs to be done in a manner that implements GAqP measures, especially on food safety, choosing species carefully.
Strengthen infrastructure	A marine cage operation has selected a site facing the open sea, with a high risk of high waves during storms. High waves can damage the cages and caused damages and mortalities in the fish.	A farm in an area prone to flooding risks invests in making the pond dikes higher and stronger. This will avoid damages of dikes, flooding and potential escapees.

Guiding questions

The trainer can use the following guiding questions throughout the module to promote interaction with the trainees and to clarify the GAqP measures through practical examples.

GAqP topic	Question
Resource use	How can a farm reduce its electricity and fuel consumption? *Possible answers:* The farm should use machinery, such as pumps, aerators, lights and motors, with a low energy consumption. Other solutions include the use of gravity to move water, to only turn on equipment when in use and to clean and maintain equipment to increase their lifespan and optimise their performance.
Integrated aquaculture	What are the advantages of integrated aquaculture? *Possible answers:* Integrated aquaculture utilizes different trophic and spatial niches, reduces waste and reduces the risk of total crop failure.
Selective breeding	Can selectively bred fish have a negative impact on the environment when they escape? *Possible answer:* Risks should be assessed on a case to case basis, but in most cases the answer is yes. Farms should always implement measures to prevent escapees. Pond outlets should be screened. Marine cage operations should conduct daily underwater inspections to reduce the risks of escapees.

Practical activities

The trainer can use the following practical activities during or at the end of the module to promote interaction with the trainees and to further enhance the learning experience of the trainees through practical examples.

Group discussion: Adapting to the effects of climate change

Many farming areas in Southeast Asia are located in low-lying areas that previously contained natural swamps, wetlands and mangroves. By now, these areas have been converted to aquaculture farms and are fully covered by ponds. This group discussion focuses on how farmers in such areas can prepare themselves for climate change and the increased occurrences of extreme weather events?

Trainees should provide and discuss potential solutions with regards to the farm layout and design.

Possible solutions:

- Increase the height of dikes
- Increase the width and strength of dikes
- Increase the number of drainage canals
- Increase the size of the drainage canals
- Create larger overflows

- Replant mangroves and other native tree species around the farm, and plant native grass species and shrubs on pond dikes
- Plan and strategize among farmers, and with local municipalities, to create a common approach to tackle these issues
- Farmers should also have a contingency plan in place so that their employees know what to do in case of an emergency, like a flooding or a broken dike.

Case study: Climate change in the Thua Thien Hue province in Viet Nam

'Viet Nam's topography, climate and long coastline makes the country vulnerable to extreme events and sea level rise. Thua Thien Hue has a coastline of 128 km and a large lagoon where over 30% of the population resides. Aquaculture is a major industry in the lagoon and many households are involved in aquaculture. An increase in water temperature has had a large impact on the aquaculture production. Local farmers have observed a higher frequency of disease occurrence and a decrease in water quality. They experience floods earlier in the year and extreme events such as typhoons occur more often resulting in a large number of mortalities. Another problem is the prolonged rain that is causing a drop in salinity and temperature, followed by a very hot period wherein the salinity increases lead to a prolonged culture period and in turn, result in slow growth of fish. The area is also prone to sea bottom erosion and landslides affecting aquaculture areas resulting in a drastically change of tide amplitude. As a result, many households shifted from intensive to extensive culture or changed their jobs'.

Reference: Le Duc Ngian 2018 and Binh et al. 2016

The trainer should present the situation of Thua Thien Hue to the group of trainees. The trainer then divides the trainees in small groups of 4-5 persons and ask them to discuss what adaptation measures could be implemented to decrease the risks and vulnerability of the small farmers to the changing climate.

Possible solutions:

- Polyculture using native species showed very positive results with high economic returns
- Capacitate farmers on climate change effects
- Strictly implement Good Aquaculture Practices
- Build embankments for flood prevention and ensure high water levels during droughts
- Plant trees to prevent erosion
- Use strong fish cages instead of the lagoon

The answers that are given are then discussed with the whole group, until an agreement is reached on which measures should be implemented.

Teaching methods

LEARNING OBJECTIVES

Trainees should understand the importance of the following topics in relation to the implementation of GAqP:

- Training preparation
- Teaching skills
- Trainee evaluation
- Training materials and tools

Introduction

This Trainers' Guide was developed with a participatory approach to teaching in mind, whereby trainees should be encouraged to share their experiences and knowledge. Presentations should be short and focused but interactive. The presentations should be alternated with group work to ensure that the trainees stay concentrated. For this purpose, this guide includes training aids in the form of examples of good and bad practices, and guiding questions that can be used by the trainer to engage trainees. Suggestions for practical activities such as exercises, discussion topics, role play activities and case studies, are included in each section as well. It is advisable to have a maximum of 25 trainees to ensure easy communication between trainer and trainees and to facilitate the group work. Training should be provided in a language that all trainees understand.

Training preparation

A training schedule for this training course is included in the introduction of this Trainers' Guide. The trainer can adjust this schedule to the needs of the trainees.

For each of the teaching module in this guide the trainer should develop a training plan that includes the following aspects:

1) *Define learning objectives: what knowledge and skills should the trainees have obtained after the teaching module is completed.*
    - Determine what the trainees already know about the topics discussed
    - Determine what the trainees should know and what skills they need
    - Build on the knowledge and skills of trainees

2) *Prepare tools and materials that are needed for each module*
    - Prepare hand-outs
    - Prepare materials needed for practical activities
    - Ensure the venue is arranged and necessary furniture and equipment are available
    - Classroom set up is important for the success of the training sessions. This may need to change depending on the format that will be used such as group work versus lecture sessions

3) *Ensure familiarity with training content and materials*
    - The trainer should be familiar with the information provide in the module, and if needed, further reading on the topic should be done
    - It is advised that the trainer has a look at the references included in this guide
    - The trainer should also anticipate the questions that can be asked by the trainees

4) *Assess and evaluate trainee progress*
    - Plan for methods to assess how trainees are doing during the course. This can be done by asking questions, observing behaviour and by testing the trainees. A sample exam is provided in Annex 2 of this guide.
    - A suggestion is to ask 3 trainees to summarise one topic each at the end of the day. Each day different trainees should be picked, but this should only be done at the end of the day. This also gives the trainee an extra reason to actively engage in the training course.

Teaching skills

Besides having the practical and technical knowledge on the teaching modules, these teaching skills can help the trainer to provide a successful course:

- *Make connection with the trainees*

Chat to the trainees when they enter, find out their expectations and introduce yourself at the start of the course.

- *The trainer should be confident, relaxed, and self-assured*

In order to appear confident, the trainer should take his/her time and keep a good pace during the presentations. Make sure all trainees can hear you well by speaking out loud, and by speaking not too fast. Maintain eye contact with the trainees. Summarise key points at the end of each module.

- *Explanations should be clear*

Keep explanations simple and make sure to include a core message for each topic. Including practices examples helps in improving the understanding of trainees as well. With more complicated topics, ask the trainees if they have understood. If necessary, repeat the explanation, this will also help the trainees remember the matter better.

- *Encourage discussions and involve trainees*

Posing questions encourages trainees to think for themselves. Questions should be challenging and well-timed. The guiding questions in each module can be used for this. The trainer can also ask the trainees to discuss these questions in pairs, breaking up the activity, and giving the trainer the chance to mingle with the trainees and check levels of attention and understanding. It is also recommended to encourage the trainees to the exchange ideas.

- *Listen actively*

Take time to listen to listen to the trainees and check if the trainees understand the learning materials.

- *Provide constructive feedback*

Giving feedback is an important tool in building the confidence of trainees, it also helps in transforming their understanding and motivation, and contributes to the development of their skills. Feedback should be clear, regular, a balance between positive and negative, and specific. It can also be formulated as an opinion, for example using 'I believe', or 'I think'.

- *Adapt to changing dynamics in the group*
  A trainer should be able to adjust the training methods, program or activities when needed. The trainer can for example adapt the course to the local context in the AMS, introducing country specific examples and case studies.

Trainers can improve their teaching skills by practicing teaching, attending other training courses and presentations and prepare their training sessions well. At the end of the course the trainees fill up an evaluation form (Annex 1) which can be used by the trainer to improve the training course.

Evaluation of trainees

The trainer should assess the performance of the trainees to ensure that trainees have the desired skills when they complete the course. During the course, the trainer should assess the trainees regularly to see if there are any problems. If the results are not satisfactory, the trainer should adapt the training course or methods.

To formally assess trainees at the end of the course, evaluations or performance reviews can be used. A diagnostic test at the start of the course should be done to check prior knowledge and skills. Performance can be assessed by observation of the trainees while performing a task, answering questions, or during group discussions. Performance can also be tested through oral or written tests.

A sample of a test form can be found in Annex 2. The test form can be used both as a diagnostic test (section A and B) and as final exam (all sections).

Training materials and tools

PowerPoint presentations are provided for the introduction, teaching modules and the teaching methods. The presentations should be used to clarify issues and not as the main source of material. The trainer should not read from the slides but explain the messages displayed on the slides.

To aid the trainer during discussions or exercises, a white board, projector, computer and screen are needed. Papers for group work, chalk, marker pens in different colours, and other materials needed for the exercises should also be available.

Hand-outs of the presentations can be shared with the trainees. Ideally digitally or else print 4-6 slides on one page to save paper.

Certification for trainees

If trainees pass the final exam, a certificate should be provided. Only trainees with a certificate of successful completion of the ToT should be allowed to provide further training in order to ensure quality of training. For training of farmers, a certificate should also be provided to the trainees.

Field trip

Practical training will add substantial value to the training course. The trainer should consider bringing the trainees to an actual fish farm or hatchery. To prepare for the field trip, the trainer should consider the following:

- Select a farm that maximizes the learning value of trainees
- Make arrangements with the fish farm owner
- Conduct a pre-visit to the farm
- Arrange transportation for the trainees

- Provide lunch if necessary
- Bring water quality test kits and tools

The following activities can be implemented at the fish farm:

- Tour of the farm by farm manager
- Practical exercises in small groups (divide the group in 3 groups) and give them 30 minutes for each of the activities:
    1. Farm evaluation: Go around the farm and write down instances of good and bad practices on the farm.
    2. Water quality tests: Take samples from 3 fish ponds, tanks or cages. Carry out the water quality tests and note down the results.
    3. Records: If allowed by the farm owner, each group can study the records and see if there are any records missing and if any conclusion can be drawn from these records (positive or negative) related to GAqP.
- Group discussion: Discuss with the whole group and the farmer which good and bad practices were observed on the farm per module. Compare the results of the water quality tests of each of the groups. Are there any problems with the water quality? If yes, what can the farmer do to improve this? Finally, discuss the records of the farm, are the records complete, do the records show any problems on the farm? What can be improved? These questions can be put in a worksheet to bring on the field trip for easy facilitation.

Teaching exercises

Introduction of trainees

This game will be played at the beginning of the course to familiarise the trainees and the trainer with each other. Games that have the goal to get to know each other are called icebreakers.

Some ice-breaker suggestions are:

1) Question ball

Take a large beach ball or football and write questions all over it. For example, try questions such as:

- What's your current job role?
- What has been your biggest professional achievement?
- If you could have one superpower, what would it be?
- What's your hidden talent?
- What is your favourite fish species?

Tell your trainees to throw the ball around. Each time someone catches the ball, they should answer the question their right index finger landed on. They will then pass the ball on, and on it goes.

2) Introduction interviews

This game will facilitate the trainees and the trainer to get to know each other. Trainees should form pairs and then interview each other. Make sure the pairs do not know each other. Give them five minutes to learn about one another's background, professional experience or passions. Then, do the introduction round, but let the interviewer introduce the interviewee. The intros may look something like this:

This is Peter; he manages a tilapia farm. He is from Bangkok and likes to play chess.

Not only will you make the introductions fun, but you will also help people to connect.

Giving feedback

In this exercise the trainees will practice giving non-judgemental, specific and descriptive feedback.

Show the trainees the following video - web link:
https://www.mindtools.com/pages/article/newTMM_98.htm

Then repeat the following important principles:

- *Be timely*: The closer to the event you address the better. However, in a highly emotional situation it is better to wait till everyone has calmed down.
- *Provide regular feedback*: Feedback requires constant attention so people know where they stand, and it will also minimise surprises or unexpected situations.
- *Be specific*: Tell the person exactly what he/she needs to improve. Describe the behaviour that led to the feedback.
- *Direct feedback:* Feedback should come from you, not something you heard from someone else.
- *Provide criticism in private:* Make sure you are in a safe place to talk where you will not be interrupted or overheard.
- *Start your sentences with "I"*: Give feedback from your own perspective.
- *Limit your focus*: Only give feedback about 1 or 2 issues at the time.
- *Talk about positives as well*: Starting with positive feedback will put the person at ease. Try to end on a good note as well.
- *Provide suggestions:* Ensure that you both know what needs to be done to improve the situation. Check if the receiver understood your feedback.

Now, the trainer will pair the trainees and ask them to provide feedback to each other using above principles. This may be fictional feedback. The trainer walks around and provides feedback to the trainees on giving feedback.

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Annexes

Annex 1: Evaluation form

Good Aquaculture Practices for Food Fish

EVALUATION FORM

Name (optional): _____
Date: _____
Trainer: _____
Venue: _____

Objectives				
Did the training course meet the training objectives?		Yes		No
Did the training course meet your expectations?		Yes		No
Can you use what you have learned in your job?		Yes		No
Please rate the following by circling your choice: 1=unacceptable 2=poor 3= satisfactory 4=good				
Course content				
Relevance of the topics	1	2	3	4
Trainer's knowledge of the subject	1	2	3	4
Trainer was informative, helpful and approachable	1	2	3	4
Presentation of information and explanations	1	2	3	4
Effectiveness of the practical activities	1	2	3	4
Feedback provided	1	2	3	4
Pace of the modules	1	2	3	4
Duration of the course	1	2	3	4
Venue and training materials				
Venue and facilities	1	2	3	4
Hand-outs	1	2	3	4
PowerPoint presentations	1	2	3	4
Videos	1	2	3	4
Questions				
Was there something missing in the training course?				
What can be improved in the training course?				
Do you have any other comments?				

Annex 2: Test form

Good Aquaculture Practices for Food Fish

TEST FORM

Instructions: The questions in the following sections are short answer questions. They are of 2 types:

Section A: These are "True"- "False" questions. Indicate whether the statement is True or False (circle your choice)

Section B: These are multiple-choice questions (circle the correct answer)

Section C: Watch the video (https://www.youtube.com/watch?v=a13dNHcNqaw) and write down which GAqP discussed in this training course the hatchery is implementing.

Each question contains one correct answer only.

Name: _____

Designation: _____

Score: _____

Section A: Indicate which statements are true or false (circle your choice)

1	Food safety is the assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use.	True	False
2	Fish welfare should be considered during all stages of production and harvesting processes.	True	False
3	Implementing GAqP on environmental management does not benefit the aquaculture operations in the long term.	True	False
4	Socio-economic responsibility does not include adhering to labour rights, gender equity, and rights on land and water use	True	False
5	Farms should be sited next to mangroves since these have the ability to clean the water.	True	False
6	When using chemicals for cleaning purposes, products that are used at a dosage higher than recommended can cause permanent harm to employees and the cultured fish	True	False
7	Farms located in the sea do not have to monitor the water quality, since nothing can be done about it.	True	False
8	To ensure the right amount of feed is used, the daily feed requirements should be calculated depending on the biomass and size of the fish.	True	False
9	Veterinary drugs and chemicals should be used daily to prevent diseases.	True	False
10	The collection and disposal of dead and moribund fish should be handled properly, following appropriate hygiene procedures.	True	False
11	After the fish are harvested, they need to be cooled down to a temperature below 4°C as soon as possible.	True	False
12	The goal of traceability in the aquaculture supply chain is to ensure food safety and quality, and guarantee transparency on product information.	True	False
13	Excessive overtime should be allowed to ensure all tasks at the farm are carried out timely and correct.	True	False
14	Clusters have improved access to supplies and financial services.	True	False
15	To reduce the impacts of climate change, farmers should invest in infrastructure improvement, like stronger net cages and stronger pond dikes.	True	False

Section B: Circle the correct answer (or follow the specific instruction of the question)

1. Why is food safety important? a) To ensure animal welfare b) To avoid the introduction of exotic species to the environment c) To avoid foodborne illnesses
2. What is the most important factor when selecting a site? a) The site should have a steep slope b) The availability of a constant supply of clean water c) The site is affordable
3. Why does a farm need to keep financial records? a) For tax purposes b) To assess farm performance c) Both a and b
4. What factors should be taken into account when feeding? a) Feeding times b) The pellet sizes c) The quantity of feed d) All of the above
5. What can a farmer do to prevent disease entering his farm? a) Allow visitors on the farm b) Wear old clothes c) Let employees wash their hands before and pass through a footbath before entering the farm
6. What is an advantage of being part of a farmer's association? a) Farm inputs can be bought together for a better price b) All farmers can negotiate their sales with buyer separately c) Farmers can buy more seed
7. Which water quality reading is a cause for concern? a) DO of 2.5 b) Temperature of 35°C c) pH of 4 d) All of the above
8. Why should a farmer keep records? a) For traceability purposes b) To identify possible problems c) Both a & b
9. What can a farmer do to ensure healthy fish? a) Regular sampling b) Maintain good water quality c) Both a & b d) Neither
10. How can a farmer protect his farm against the effects of climate change? a) Strengthen the farms' infrastructure b) Complain to the government c) Culture sensitive species

Section C: List the GAqP measures implemented by the hatchery in the video

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Exam answers

Section A:
True: 1, 2, 6, 8, 10, 11, 12, 14, 15
False: 3, 4, 5, 7, 9, 13

Section B:
1: C
2: B
3: C
4: D
5: C
6: A
7: D
8: C
9: C
10: A

Annex 3: Glossary

Active substance	Pharmacological ingredient used to induce various effects such as improving disease resistance or accelerating growth
Affected area	Zones affected by organic or chemical discharge, pollutants or disease
Alkalinity	The acid-neutralising capacity of carbonates, bicarbonates and hydroxides in water. Total alkalinity is the total concentration of bases in water, expressed as mg/l of $CaCO^3$
Ammonia	A compound of nitrogen and hydrogen with the formula NH_3
Animal welfare	How an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter/killing. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment (OIE)
Aquaculture	Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants (FAO)
Aquaculture farm	Facility for culturing animals or plants in fresh, brackish or saltwater. In the context of this standard this refers only to facilities engaged in the culture of fish and shrimp
Biomass	Total material of living organisms in a determined place, expressed in weight per unit area or volume
Biosecurity	The optimum state in which there are established measures to prevent the introduction and the spread of disease, or the approach or the principles used to achieve this circumstance
Bottom sludge	Accumulated residual waste from uneaten food and livestock faeces
Broodstock	Adult breeders with desirable traits used to produce succeeding generations of quality farmed livestock
Child labour	Work that deprives children of their childhood, their potential and their dignity, and that is harmful to physical and mental development. It refers to work that is mentally, physically, socially or morally dangerous and harmful to children and interferes with their schooling by depriving them of the opportunity to attend school, obliging them to leave school prematurely, or requiring them to attempt to combine school attendance with excessively long and heavy work (Source: ILO)
Climate change	A change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer
Cluster	A group of people positioned or occurring closely together and collaborating towards a common goal
Competent authority	Legally delegated or globally recognized institution with the power and capacity to perform a designated function, such as a government regulatory agency. In the context of this standard the main competent authority is the Department of Fisheries under the Ministry of Agriculture, Livestock and Irrigation
Compliance	Adherence to laws, regulations, guidelines and specifications

Contamination	Presence of an impurity such as chemical residues or pathogens
Corrective action	Regulation to prompt an organization to reduce or eliminate noncompliance
Cross-contamination	Process where bacteria or other microorganisms are unintentionally transferred to a population or area through direct or indirect contact, often with harmful effects
Cultured stock	Specific livestock strains and species reared and raised for profit or research
Diagnosis	The identification of the nature of an illness or other problem by examination of the symptoms
Discrimination	Negative and unfair treatment of a person or group based on unfavourable public perception
Diseased stock	Livestock afflicted by sickness and disease, impairing their vital functions and ability to breed
Disease symptom	Physical clue which might indicate sickness and disease in livestock
Dissolved Oxygen	The level of free, non-compound oxygen present in water or other liquids
Drug residue	Drugs which remain in the edible tissue and blood of livestock exposed to medication
Ecosystem	Community of live and inert elements such as animals, plants, soil and water interacting as a system linked together by nutrient cycles and energy flows
Effluent water	Liquid waste generated by agricultural, aquaculture or commercial activities which flows out to a natural body of water or public water system. Usually contains pollutants and requires proper treatment before discharge
Environmental Impact Assessment	UNEP defines Environmental Impact Assessment (EIA) as a tool used to identify the environmental, social and economic impacts of a project prior to decision-making. It is intended to predict environmental impacts at an early stage in project planning and design, find ways and means to minimise adverse impacts, design projects suitable for local environment and present the predictions and options to decision-makers
Exotic species	Introduced species also non-native species
Expiry date	Previously determined date after which something should no longer be consumed or used
Extinction	Irrevocable termination of a species caused by the death of its last representative. Species can also disappear in a locality, making them locally extinct
Feed additive	Additional nutrients or drugs to enhance the health or value of the target species for which the feed is intended. Typical additives include vitamins, amino acids, fatty acids and steroidal compounds
Feed conversion ratio (FCR)	Rate which measures the efficiency by which the bodies of livestock convert feeds to meat. Varies per species
Food fish	Fish caught or farmed by people for consumption
Food safety	Proper handling, preparation and storage of food to prevent the spread of disease
Fish health expert	An adequately trained professional with an expertise in fish health
Gender equality	Equal outcomes for women, men and gender-diverse people

Gender equity	Provision of fairness and justice in the distribution of benefits and responsibilities between women and men according to their respective needs
Hatchery	A place or establishment for spawning, incubating and hatching fish eggs and for the rearing of young
Hazard	A level of risk to the quality or safety of a product
Hormones	Chemical signalling molecules which adjust a body's internal mechanisms and responses
Human Resources	The personnel of a business or organization
Hybrid	Offspring of two different species or genera produced by sexual reproduction, sometimes growing larger and more robust than either parent
Hygiene	Conditions and practices that help to maintain health and prevent the spread of diseases
Legislation	Law which has been enacted by a legislature or other governing body or the process of making it
Logical workflow	Progression of elements in a linked workflow. A standard flow is followed if all elements run as expected, whereas an exception path is followed if one or more elements fail to run as expected
Maximum residue levels (MRLs)	Highest level of drug residue legally tolerated in livestock meat or feeds, ensuring that food is safe for human consumption
Medicated feeds	Mixture of animal feed and veterinary premix, which are medicinal mixtures containing one or more active substances
Monitoring	Using water and livestock sensors which deliver real-time or time-series data to give aquaculture operators a clear picture of how their livestock are doing, allowing for better management and improved production
Monosex	Farming or culturing either all-male or all-female populations of a given species
National criteria	Requirements, standards and prohibitions of individual countries or blocs regarding the production and importation of aquaculture products
Native species	Species which are naturally indigenous to a region or ecosystem, as opposed to being introduced by humans
Nitrate	A salt or ester of nitric acid, containing the anion NO_3^- or the group NO_3
Nitrite	A salt or ester of nitrous acid, containing the anion NO_2^- or the group NO_2
Non-native species	Species which have been intentionally or unintentionally introduced to a region or ecosystem by humans, such as farm escapees
Nutrition	The intake of food, considered in relation to the body's dietary needs
Parasite	A plant or animal living in, on, or with another animal and harm it
Pest control	The regulation or management of a species defined as a pest, usually because it is perceived to be detrimental to a person's health, the ecology or the economy
Pathogen	Infectious microorganisms which can cause disease, includes bacteria, viruses, parasites and fungi
Plankton	Floating organisms whose movements are more or less dependent on currents (FAO)
Pollutant	Introduced substance with undesirable effects, usually negatively affecting an area
Polyculture	The production of two or more fish species within a particular aquaculture environment

Pond sludge	Accumulated organic debris which settles at the bottom of a pond. Typically, a mixture of leaves, fish waste and uneaten food. Also called muck or sediment
Post-harvest	Stage of livestock handling after slaughter which includes cleaning, cooling, storage, sorting and packing but does not include processing
Potable	Water which is safe to drink or use in food preparation
Predators	Animals which hunt and eat other animals
Prescribed dosage	Precise amount of medicine or drug to be administered to livestock for optimal results. Normally advised on the label by the manufacturer or per advice from a fish health specialist or veterinarian
Probiotics	Live microorganisms which provide various health benefits to livestock by improving gut flora, digestion and which can also have a positive impact on the water quality
Processing	The action of performing a series of mechanical or chemical operations on food in order to change or preserve it
Production area	Covers all areas where aquatic livestock are grown, raw materials such as feeds are kept, washing and preparation facilities, plus waste containment and treatment zones
Production cycle	Period where market items remain in the production process. Covers all aquaculture steps from site preparation to rearing to packaging of the finished products
Prophylactics	Substances used to deter pathogens and prevent disease which include prebiotics, probiotics, vaccines and immune-stimulants
Quarantine area	Area reserved for the inspection and possible treatment of diseases, weakened, or new livestock which can introduce pathogens along the culture stock
Raw material	Recently harvested unprocessed fish
Reservoir	Natural or manmade lake, pond or concrete tank to store large volumes of water
Risk	Situation which exposes an individual, group or livestock to possible negative consequences
Salinity	Saltiness or amount of salt dissolved in a given body of water
Sanitation	Proper treatment and discharge of wastewater and waste to kill pathogens and minimize the spread of diseases
Seed stock	Larval or juvenile livestock ready to be grown by aquaculture operators to maturity
Slaughtering	Killing livestock for food, research or population culling
Social inclusion	The process of improving the terms on which individuals and groups take part in society—improving the ability, opportunity, and dignity of those disadvantaged on the basis of their identity
Social responsibility	An ethical framework which suggests that an entity, be it an organization or individual, has an obligation to act for the benefit of society at large
Specification	Set of documented requirements to be satisfied by a product or service
Stocking density	The number or biomass of fish stocked per unit area or volume
Stress	Physical or chemical factors which cause bodily reactions that can lead to disease or death. Stressed livestock are highly prone to disease and parasite infection and chemicals released during stress decline the quality of the tissue
Stunning	Process of rendering livestock immobile or unconscious, with or without killing the animal, when or immediately prior to slaughter

Suspended solids	A water quality parameter that is defined as the quantity of material suspended in a known volume of water
Sustainability	The management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations
Traceability	The ability to discern, identify and follow the movement of a food or substance intended to be or expected to be incorporated into a food, through all stages of production, processing and distribution
Value chain	The entire series of activities and transactions needed to make a product and deliver it to consumers
Verification	Evaluation of whether or not a product, service or system complies with a regulation, requirement, specification or imposed condition
Veterinary drug	Drug used by veterinarians in the treatment of animal diseases
Viability	Ability of an organism or concept to sustain itself or fulfil its potential
Water quality	The sum of the physical, chemical and biological characteristics, the same as biotic and abiotic factors influencing the use of a waterbody, based on the performance of the site living species
Wild breeder	Wild-caught and sexually mature livestock kept to produce quality seed stock
Withdrawal period	The time needed after drug administration to any food animal where drug residues may still be found in marketed meat or other edible parts or products

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