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Best management practices for commercial tilapia reproduction in Northeast Africa

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Best management practices for commercial tilapia reproduction in Northeast Africa

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Table of contents

Introduction

Tilapia hatcheries are the most common type of fish hatchery in Egypt, as well as many other countries globally. Their success has helped supply fish farms with quality tilapia seed, which in turn has increased farmed fish production in many parts of the world. With the fish farming industry growing so quickly, however, tilapia hatcheries must improve the quality of their seed production for fish farmers to maintain their profit margins.

To this end, these guidelines document the most optimal, locally appropriate, management practices for culturing Nile tilapia. There are currently three hatchery systems in use in Egypt for Nile tilapia: (1) concrete tanks with a water-heating system, (2) hapas under plastic tarps and (3) hapas in open ponds. Observing the best management practices (BMPs) in these guidelines will increase productivity in hatcheries and produce highly vigorous and uniform fry that are free from disease and malformations. In this way, hatcheries will be better placed to meet the demand among fish farmers in the country for high quality tilapia fry and fingerlings.

BMPs emphasize the optimal use of production inputs such as good broodstock and appropriate feeds for each specific stage. They also underscore the proper management necessary for rearing broodstock and collecting eggs as well as for better nursing approaches for fry after the eggs hatch, with a focus on nutrition. Attending carefully to these BMPs ensures that the available resources and operation elements are used properly, without compromising environmental protection.

To draft the first version of this report, WorldFish Egypt organized a workshop for private sector experts and entrepreneurs to discuss the BMPs for local tilapia hatcheries in 2013. Those BMPs are summarized in this manual.

1. Site selection and hatchery design

1.1. Site selection

The hatchery site must be located in an area where it is legally permissible to establish the project, so as to facilitate licensing.

In addition, the following points need to be taken into account:

- The local regulation authority permits an aquaculture project to be established at the location and issues a business license when/if needed.
- The site has access to a sustainable and sufficient source of water.
- The site is located close to fish farms for easy marketing.
- The site is accessible by paved road.
- The site has access to an energy source, either electricity or fuel.
- Water must be free from pollutants. Underground water is best-suited for use in fish hatcheries, as long as it is free from contamination.
- There must be sufficient distance between the site and nearby fish farms to apply biosecurity measures.
- The site is suitable in terms of weather conditions, avoiding areas with extreme ambient temperatures.

1.2. Spawning units

This manual describes the most common hatchery designs that can work in countries where the Advancing Climate Smart Aquaculture Technologies (ACliSAT) project operates, as well as in many countries in Africa. The main hatchery designs are concrete tanks under a greenhouse, hapas in open ponds and hapas under a greenhouse.

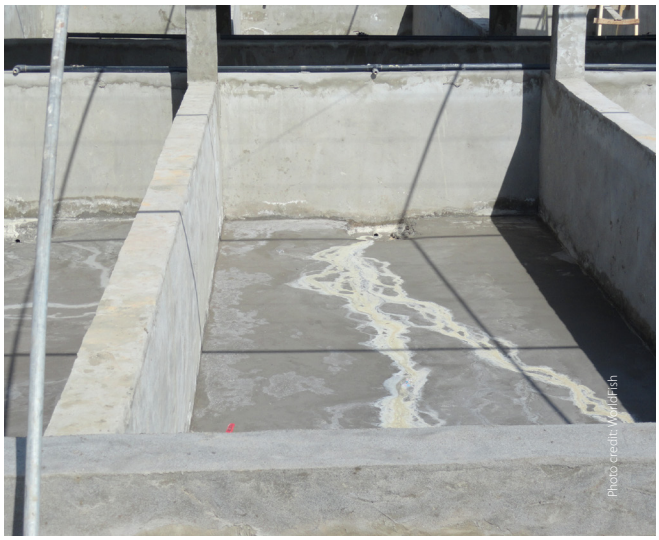

Plate 1. Traditional concrete tank for tilapia spawning.

1.2.1. Concrete tanks

- In Egypt, the most common design for tilapia hatcheries is the concrete tank: 8 m long x 3 m wide x 1 m high.
- Each tank is supplied with an irrigation inlet (cold and warm water), with a drainage outlet at the opposite side.
- The tank's bottom slopes toward the drainage outlet and ends in a small basin (50 x 50 cm) for fry collection.
- Use an epoxy paint for the tank walls to make cleaning easier and to reduce pathogens' build up in the cracks of the cement. Epoxy paint is safe for fish.
- All tanks are equipped with an aeration system through hoses attached to an air blower. Install narrow-meshed nets on both irrigation and drainage pipes to prevent undesirable eggs and/or fry from entering the tank.
- To make servicing the tank simpler, place a wooden walkway in the middle of the tank for easy movement.

1.2.2. Hapas

- Use hapas for spawning or as fry rearing units. The dimensions are 6–8 m long x 2–3 m wide x 1 m high.

- Fix hapas inside an earthen pond with wooden sticks.
- Cover the pond with a plastic sheet to form a greenhouse. This will raise water temperatures early in the season, making them suitable for spawning.
- At times, replace the pond water, especially on hot or sunny days.
- If the water temperature is low, warm it up to the appropriate level.
- When needed, use a blower to maintain dissolved oxygen levels.
- If predatory birds are in the area, cover the hapa pond with a bird net.

Plate 2. Hapas fixed in open ponds for spawning.

1.3. Hatchery design

A hatchery should have a settling pond or basin to filter or treat the incoming water in order to enrich the water source with oxygen and reduce the level of ammonia. The same source can be used to recycle water within the hatchery if the quality of the water deteriorates.

When designing a hatchery, the following points must be considered:

- Specify the spawning system using one of the three different hatchery systems of Nile tilapia listed in the introduction.
- Specify the targeted annual production to define the number of brooders and fry units, and the required capacity of water pumps, water-heating and ventilation devices.
- Specify the number of tilapia broodstock (males and females) based on the targeted annual production.
- Ensure easy access to irrigation and drainage to facilitate operation and reduce costs.

1.4. Egg incubation unit (egg hatching lab)

Some hatcheries depend on collecting eggs from brooders, with a view to obtaining the largest possible number of fry during the season. In this case, the hatchery will include egg incubation vessels connected to a source of running water from bottom to top to ensure the eggs are regularly stirred until hatching takes place. Fry are then moved to the rearing units for feeding.

Plate 3. Egg incubation vessels in tilapia hatcheries.

1.5. Heater for warming water

Most tilapia hatcheries in Egypt start operating in mid-January or early February. This allows enough time to produce seed that are ready for sale by the beginning of April, which is when the growing season begins for farms. To stimulate spawning, the water needs to be warmed up to 26°C. This is why a heater is needed to produce seed at this time of year.

Some hatcheries are equipped with automatic built-in thermostats to control the water temperature. But most use a heater to heat up the water and add it to the spawning tanks/units at night or during the day whenever the temperature is too low.

1.6. Plastic tunnels (greenhouses)

Plastic tunnels are used in winter and spring. The plastic sheets are removed in summer. When covered with plastic sheets, the hatchery's water temperature rises 3°C–4°C. The sheets also help maintain the water temperature in hatcheries that use water boilers. The main purpose of using plastic sheets is to warm up the water to enable early spawning.

1.7. Air blower

High stocking densities for fry during rearing require an aeration source, like an air blower, especially as the fry get bigger. It is imperative to maintain a dissolved oxygen level higher than 4:5 mg/L to guarantee the highest possible growth rate during the nursing period.

1.8. Generator

A generator is needed as a backup source of electricity to replace the main supply in case of an electricity failure. It is necessary for operating pumps and other electric appliances at the hatchery.

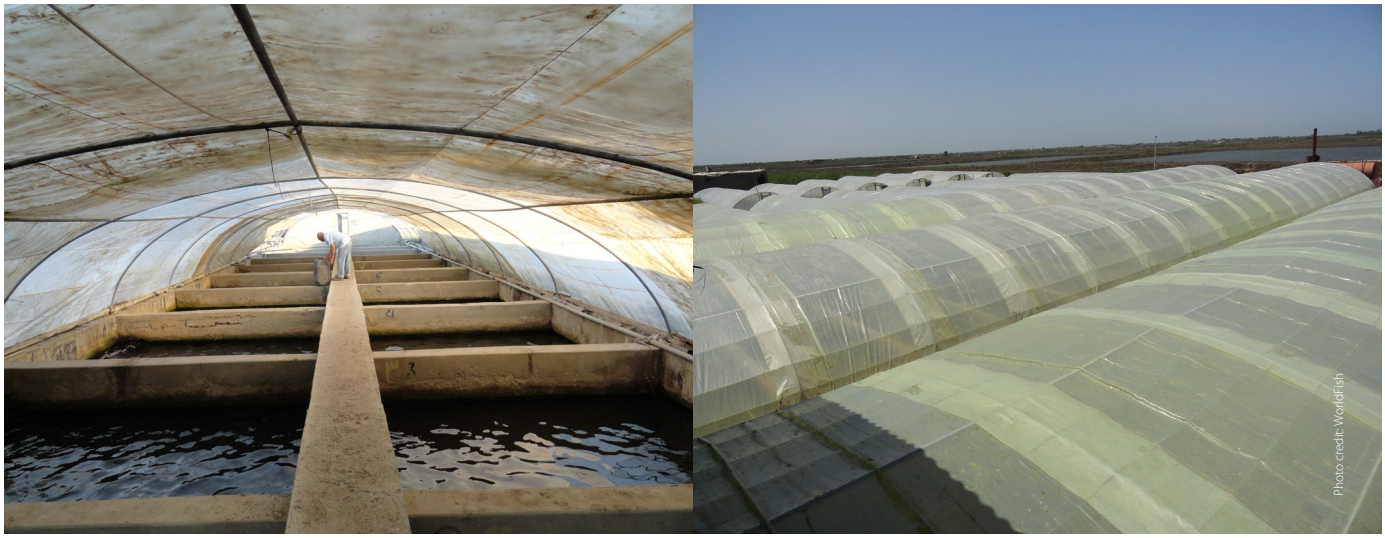

Plate 4. Tilapia hatcheries under plastic sheets.

2. Broodstock selection and management

A major key to the success of any hatchery is selecting and replacing broodstock. This is done based on overall appearance, health and vigor. However, farmers must also take into account the following factors:

- Nile tilapia has transverse and longitudinal dark lines along the entire length of both the tail and back fins. The fewer the number of lines or the absence thereof on the tail fin, the more probable that the fish is a hybrid with other species.
- Establishing a broodstock population with high reproductive efficiency and prolonged life requires selecting younger brooders (1–1.5 years old). Brooders should weigh an average of 300 g. It is also advisable to renew the broodstock every 3 years or at 4–5 years old.
- Select highly vigorous, well-fed brooders and avoid feeble or diseased ones.
- Replace broodstock periodically to maintain their reproductive performance.
- The replacement and renovation program must outsource broodstock from different areas to avoid inbreeding, as this results in problems with fry development, such as low growth rates and malformation.

Plate 5. Nile tilapia

2.1. Managing genetically improved tilapia brooders

When spawning a genetically improved strain of Nile tilapia, the hatchery operator must have adequate management knowledge and skills to avoid inbreeding and to maintain the genetically improved traits, such as rapid growth.

Inbreeding results from mating among closely related brooders. When a limited number of brooders is used in spawning, the chances of inbreeding increase. Inbreeding reduces the quality and immune response of fry, making them more susceptible to disease, which can lead to a higher mortality rate in seed. It also reduces the reproductive performance of the brooders and subsequently their ability to produce genetically improved seed.

Good broodstock management requires the following:

- Replace brooders (males and females) regularly from specialized multiplication centers.
- Keep records for each batch of broodstock, including all relevant information and place of storage (tank, pond, hapa). Maintain each brooder's age category separately.
- Renew the broodstock population every 3 years (i.e. generations) from the multiplication center.
- Increase the effective size of the broodstock population to minimize inbreeding.
- Breeders must recommend a female to male sex ratio of 1:1 to minimize inbreeding, especially in strain production.
- Maintain regular communication with the strain improvement center to keep abreast of developments in the genetic improvement program of Nile tilapia.

3. Hatchery pre-spawning preparation

Before the start of the spawning season, hatcheries must make the following preparations:

- Clean brooder units and prepare to receive the broodstock before filling the units with water. Make sure that a narrow-meshed net is tightly fixed to the irrigation and drainage pipes and that the plastic sheet of the tunnel is free from any punctures or cracks.
- If the hatchery uses hapas, clean and examine them to confirm that there are no defects. Make sure that aeration hoses have been placed into the units. Prepare barrels to be used for moving female broodstock from the earthen ponds to the hapas.
- Check the efficiency of water pumps, ventilators, boilers and egg incubators. Do any necessary maintenance as the need arises.
- Make sure that spawning inputs and tools, such as nets, scoop nets and utensils, are available.
- Make sure that laboratory requirements, including chemicals and disinfectants, are available.
- Buy feeds for broodstock and fry, and then store them in a well-ventilated, rodent-proof warehouse.
- Ensure easy access to fuel for hatchery equipment, such as heaters, pumps and generators.

3.1. Stocking brooders

Normally, brooders are stocked into the spawning units (tanks or hapas) about 15 days before the spawning season. They are collected during the daytime when the temperature is warm, and males and females are moved separately into the hatchery.

Keep males and females in separate tanks or hapas for feeding before spawning. Start feeding the day after stocking, and raise the water temperature gradually up to 26°C. Use specialized feeds to compensate for weight loss during the wintering period in the earthen ponds and to accelerate ovulation and spawning.

After confirming that females are ready to ovulate, stock both sexes into the spawning units at a rate of 2 females to 1 male. Keep the average weight of broodstock in each spawning unit just about equal.

Plate 6. Male (left) and female (right) Nile tilapia.

3.2. Feeding brooders

Tilapia females incubate eggs in their mouth, so brooders should stop feeding them during the incubation period. The fish exhaust their internal food reserve 10–12 days from the start of egg incubation until hatching takes place. This explains why spawning is so stressful for female fish. It also justifies the need for balanced feeds to improve their reproductive capacity and to produce highly vigorous fry that are free from malformations.

The crude protein content of feed for brooders should be 30%–35%. Floating feeds are currently used to reduce feed loss and maintain water quality. Feeding takes place twice a day at a rate of 1%–2% of bodyweight. As the female fish start to spawn, their appetite decreases remarkably because of egg incubation in the mouth before hatching. Explained in section 5; when female eat less, this indicate spawning started and that she is carrying egg in their mouth.

4. Water quality management

The hatchery's water must be appropriate for fish growth and reproduction (Annex 1). As such, it is important to analyze water from the source to detect any abnormalities in physical characteristics (such as clearness, turbidity, odor and temperature) or chemical properties (such as dissolved oxygen, salinity, alkalinity, pH, ammonia, nitrite, nitrate, phosphorus, potassium and pollutants).

The hatchery operator must determine the amount of water needed daily to secure the equipment necessary for replacing the water. Regular water analysis determines the most suitable approach to water quality management in the hatchery, and it also helps define when to replace the hatchery's water and use aeration equipment.

Using underground water, where legally permissible, can be useful to make up for a shortage in surface water. However, it is necessary to check the quality of the groundwater before using it (Annex 1). Groundwater is preferred for tilapia spawning because the temperature is close to the optimal level for spawning. During periods when water is scarce, operators can reuse water after filtration. But water use, or reuse, must be rationalized to reflect required needs.

4.1. Water replacement

Water replacement is a function of the following:

- stocking rate (fish or fry) in ponds/tanks (fish biomass)
- quantity of fish feeds added to the rearing unit
- dissolved oxygen level in the water
- quantity of organic waste and settled solids in the pond
- water temperature.

Deteriorating water quality exposes brooders to stress and reduces their appetite. Fish held in low quality water are more susceptible to disease, which has a negative impact on their reproductive capacity.

In fry nursery units, low quality water can lead to the following:

- low appetite and incomplete sex inversion to all-male populations
- poor growth rate, production of malformed fry and declining survival rates
- sharp shortages in the level of dissolved oxygen, which can lead to higher mortality and therefore reduced sales revenue, even financial loss for the hatchery.

Fish tank aeration.

5. Spawning management

Spawning management starts immediately after stocking brooders into spawning units. After stocking, feeding starts along with regular cleaning of the rearing units. Water temperatures in greenhouses must be maintained around 26°C. In Eritrea, the spawning season differs with location. In the highlands, it extends from mid-April to mid-June, but lasts all year in the lowlands.

It is important for hatcheries to follow these measures:

- When brooders eat less feed, this means spawning has begun and females are incubating eggs in their mouths.
- After 10–12 days (according to the temperature), collect fry from the brooder basins and move them into the fry rearing units. When collecting eggs from brooders, transfer the eggs into the hatching jars, where the incubation period continues until hatching occurs. Keep the water temperature between 25°C and 28°C. After hatching, move the fry into the nursery units for hormonal treatment after they have absorbed their yolk sac.
- It is better to replace brooders after the release of eggs with similarly prepared ones for subsequent spawning. Brooders need intensive feeding to compensate for the loss of feeding during egg incubation, whereas previously prepared brooders need only 10–12 days for spawning. Replacing brooders is intended to increase fry output at the beginning of the season and for earlier sale of the largest possible quantity to meet the high demand at the start of season.
- When the number of fry collected from a specific spawning unit declines, replace the males in the tank with rested males.

Tilapia fingerlings before delivery.

6. Fry nursery and monosex fry production

Larvae hatch during the first phase. They carry their yolk sacs with them and continue to feed on them for 2–3 days, according to the ambient temperature. After they completely consume their yolk sacs, they are then stocked into the treatment units at a rate of 2000–3000 fry per square meter. The holding capacity of each unit is reached within no more than 1 day to avoid discrepancy in fry sizes after treatment. Any increase over this density could reduce the effectiveness of the hormonal treatment, which is calculated from the day following stocking in the nursery unit.

6.1. Fry feed preparation

The level of protein in fry feed should not be less than 40%. Feed must also be rich in fats, vitamins, minerals and immunity-enhancing ingredients to feed the fry during the nursing period.

Plate 7. Top: recently hatched tilapia fry (during collection). Bottom: stocking tilapia fry in rearing units.

6.2. Sex reversal

Most tilapia hatcheries in Egypt use the masculine hormone 17 α-Methyltestosterone (MT) to produce monosex fry. The process of monosex production using MT is not prohibited, as the EU and US markets allow tilapia to be imported from countries producing monosex tilapia. The ministerial decree organizing this issue states that mixing hormone with feed should be done with caution in feed mills.

The following steps describe what hatcheries must do when mixing MT with fry feed:

- Train dedicated staff on health safety measures and on wearing masks and gloves before preparing the feed and mixing it with hormone (section 13).
- Dissolve 10 g of MT in 1 L of 95% ethyl alcohol, and keep the solution in a fridge. It is good for use within 3 months.
- Grind the feed well. Particles should be fine, with the diameter ranging between 400 and 1000 micrometers so that early hatched fry can feed on them. Use a narrow screen sieve to remove larger feed particles.
- Add the hormone at a rate of 60 mg for each kilogram of feed, with 6 ml of the standard solution added to 0.5 L of pure alcohol. Add the mixture to 1 kg of the prepared feed to disperse the hormone properly throughout the feed. Then spread the feed over a clean plastic sheet in a well-ventilated place, without direct exposure to the sun. The feed layer's thickness should not exceed 2 cm so that the alcohol will evaporate within 24 hours. By this time, the feed is ready for fry to eat.

6.3. Feeding fry

Feed fry with a previously prepared ration that is rich in protein and the added hormone. Tilapia fry are fed at start of nursery at a ratio of 20%, to be reduced to 12% by end of nursery (21 days). Provide feed to tilapia fry 5–6 times a day until the end of the hormonal treatment or the primary nursery period. Spread the hormone-treated feed on the surface of the water of the rearing unit to

give all fry equal access to it. Continue feeding for 21 days to ensure successful sexual inversion, where the male ratio reaches 98%.

6.4. Fry harvest

Harvest fry at the end of the nursing period. Either move them to clean basins as a preliminary step before they are sold or to rearing units for growth into fingerlings. When selling fry directly from nursing units, the hatchery operator must make sure that there is no waste or precipitate in the units.

Hatcheries must carefully observe the following conditions at fry harvesting:

- Avoid harvesting/handling the fry at noon or in case of high temperatures.
- Grade the fry at harvest to accurately determine their numbers before sale or transportation. Avoid size discrepancies that could occur at the rearing units.
- Move the fry to the storage units in barrels or plastic basins, and avoid overcrowding to reduce stress or loss of part of the harvest during transfer.
- The size of the counting scoop net at sale varies with the size of the fry. Count a scoop sample before packaging the fry for sale. The number of fry per bag varies according to the size of the fry and the distance traveled.

Plate 8. Preparing fry feed (spread for alcohol evaporation).

7. Fry rearing for fingerling production

Larger operations with adequate areas of earthen ponds use the ponds to rear fry into fingerlings, especially in July and August when demand is low. Fingerlings reared in this way are sold at the beginning of the following season, when they can fetch a premium price.

Hatcheries should apply the following steps to rear fry successfully:

- Dig a ditch in the middle of the earthen ponds to prepare rearing units for overwintering. The fry use the ditches when temperatures drop.
- During rearing, stock the fry at a rate of 100,000–300,000 per feddan (one feddan is 4200 m^2 or 0.42 ha), according to the targeted fry size and the duration of rearing.
- When stocking fry in ponds, do so in the direction of the wind across the pond.
- At the beginning of rearing, give fry powdered feed, with 30% protein, at 10% of their bodyweight. Reduce the amount of feed gradually to 5% of their bodyweight by the end of the rearing period. To reduce the cost of rearing, make sure to fertilize the rearing ponds.
- Before the start of winter, increase the water in the nursery or overwintering ponds to the highest level to reduce the effect of lower air temperatures on fry reared in the ponds.
- Harvest fingerlings at the end of winter or in early spring to sell them at a premium price.

Putting the fry in bags.

8. Marketing

Marketing is an important part of hatchery management that requires knowledge of the whereabouts of fish farmers and their requirements throughout the year. Several factors affect marketing, including the track record and reputation of the hatchery and the results achieved at the farms that bought their seeds from the hatchery in previous years.

A successful marketing strategy requires the following:

- Avoid selling fry in hot weather.
- The number of fry per plastic bag is a function of the size of the fry and the distance to the destination. When transporting to remote distances, reduce the number of fry per bag.
- Use clean water and avoid turbidity inside the bags.
- Load the fry packages on the vehicle. Make sure that there are no protrusions to avoid any possible punctures.
- Fill each bag with one-third of clean water. The other two-thirds are filled with oxygen. Do not use air from a blower to fill the bags.
- Cover the bags in the car with a sheet to protect the fry from the sun.
- In hot weather, place crushed ice around the bags to help keep them cool and avoid stressing the fry.
- Transfer fry or fingerlings in fridge cars during hot weather.

Plate 9. Transferring the bags in a fridge car (left) and scooping fry (right) at a private hatchery in Kafr El-Sheikh governorate.

9. Recordkeeping

Bookkeeping is an important day-to-day function at any hatchery. Bookkeeping includes for example, (i) recording basic process, together with other spawning unit data, (ii) all technical operations of brooder and fry units and (iii) the start and completion dates of hormone treatments and nursing for all units. Likewise, the tentative date of fry delivery, along with the survival and feeding rates at every nursing unit, should be recorded as well.

Records are often consulted to rapidly assess any operational problems that can emerge at a hatchery. They are particularly useful when new brooders are introduced from outside the hatchery to determine where to stock them and for monitoring their seed production.

Hatcheries should keep the following records:

a. Broodstock record

Year: _____ Month: _____

Unit #	Brooders			Mean weight		Mortality		Total	Remarks
	M	F	Total	M	F	M	F		

b. Nursery unit record for Nile tilapia fry

Batch number: _____

Hatching season: _____

Unit #	Start date	Number of fry	End date	Number harvested	Mean weight (g)	Survival rate	Remarks
Total							

c. Feeding records of brooders for each unit

Unit number: _____

Stocking date: _____

Expected date of spawning: _____

Number of broodstock (male and female): _____

Average weight of broodstock (male and female): _____

Date	Feed/day/kg	Temperature	Remarks
Feed Total			

d. Fry feeding record for each unit

Unit number: _____

Date of rearing: _____

Expected date of completion: _____

Total number of fry: _____

Number harvested: _____

Average weight (g): _____

Date	Feed/day/kg	Temperature	Remarks
Feed total			

10. Biosecurity and health management

Managing the health of brooders and seed is another key to the success of any hatchery operation. Good health management leads to the production of highly vigorous fry that are free from disease.

Hatcheries should take the following biosecurity measures for hatchery design, management and equipment maintenance.

10.1. Design

- Use a wheel dip with disinfectant at the entrance to the hatchery.
- Make a footbath and a handwashing station available for workers and visitors before entering any hatchery unit.
- Ensure each tank is a separate unit (with its own water inlet and outlet) to avoid cross-contamination.
- Build the quarantine unit away from other hatchery units.

10.2. Management

- Avoid unnecessary movement of fish or rough handling, and maintain appropriate stocking density.
- At the beginning of the season, place brooders in a 3% saline water bath for 30 seconds before stocking them.
- After collecting fry or eggs, disinfect brooders with potassium permanganate before transferring them to other units.
- Remove any dead fish immediately and dispose of them properly, as they could be a source of infection.
- Send moribund or recently dead fish to a health lab for proper diagnosis and to determine appropriate treatment.
- Keep accurate records for health monitoring. These include introducing new fish, looking for abnormal behavior, the onset of mortalities, number of affected fish, clinical signs and applied treatment, as well as any other factors that likely contributed to disease occurrence.
- Whenever brooders are brought in from outside the hatchery, rear them in separate rearing units (quarantined) for 1 month before stocking them with the hatchery's brooders. This will help avoid introducing new disease-causing agents into the hatchery. During the quarantine period, carefully monitor the health of the new stock. Handle the quarantined brooders as a separate unit. Treat drainage water coming out of the quarantine, and disinfect it before discharging it out of the unit.
- If the brooders have been imported, get a health certificate that ensures they are free from pathogens of major concern.
- Maintain water quality at optimal levels to avoid stressing the brooders or fry.
- Use high quality feeds for both brooders and fry. Immunity-enhancing substances can be added to the feeds to improve health and prevent malnutrition.
- Store feeds in an appropriate storehouse away from high temperatures, humidity and rodents.
- The order of movement for hatchery staff is important. Visit the youngest batch first, then the oldest batch. In addition, be sure to handle asymptomatic or apparently healthy stock first and then infected or diseased stock afterward.

10.3. Equipment

- Clean all hatchery equipment, such as plates, buckets and nets, prior to use, and then disinfect them for 1 minute using potassium permanganate at a dose of 1 g/L.
- Keep equipment separate for each unit. If possible, each tank should have its own equipment. Also, use specific equipment to collect dead fish.
- Annex 2 includes a list of common disinfectants used in a freshwater hatchery. Note that the duration of treatment varies according to the dose.

11. Quality assurance

Producing good seeds is necessary for a hatchery to build and maintain a good reputation.

The following procedures must be carefully observed to produce highly vigorous seeds of uniform size that are free from disease:

- Secure brooders from a trusted source. The strain has to meet the morphological characteristics of Nile tilapia. It is, however, advisable to buy brooders from a multiplication center for genetically improved strains.
- Replace brooders with new ones of the same species every 3 years.
- Buy hormone from a reliable source and keep it in a refrigerator.
- Use pure alcohol when preparing the standard solution for solubility of the hormone.
- Feed brooders balanced diets to produce highly vigorous fry and to reduce loss.
- During the nursing/treatment duration, feed fry with specialized high quality artificial feeds of proper size to safeguard the production of highly vigorous fry.
- Prepare feeds (section 6) and keep them in the fridge until they are used to feed the fry.
- Abide by the hormone concentration (60 mg/kg) of the feed to produce a monosex fry population (98% males). Note that higher concentrations of hormone could reduce the efficiency of the sex reversal process.
- Start feeding the fry with a hormone-treated feed immediately after they finish consuming their yolk sacs. Delaying feeding could entice the fry to feed on natural food, which reduces the potential success of sex reversal.
- Feed fry hormone-treated feed for 21–28 days.

Remarks

- A higher concentration of hormone does not reduce the treatment period. Doing so could even reduce the efficiency of the sex reversal process for the fry.
- Reduce fry density in the plastic bags, especially when they are transported to remote areas. Inject an adequate quantity of oxygen to reduce fry losses.
- Rear a sample of the fry in units annexed to the hatchery, and examine them to confirm the percentage of males. This is a good practice for any hatchery to build its reputation and credibility.
- Good hatcheries should consider applying for certification by complying with all the requirements of either a public or private third party to get their hatchery certified.

12. General considerations for environmental protection

Any attempt to produce an all-male population by treating tilapia fry with a hormone can have negative environmental effects, as the hatchery's drainage water can contain residues of the hormone. This could affect fish in the surrounding water streams, either directly or indirectly, through them feeding on microfauna or microflora, which would increase the hormone concentration in natural fish populations. Likewise, disinfectants used at the hatchery could end up in the surrounding waterways through the drainage water.

To mitigate the environmental impact around the hatchery, it is necessary to implement the following precautions:

- To break down hormone residues, drain the hatchery water into specially designed sedimentation basins.
- Apply disinfectants at the recommended concentrations to minimize their impact on fish and living microorganisms in the drains.
- Bury dead fish immediately. Do not dispose of them in adjacent drains.
- Manage fry feeds well to reduce feed losses and maintain the hatchery's water quality. Notice that lowering the fry feeding rate reduces the efficiency of producing monosex fry.
- Ration water use at the hatchery, and aerate the water to minimize water replacement. Do not use too much water when washing the rearing units.

Collecting fry from hapas.

13. Social responsibility

Social responsibility in the framework of commercial tilapia reproduction means strengthening the relationship between the hatchery operators and the surrounding community, including individuals, residential areas and other activities.

Hatcheries should consider taking the following measures to strengthen their reputation within the community:

- Participate alongside the community in emergency situations that could happen in surrounding areas, and support the activities of community development associations.
- Work in hatcheries requires getting into the water. This can negatively affect the health of staff, so meeting their social needs and health care requirements is imperative, not only for laborers but also for their family members. This will undoubtedly increase their sense of belonging to the workplace.
- Train staff on how to use disinfectants properly for their own personal safety.
- Ensure that masks and gloves are readily available at the hatchery, and train staff on how to use them when dealing with or handling chemicals.
- Contribute to community development and charitable projects in the community.
- Employ labor/staff from people living around the hatchery, especially seasonal labor.
- Cooperate with other nearby hatcheries in abiding by the recommended hormone concentration.
- Dispose of waste safely to protect the surrounding environment.

Tilapia egg incubation in a hatchery.

Annex 1. Water quality parameters

	Optimal limit
Dissolved oxygen	5–15 mg/L
TAN	< 0.4 mg/L
NH_3	< 0.1 mg/L
NO_2	< 0.3 mg/L
pH	7–9
Phosphorus	0.005–0.2 mg/L
Calcium	5–100 mg/L
Sodium	2–100 mg/L

Source: Boyd CE and Tucker CS. 1998. Pond aquaculture water quality management. Springer Publishing Company. New York, USA.

Table 1. Optimal water quality parameters for freshwater fish farming.

Annex 2. Disinfection

Disinfectant*	Dose and use		
	Dipping	Water bath	Indefinite
	30–60 seconds	60 minutes	
Copper sulfate	500 mg/L	4 mg/L	Alkalinity level/100
Formalin	400 mg/L	250 mg/L	15–25mg/L
Potassium permanganate	1000 mg/L	20 mg/L	2 mg/L
Madeline blue	1000 mg/L	20 mg/L	2 mg/L
Salt	3% (30 g/L)	1% (10 g/L)	0.02% (0.2 g/L)

Source: Edward J. Noga. 2010. Fish Disease: Diagnosis and Treatment, Second edition. Wiley-Blackwell, Ames, Iowa.

**Always consult the local authority, as permission to use disinfectants can vary from country to country.*

Table 2. Doses and use of disinfectants for treating fish in a hatchery.

About WorldFish

WorldFish is a leading international research organization working to transform aquatic food systems to reduce hunger, malnutrition, and poverty. It collaborates with international, regional, and national partners to co-develop and deliver scientific innovations, evidence for policy, and knowledge to enable equitable and inclusive impact for millions who depend on fish for their livelihoods. As a member of CGIAR, WorldFish contributes to building a food- and nutrition-secure future and restoring natural resources. Headquartered in Penang, Malaysia, with country offices across Africa, Asia, and the Pacific, WorldFish strives to create resilient and inclusive food systems for shared prosperity.

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