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Better management practices for tilapia culture in Egypt

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Better management practices for tilapia culture in Egypt

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FISH is developing the Better Management Practices (BMP) guidelines at the global level and contextualised BMP resources at the country level to support sustainable and responsible tilapia farming in WorldFish focal and scaling countries. This country specific BMP instruction manual, produced as part of this approach, is hoped to enhance the capacity of grow-out farmers and extension service providers in Egypt to support scaling of WorldFish technologies (e.g. GIFT) and package of practices (e.g. BMPs).

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Introduction

This manual is the second version of the guidelines for best management practices that were developed in 2013 through the Improving Employment and Income through Development of Egypt's Aquaculture Sector, funded by the Swiss Agency for Development and Cooperation. The first draft of this manual was developed after a field survey of existing fish farming practices and a 2-day workshop held at WorldFish Egypt with local experts. Through the CGIAR Research Program on Fish Agri-Food Systems (FISH), WorldFish organized a global workshop for developing a standard version of the guidelines for better management practices (BMPs). BMPs refer to a set of standardized management guidelines that are developed based on existing practices and associated risks, as determined in consultation with farming practitioners and relevant industry stakeholders. Where appropriate, new innovations are also routinely incorporated into BMPs to facilitate continuous improvement in farming practices (Thanh Phuong et al. 2011).

BMPs are not designed to achieve certification. Rather, they are considered to apply at the "precertification" stage, after which farmers are likely to be better prepared to comply with more stringent certification standards should they wish to proceed down this path for purposes of securing market access.

Photo credit: Sayed Abdel Kader/Ahram newspaper photographer

Ponds overview.

1. Site selection and pond design

Site selection

Before selecting a site to establish a fishpond, farmers need to consider some technical and legislative factors. In addition, they need to explore and survey available areas allowed for aquaculture activities.

A site should meet the following criteria:

- The local regulation authority permits establishing an aquaculture project at the location and issue a license for business when/if needed.
- The site has access to an adequate and sustained quality water supply and is connected to a drainage canal to drain the pond water when needed.
- The soil is compact, has good water retention capability and is fertile (clay soil).
- The site is accessible by road.
- The site has an available power source, either electricity or fuel, and a drinking water source.
- The site is close to markets.
- The site is away from any contamination, seawater rise and flood runoff.
- There are no disease outbreaks in surrounding farms.
- There is sufficient distance between the selected site and nearby farming activities to apply biosecurity measures.

Pond design and construction

It is advisable to have a settling pond/basin for biological filtration of the water coming through the inlet to enrich the water source with oxygen and reduce the level of ammonia. The same pond/basin can be used for recycling water within the farm if the quality of the water source deteriorates. For biosecurity considerations, every farm should have a treatment basin/pond to treat or aerate the water before it flows into the ponds. This will reduce ammonia levels in the water, enrich it with oxygen and eliminate unwanted fish species from getting into the farm.

When designing and constructing a pond, farmers must consider the following:

- Ponds range in size from 0.5 to 2 feddan (0.25–1 ha)—1 feddan is equivalent to 4200 m2 (0.42 ha)—according to land topography and level of intensification, cultured species and marketing strategy. Smaller ponds are easier to manage and use in intensive production than larger ponds.
- It is recommended to orientate ponds from west to east to avoid dike erosion from wind-driven water currents.
- Rectangular ponds are better than square ones because they are cheaper to construct and easier to manage.
- Make sure that pond dikes have appropriate slopes and have been sufficiently compacted to prevent water leaking from one pond to the other.
- Slope the pond bottom toward the direction of the drain outlet or to the ditch.
- To facilitate fish harvest, dig a ditch 2–3 m wide in the lowest area of the pond bottom, and make sure the ditch slopes toward the drain outlet.
- In small ponds, the ditch can lie in the middle of the pond, while in larger ponds the ditch should take an L shape.
- To maintain the ditch, leave a strip 3–4 m between the dike and the ditch.
- Place the inlet and outlet pipes at opposite ends of the pond.
- Attach a fine screen on the inlet and outlet pipes to prevent unwanted fish from entering the pond.
- Place the drainpipe at the bottom of the pond and place the irrigation pipe above the water surface.

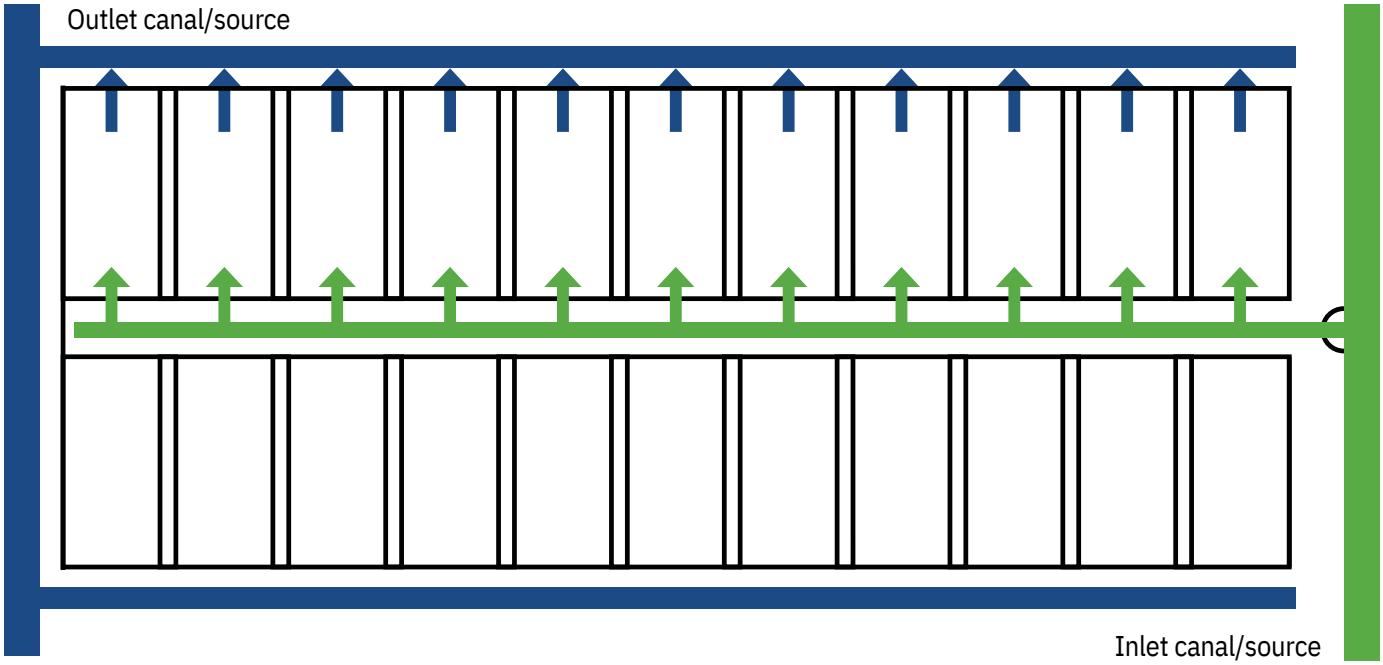


Figure 1. Farm layout showing pond design, water inlet (green) and water outlet (blue).

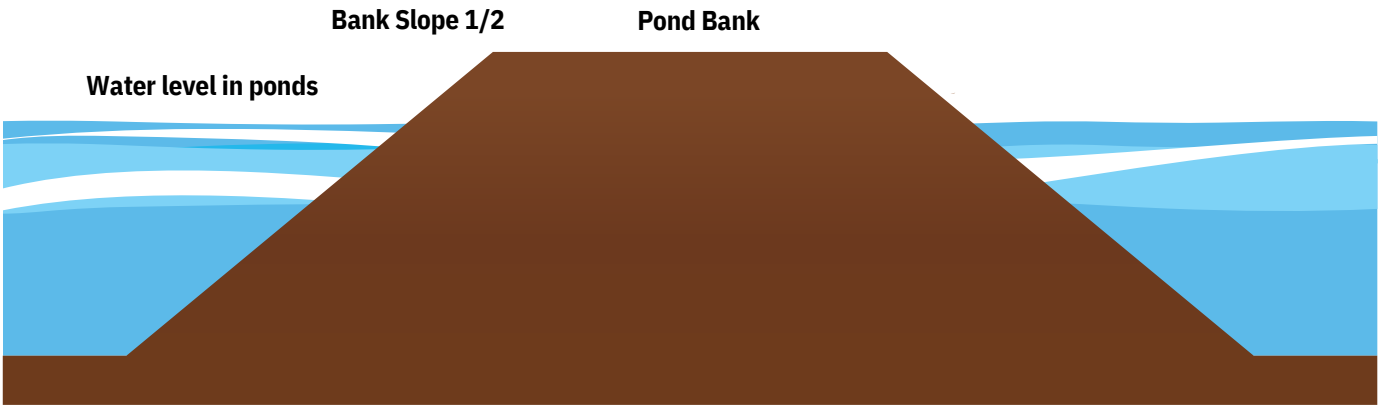


Figure 2. Cross section in pond bank separating two fish ponds. (Note the bank slope, water level in ponds and bank height.)

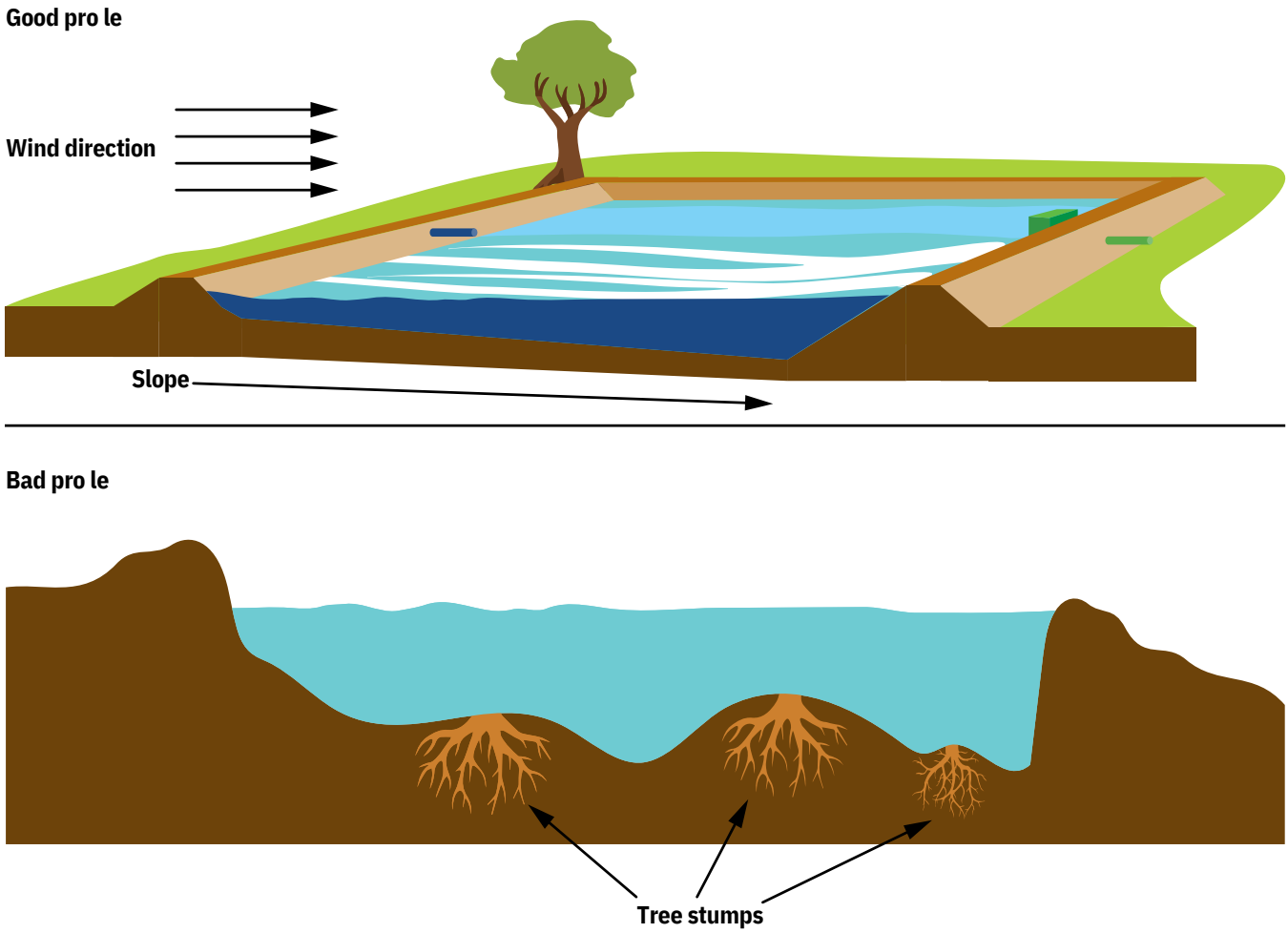


Figure 3. Bottom of pond. (Note the slope toward the drainage point and the absence of deep parts at the bottom of the good profile)

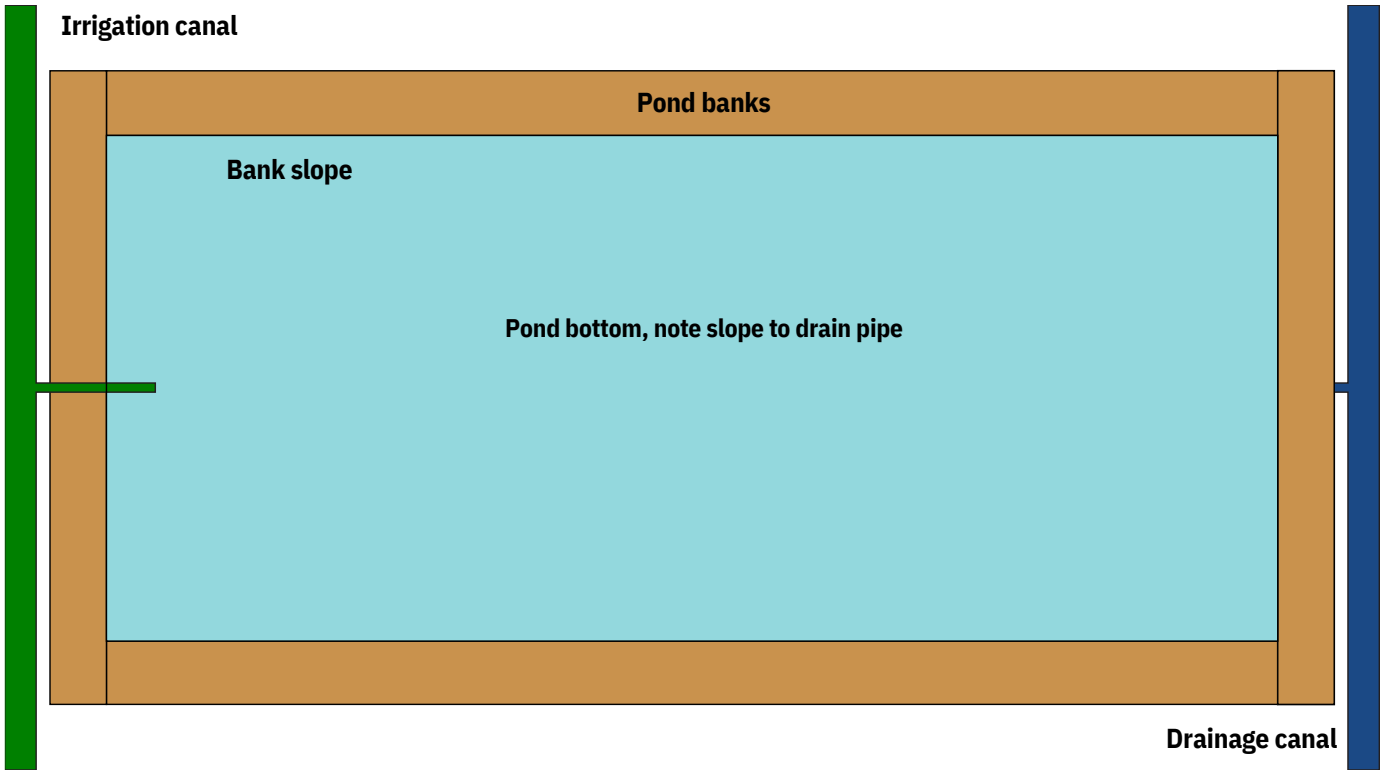


Figure 4. Pond layout with water inlet and outlet, sloped bottom toward the drain, and the ditch canal in the middle for easy harvesting.

2. Pond preparation

Pond preparation is very important at the start of the growing season. The process eliminates waste from the previous production cycle, breaks down organic matter at the pond bottom and disinfects ponds from any disease causes.

The following are the steps involved in pond preparation:

1. Drain and drying

After the harvest from the previous cycle, drain the pond water and dry the ditches as much as possible. Keep the pond bottom dry until it cracks; this helps improve soil properties and dispose of organic waste.

2. Disinfection and cleansing

This step varies depending on the presence or absence of disease outbreaks during the previous production cycle. In a pond with no disease history, disinfection by limestone is not necessary. If disease is present, use limestone at a rate of up to 1 t/ha. Treat any remaining water in the ditch using an appropriate disinfectant to get rid of unwanted fish, taking into account the environmental and health precautions when applying disinfectants.

Plate 1. Pond drying (top) and disinfection (bottom).

Plate 2. Pond ditch (top) and dike maintenance (bottom).

3. Plowing or raking
It is preferable to plow the pond bottom lightly to get rid of microbes and parasites by exposing them to the sun.

4. Dike and ditch maintenance
Carry out seasonal maintenance of ditches by lifting the mud to the dikes. At the same time, it is necessary to maintain the dikes and re-slope them.

5. Maintaining inlets and outlets
If necessary, maintain irrigation canals during maintenance. This step ensures that intact nets are installed over the water inlet and drainage pipes to prevent cultured fish from escaping the pond and unwanted fish from getting into it.

Initial fertilization
To enhance the productivity of natural food in the pond water, add fertilizers as a source of nutrients for the food web—phytoplankton and zooplankton. Applying fertilizer to the pond bottom before filling the pond is also important, especially for small fish in the early stages of life. The rate of fertilization depends on the fertility of the soil and water used (section 5).

Plate 3. Water inlet with old screen (top) and replacement screen (bottom).

Plate 4. Initial fertilization during pond preparation.

3. Cultured fish species

Four species of tilapia have been identified in Egypt (Elghobashy 2001): Nile tilapia (Oreochromis niloticus), blue tilapia or tilapia aureia (Oreochromis aureus), galilee tilapia (Sarotherodon galilaeus)
and tilapia zillii (Coptodon zillii). Among them, the species with the fastest growth rate and the most suitable for fish farming is Nile tilapia (Plate 5). There are also two strains of mullet that are collected from the wild for pond culture: the flathead grey mullet (Mugil cephalus) and the thinlip grey mullet (Liza ramada) (Saleh 2008). For marine culture, fish species include European seabass (Dicentrarchus labrax), gilthead seabream (Sparus aurata), meager (Argyrosomus regius) and penaeid shrimp. This manual focuses on tilapia monoculture or polyculture with mullet, catfish and carp.

Nile tilapia and mullet are the most commonly farmed fish species in Egypt. Most Egyptian fish farmers culture all-male Nile tilapia for increasing yield and revenue by harvesting homogeneous large fish. It is recommended to stock ponds with fingerlings for faster growth and to reduce the mortality rate. The majority of tilapia hatcheries in Egypt sell all-male tilapia fry at the fingerling stage (Nasr-Allah et al. 2014). When buying tilapia fry from hatcheries, they must be reared to fingerlings in smaller ponds. During rearing, the stocking rate of fry per feddan ranges between 100,000 and 300,000 fry, according to the targeted size and the duration of rearing. At the beginning of rearing, fry must be fed with powdered feed that contains 30%–35% protein at a rate of 10% of their bodyweight. Toward the end of the rearing period, the feeding rate should be gradually decreased to 5% of their bodyweight.

Farmers should consider the following recommendations when purchasing tilapia fry/fingerlings:

- It is important to culture fast-growing fish strains, such as the Genetically Improved Abbassa Nile Tilapia (GIANT) to produce a higher yield.
- Buy seed from a hatchery with a good reputation that reproduces genetically selected strains.
- Source your seed from a hatchery that has a good record of dealing with farmers.
- Avoid dealing with seed dealers or brokers.
- A few farmers use carp (common and silver carp) in their ponds. Recently some farmers have started to stock African catfish in some areas.
- For mullet, it is best to buy seed from dealers who transport them in sealed plastic bags rather than open tanks; this will help avoid fraud and ensure that the fish are healthy.

Plate 5. The most important tilapia species in Egypt are Nile tilapia (left) and blue tilapia (right).

4. Pond stocking

This section describes stocking after pond preparation. The carrying capacity of the pond determines the stocking rates. The stocking rate will also vary according to the common fish culture practices in the surrounding area and the financial capability of farmers. For example, if the farm is equipped with aerators, stocking rates can be increased. Stocking rates vary depending on the quality and availability of water, soil and capital as well as the desired marketing size of the fish.

Stocking rates also vary between different areas of farming and farmers in the same region. For example, fish farmers in the Behera governorate prefer to use a tilapia monoculture system, where rates range from 8000 and 40,000 per feddan depending on the availability of water, soil fertility and the farmer's ability to buy feed. This discrepancy is attributed to the difference in water availability in each area. In areas where water is constantly available, farmers tend to increase the density to about 30,000 per feddan, and the size at harvest is less than the sizes that result from using lower stocking rates.

In the Sharkia governorate, the usual stocking rate is 12,000 to 15,000 tilapia per feddan, in addition to 2000 flathead grey mullet and 500 thinlip grey mullet. In the Kafr el-Sheikh governorate, fish stocking rates and species composition vary from one district to the other, ranging from 15,000 to 17,000 fish per feddan. In the sugar beet factory area and Hamoul, where farms use Nile water, the average stocking rate is about 15,000 tilapia per feddan, and farmers only sometimes add mullet at a rate of 500 per feddan and reach the marketable size of 3 fish per kilogram. In the surrounding drainage area, the stocking rate per feddan is 15,000 tilapia plus 300 to 500 flathead grey mullet and 2000 thinlip grey mullet.

Plate 6. Counting tilapia fry (left) and stocking tilapia fry (right).

5. Pond fertilization

The purpose of fertilization in open pond aquaculture is to provide exogenous elementary nutrients (carbon, nitrogen and phosphorus) to enhance natural food in the water. Natural food includes tiny plants called phytoplankton, which are nearly buoyant in the water column, giving the water a greenish color. Algae can be consumed directly by fish or be food for zooplankton, which the fish can also eat. Primary productivity in a pond can be augmented by increasing the availability of nutrients using fertilizer. Fertilizer increases nutrient concentrations to enhance plant growth. There are two types of fertilizer: chemical and organic. The term "manure" usually is reserved for animal excreta and agricultural by-products used as organic fertilizers. Relatively purified compounds that contain nitrogen, phosphorus, potassium or other nutrients are called chemical fertilizers (Boyd and Tucker 1998). Nitrogen and phosphorus are usually the two nutrients present in the smallest quantities relative to food web requirements.

General criteria

The use of fertilizers depends on need after estimating the fertility of the water and the need for nutrients (nitrogen, phosphorus, potassium). When using fertilizers, farmers should either avoid replacing the water or reduce the amount replaced to the lowest level, except in the case of an emergency. Ponds should be fertilized only on sunny and warm days, and pond fertilization should begin in the spring when water temperatures exceed 18oC.

Examples of fertilization programs

I. Initial fertilization program

- Apply 300–400 kg per feddan of air-dried poultry manure or 1 t per feddan of cattle manure. (The amount here is based on the nutrient content of the fertilizer: if the manure is rich in nutrients, apply the lower rate; if the nutrients are poor, apply the highest rate.) Distribute fertilizer all over the dried bottom of the pond.
- Apply 7–10 kg of urea granules (46% nitrogen) per feddan and spray them on the dried pond bottom.
- Raise the water level in the pond to 20–30 cm.
- Dissolve 15–30 kg of superphosphate fertilizer in containers. Let them soak for 24 hours, and then spray them on the surface of the water.
- Leave the water in the pond at the level of 20–30 cm for 4–5 days to allow for the algae to grow and reproduce, which is indicated by the green color of the water. This shows that the development process for natural food has been successful and the pond is ready to receive fish seed.
- Raise the water in the pond to its maximum level and then stock the fish 1 week later.
- If the water source for the farm is agricultural drainage water, reduce the amount of manure and fertilizer because the water is already rich in natural food and nutrients.

II. Pond fertilization after stocking

- Choose between fertilizing every week or every 10 days, or even every 2 weeks.
- Use different types and sources of fertilizers interchangeably. But use only one type of fertilizer if others are not available.
- In the first week, add organic fertilizer (usually dry poultry manure) at a rate of 75 kg per feddan, and in the following week add 3–5 kg of urea plus 10–15 kg of potassium superphosphate. Continue alternating these fertilizers every week for duration 8-12 weeks after stocking.
- Continue this system for a fixed period or use it throughout the growing season while also feeding the fish at same time. This allows the fish to take advantage of natural food as well as supplementary feed (25% protein).

III. Traditional fertilization

This fertilization strategy is only followed for 2 months (8 weeks) after which farmers switch to using only artificial fish feed. In this model, doses of organic manure (poultry litter) are introduced into ponds weekly at the following rates:

• Weeks 1 and 2: apply 100 kg per feddan.

• Weeks 3 and 4: apply 150 kg per feddan.

• Weeks 5 and 6: apply 200 kg per feddan.

• Weeks 7 and 8: apply 300 kg per feddan.

• Add small amounts of feed into the pond to train fish on feeding from the beginning of Week 7.

A Secchi disk can be used to estimate the abundance of natural food in ponds and to regulate fertilization rates. The reading should be between 15 and 25 cm. If the disk reading is higher than 25 cm, a full dose of fertilization should be applied. If it is between 15 and 25 cm, the dose can be reduced. Ponds should not be fertilized if the reading is lower than 15 cm. Another way of regulating fertilization rates is to measure water quality parameters (nitrogen and phosphorus) directly and adjust application rates based on these measurements.

Plate 7. Adding organic fertilizer to pond bottom before filling with water.

6. Fish feeding

General criteria

The largest part of production costs is fish feed (60%–70%). Using feed efficiently will reduce the cost of feed and improve economic performance. Farmers should carefully select feed sources, choosing proper feed for cultured fish species and growth stage. The recent development of the fish feed industry and the availability of extruded fish feed have reduced the proportion of the unit of fish feed needed for producing one unit of fish. This is called the Apparent Food Conversion Ratio (AFCR). It refers to the unit of feed consumed to the unit of fish produced. Using extruded floating feed enables farmers to monitor fish consumption and reduce feed waste in pond water. This will lead to lower production costs and higher pond water quality to generate increased revenue for fish producers.

The following list contains important issues farmers should consider when sourcing feed and for feed management at the farm level:

• Buy feed directly from mill producers or deal with a trusted intermediary to avoid fraud or bad storage.

- Select a feed type suitable to the cultured fish species in the farm and the growth stage of the cultured fish. Give smaller fish smaller feed (1–2 mm diameter), and give larger fish larger feed (3–6 mm in diameter).
- Make sure the feed bags are labeled with the details of the feed ingredients, production date and nutritional content, such as the percentage of protein and fat.
- It might be worth organizing a feed analysis to ensure the quality of the feed is as stated on the product label.
- Store different feeds separately in a well-ventilated, dry and properly designed feed store.
- Keep records of feed purchases, including feed type and source of purchase, prices and quantities.
- Follow the appropriate feeding management for cultured fish species and size.
- The number of times feed should be distributed per day varies according to fish size. Feed small fish (up to 50 g) 3–4 times per day, but feed large fish only 2 meals a day. Make sure that the amount does not exceed the calculated daily feeding rate for each pond.

Plate 8. Farmer feeding tilapia in In-Pond Raceway System (IPRS) culture system (left) and using a demand feeder (right).

• As fish grow larger, their protein requirements decrease. It is therefore advisable to reduce the feeding rate (the percentage of feed fed per estimated live bodyweight of fish) and the percentage of protein in the feed.

• When using floating feeds, use a floating hose ring or pipes to contain the feed and stop it from floating away to the pond margins, where it attracts birds and is harder for the fish to consume.

• Use demand feeders to help reduce feed loss and improve feed efficiency. Fiberglass demand feeders are better than those made of iron, which rusts quickly due to the high moisture levels in fishponds.

• Take regular fish samples to monitor the growth rate, and monitor the feed performance during the growing season. A regular sample is important when feeding sinking fish feed to determine the daily quantity required for every pond.

Examples of different feeding programs

I. Feeding to apparent satiation

This feeding strategy can be used mainly in farms using floating fish feed.

• Using floating feed allows farmers to monitoring fish during feeding. Feed should be consumed within 20 minutes of being given to the fish.

• If the fish do not consume all the pellets within 20 minutes, reduce the quantity. If the problem persists with an accurate feeding rate, a lack of appetite could be an early sign of health problems.

• For the following 10 days, apply the same amount of feed that fish consumed within 20 minutes. Then repeat the process to adjust the new daily feeding rates.

II. Feeding according to fish weight

This feeding strategy can be used in farms using sinking fish feed:

• At the start of the growing season, use feed that is high in protein (30% or higher) with high feeding rates (5%–7% of total bodyweight) for small fish. For larger fish, reduce the protein level in the feed (25%–27%) and lower the feeding rates (2%–3% of total bodyweight) to reduce production costs and maintain good water quality.

III. Traditional feeding

This strategy has been adopted in some locations where farmers use pelletized sinking feed:

• About 2–3 days after stocking the pond, start feeding fish with powdered or crumbled feed (25%–30% protein) for 20 days. Then use pellet feed at a rate of 5% of live fish biomass in each pond per day until the fish weigh approximately 50 g. When fish grow larger than 50 g, reduced the feeding rate to 3% of the live biomass per day and continue with this rate until harvest.

• Take fish samples 1 month after stocking and then every 15 days to follow growth performance.

• Among Egyptian fish farmers using this method, it is common for fish to eat 500 g of feed per 250 g of bodyweight (2:1 FCR). However, with better and proper feeding management, this ratio could be improved to lower that amount.

7. Fish sampling

Fish sampling is an important means for monitoring fish growth, feed use and health status. Periodical fish sampling helps the farmer to:

- Follow up cultured fish growth in ponds.
- Estimate feed requirements according to increased fish weight.
- Follow up used fish feed performance according to an increase in fish weight.
- Estimate the expected fish yield from the production unit.
- Determine the harvest time according to fish size.
- Conduct a taste test of the fish before harvest.

For scientific purposes, the farmer must also calculate the fish condition factor (an indicator of fish growth and health status), which is the relation between weight and length. To get a proper representative sample of the fish population in the pond, farmers should consider the following instructions before and during sampling:

- Select an appropriate time for sampling. Avoid hot, cold or foggy weather, and strong winds. Usually, sampling takes place at the time and spot where fish received their first meal.
- Make sure the number of fish in the sample is sufficient to represent the pond stock.
- Handle fish gently and quickly in the water to avoid stress.
- Avoid crowding fish during weighing and counting to reduce potential stress.
- Record sample data (total weight and number of fish) for each pond separately.
- Generally, do not return the sampled fish to the pond to avoid diseases.

Avoiding fish stress is important to maintain a healthy cultured fish and to ensure efficient use of artificial fish feed and obtain the optimum growth rate. Sampling should be done when the fish are stressed from any of the following: water quality problems, poor weather conditions (such as cold and wind), fish disease problems, high turbidity in the pond water, heavy rain.

Plate 9. Fish sampling and weighing for monitoring growth and estimating feed required.

8. Water quality management

Relatively few methods have proven useful in improving water quality in ponds. Water quality consideration starts from selecting a site for the farm where the water supply is of adequate quality. Adopting good fish feeding management practices also leads to improved pond water quality. Using mechanical aeration to increase the level of dissolved oxygen and eliminate ammonia improves water quality and reduces the need to replace the water. Still, replacing water can be a good option to increase dissolved oxygen in a pond and discharge water rich in organic load. Controlling suspended solids in incoming water and liming the pond bottom to neutralize acidity both help to improve water quality. Farmers should avoid applying herbicide and algicide and treat effluent water discharged into sedimentation pond or wetlands to reduce the impact of aquaculture on the surrounding environment. Aquaculturists need to have sufficient knowledge of water quality to know which treatments to apply in any given situation. They should also be able to determine the proper treatment rate and application technique for a pond amendment, know what beneficial effects to expect from the treatment, and understand the interactions that may occur among the treatment, the pond environment and biota, and the culture species (Boyd and Tucker 1998).

General considerations

Farmers should consider the following to maintain good quality pond water:

• Identify the quality of water to be used and its suitability for fish production.

• Perform a chemical analysis of the water source, such as checking for salinity, alkalinity, dissolved oxygen, pH, ammonia, nitrite, nitrate, phosphorus and potassium, as well as the most expected pollutants.

• Regularly calibrate all equipment used for measuring water quality.

• Take note of the water's transparency, color and smell (odor).

• Monitor water characteristics periodically to determine if the water requires replacing or aeration. This also helps identify the appropriate method of water management and stocking rates and appropriate fish species, as well as fertilizer type and amount used.

- Identify the daily amount of water required for the farm, and know how to manage the capacity of the water pumps.
- It is important to be aware of changes in water volume in the source canals throughout the season.
- It may be useful to use groundwater, if allowed, to cover the shortage of surface water during some periods of the season.
- Effluent water from fish ponds is suitable for irrigating plants, so it can help integrate fish farming with field crops, vegetables and fruits.
- In the case of declining water supplies, water recirculation systems can minimize the need for water.
- Some scientists recommend using bacteria and chemicals to improve pond water quality and improve the level of dissolved oxygen in the water.

Water replacement

Farmers tend to flush pond water and replace it with fresh water to improve water quality parameters and increase carrying capacity. This practice helps avoid a sharp decline in the level of dissolved oxygen or a high level of ammonia in the water. It also reduces fish stress and leads to an increase growth rate and fish yield.

The rate of water replacement is based on the following:

• Stocking density, fish biomass and quantities of feed given

• Level of dissolved oxygen and ammonia in water

• Quantities of waste and solid residues in the pond

• Temperature of the pond water

• Fish vitality and disease occurrence

Farmers must also take into consideration the following:

- Fish need more oxygen at night when no photosynthesis occurs, so that is the most appropriate time to do a partial water exchange.
- Replace water only when needed and according to necessary rates. Be sure to take into account the needs of fish in the pond.
- Extruded feeds have less impact on water quality compared to pressure pelleted and farm-made feeds. Traditional feeds break down and sink to the pond bottom quickly, so they do not benefit the fish and can cause problems in the water.
- In earthen ponds, the daily rate of partial water replacement is very low. In fact, it might not be required at all at the beginning of the season when the fish are small and much lower than pond's carrying capacity. As fish grow, however, and their size increases, the need for water replacement increases. At the end of the season, it can reach up to 20% or more per day depending on the stocking density, fish size and species.

Pond aeration

Aeration devices such as paddlewheels and air blowers are used to increase the level of dissolved oxygen in ponds. This improves water quality parameters and increases carrying capacity. Aeration is an important option to minimize the need for replacing water and reducing stress on water resources. Usually, the level of dissolved oxygen in open pond aquaculture declines at night and reaches its lowest level in the early morning, so the optimum time for running an aerator is at night to avoid a lower level of oxygen in the early morning. Aeration devices require electricity, which can come from the main electricity network, standby generators or renewable energy sources. Farmers should consult professionals and experts to assess the number and size of aerators needed to supply their ponds with oxygen.

The need for using aerators will increase with rising stocking rates and fish biomass in the pond. It could even require full-time operation in intensively farmed ponds. Using aeration equipment can help move solid residues into the direction of the outlet if they are placed in the appropriate way and thus help remove sediment through wastewater.

Paddle wheel.

9. Biosecurity and fish health management

Biosecurity starts from pond preparation all the way through to harvest and includes all preventive measures needed to minimize the risk of introducing or spreading diseases (Yanong 2013). Fish diseases have a negative impact on economic investment. They lead to additional costs for treatment, increases in fish mortality and reductions in fish growth rate. Most disease agents are naturally present in water and normally do not cause problems since the natural defense mechanisms of fish (skin, mucus and immune system) keep disease agents under control.

Diseases are expected in the following cases:

• An increase in the number or virulence of pathogens

• Unsatisfactory water environment, such as a low dissolved oxygen level or a high ammonia level

• Low resistance of the fish stock as a result of poor quality of fish seed

• Poor management and stress through bad handling, fluctuations in water temperature, etc.

General BMPs on biosecurity: Precautionary measures

I. Pond preparation

• Dry the pond bottom well until it cracks (Plate 7).

• Get rid of aquatic weeds and fish waste.

• Apply quicklime following proper drying methods, especially following disease outbreaks to eliminate causes of the disease on the pond bottom.

II. Source, transportation and handling of seed

• Obtain seed from reliable and reputable sources.

• Visit fish nurseries to make sure that fry are healthy and of high quality.

• Choose fry that are uniform in size and healthy. Fry should be free from diseases and wounds, and they should be active, strong and have intact fins and scales.

• Transportation

Stop feeding fish 1 or 2 days before moving them.

Make sure the water is clean and contains a sufficient amount of dissolved oxygen.

Adjust loading density during transportation.

Avoid injures to fry caused by rough handling or overcrowding.

Avoid transporting seed in hot or cold weather. In summer, transport fish in early morning to avoid stress.

• When releasing fry into the pond, handle them gently by tilting the container under the surface of the water so they can swim out slowly.

• Keep newly introduced stock in a separate pond for at least 2 weeks before mixing them with existing stock or any other fish from different sources.

• Keep different age groups separate.

III. Grow-out ponds

• Monitor oxygen levels and other parameters on a regular basis.

• Monitor water quality by observing the color of the water and fish behavior.

IV. Feed management

• Store feed for a short period so as not to exceed the expire date. Make sure it is stored in proper conditions in a place with low humidity. Good storage prevents the feed components from breaking down and stops fungi and their toxins from forming.

V. Water management

• Farmers should follow all instructions highlighted in section 8. This is in addition to regular collection and disposal of dead fish in a hygienic manner.

VI. Vector control: People, animals and equipment

People

• Visitors and workers working in multiple farms must disinfect their footwear, clothes and hands properly before entering the facility.

• Workers should handle healthy fish first and then suspected or infected fish afterward. They should also visit the youngest batch and then the oldest (Brenta and Ali 2018), as shown in Figure 5.

• Visitors should move in a certain order in the farm, as shown in Figure 6.

Animals

• Prevent wild fish from entering the pond by using filters and screens over the water inlet.

• Whenever possible, control fish-eating predators, such as birds. Snails should be also controlled since they act as intermediate hosts for different parasite.

• Birds, pets and large animals moving freely from one farm to another are a potential source for disease transmission, either mechanically or biologically.

Equipment

• Avoid sharing nets, buckets and feeding equipment to minimize the risk of cross contamination. If possible, keep one set of equipment for each tank or pond. Disinfect the equipment and keep it off the floor. If this is not possible, washing and sun drying are also acceptable.

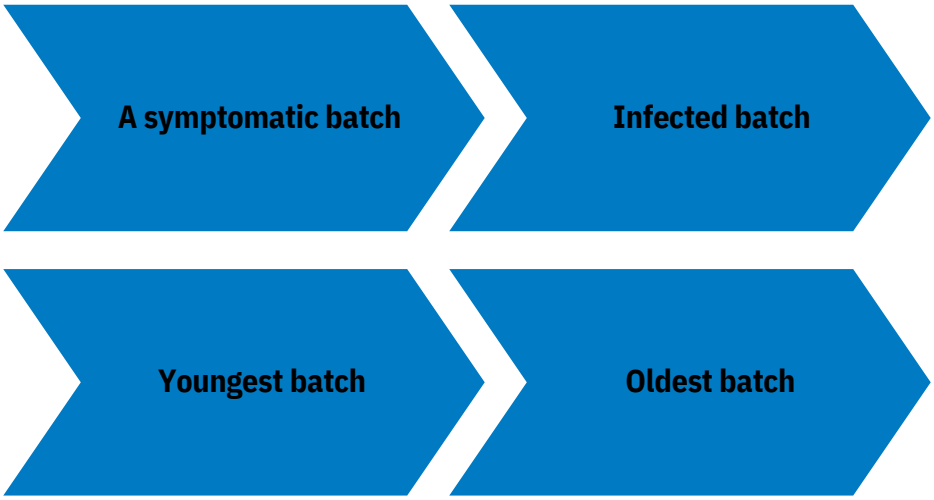


Figure 5. Order of worker movement in the farm.

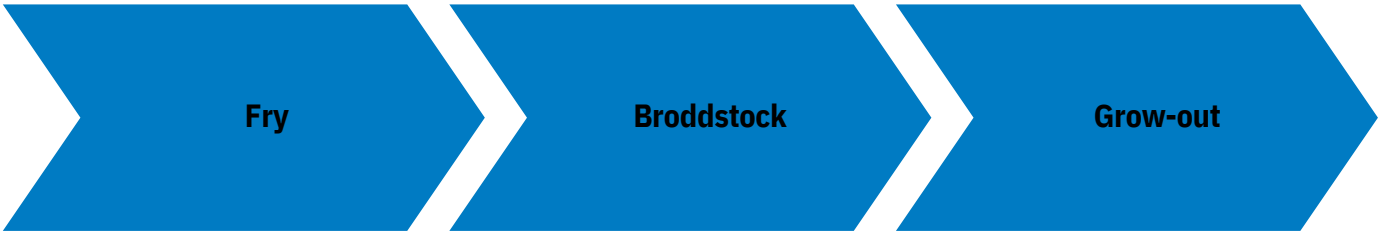


Figure 6. Order of visitor movement inside the farm.

VII. Mortality disposal

• Collect dead fish regularly and dispose of them in a hygienic way. Hygienic disposal of dead fish involves either burial or incineration. Both methods will eliminate pathogens, though burial is less expensive and more practical, especially for large numbers of fish.

Burying

• Choose an area to dispose of the dead fish. It must be at least 30 meters away from the surface of the water.

• Dig a pit that is 1.2 m above the high water table.

• Put the dead carcasses in the pit and cover them with quick lime to prevent them from smelling and to speed up the decomposition.

• Cover with soil to offer protection from scavengers as shown in Figure 7.

Incineration

• Incineration is also an acceptable method if applied properly. The fire must be hot enough to cover all dead fish.

Fish health management

Farmers must observe their fish regularly to recognize their normal behavior. To maintain healthy fish, farmers should consider the following:

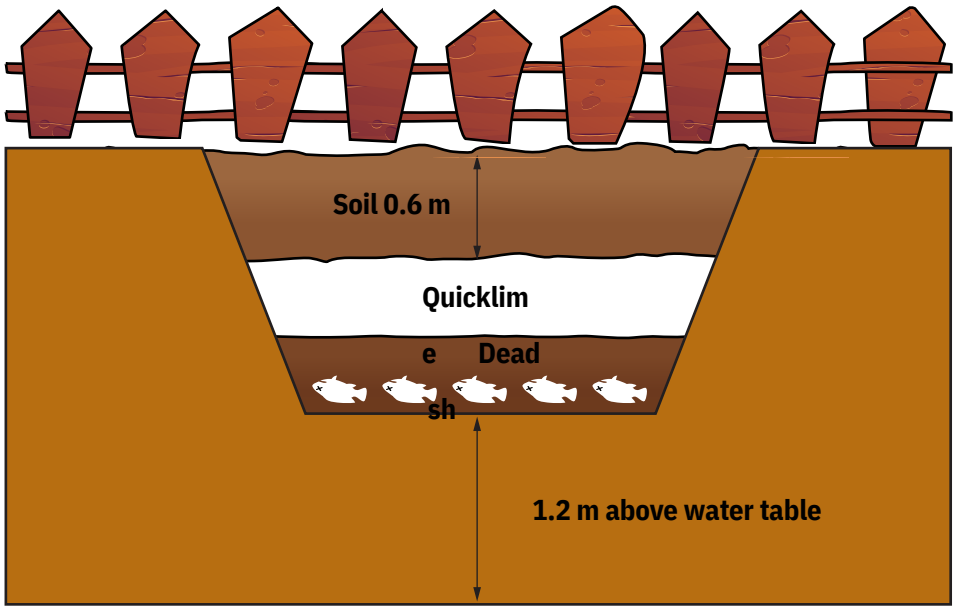
• Watch how the fish swim, breathe and eat. A healthy fish has a good appetite and is an active swimmer.

• Fish gasping for breath near the surface of the water is an indication that there is something wrong with the fish or the water. The problem could be a lack of oxygen, poor circulation or the presence of toxins in the water, or it could indicate gill parasites or injuries to the fish.

• Sick fish often acquire a dull color and turn pale or gray. Tails or fins become hemorrhagic, eroded, stiff or falling apart. They also show open sores (ulcers), exophthalmia (Plate 10) and sometimes skin spots on their body.

• Collect fish samples regularly to check on the health of the fish.

• Be aware of the seasonality of various diseases in each region and methods for prevention.



- Isolated area
- At least 30 metres from any other surface water
- Pit bottom is 1.2 metres above the high water table
- Cover with quicklime
- Covering carcasses with about 0.6 metres of soil

Figure 7. A hygienic method for disposing of dead fish.

Disease outbreak

In the event of a disease outbreak, farmers should take the following measures:

- Record fish mortalities daily as well as the mortality pattern (every day, week, started high then reduced or the opposite).
- Never wait to lose half of the fish to ask for help.
- Consult an authorized fish health expert as early as possible.
- Never try unlabeled health products and recipes from unauthorized persons.
- Remember that causative agents for diseases are different, so treatments applied with success with a neighbor usually will not work to treat your fish.
- Dispose of dead fish properly.

If a fish health expert is not available, farmers should take the following measures:

- Ship fish samples to the closest trusted diagnostic lab.
- Ideally, moribund fish showing clinical signs of disease are the best for diagnostic labs. If not possible, use fish that have recently died.
- Send live fish in a plastic bag filled with oxygen.
- Send samples of recently dead fish to the lab on crushed ice by wrapping each fish with several sheets of paper and placing each one individually in a separate plastic bag.
- Never send fish to the lab that have been dead a long time. They decompose fast and other bacteria will grow over the cause of the disease, which makes identifying it impossible.
- Remember to include your name, contact information and any records describing the fish and the number of dead fish, along with their appearance, approximate size and the type of culture system (farm information).
- Personal observation is important. Be sure to record all relevant information, such as why disease is suspected and why now (have the source of the fish feed been changed).
- Send a fresh water sample from the pond system to the lab and include water quality parameters recorded before and during the disease outbreak.
- When treating the fish, perform preliminary testing of used disinfectant or any chemicals on a small number of fish to ensure their safety.
- For consumer health safety, do not harvest treated fish for marketing before the minimum withdrawal time for the used treatment (usually 21 days after treatment).

Plate 10. Hemorrhagic ulcer (left) and exophthalmia (right) as a result of the stress of transportation.

10. Harvest and postharvest handling

Before harvesting, farmers should observe the following:

• When deciding to harvest a pond, stop feeding the fish at least 1 day beforehand.

• Carry out a taste test before harvest to make sure the fish taste is acceptable and there are no undesirable odors or taints.

• Provide training for workers on the best methods for harvesting, sorting and handling fish.

• Make sure that the main drain canal can receive sufficient water to allow the pond to drain completely.

• Drain the pond quickly, and make sure that effluent water is discharged into the drainage canal not the supply canal.

• Make sure to close the water supply inlet while draining the pond and install a net over the drainage pipe.

• When harvesting, drain ponds at night during the summer to avoid high temperatures, and during the daytime in winter to avoid cold.

• Try to finish the harvest before sunrise to avoid high temperatures when handling and transporting fish, especially in the summer.

- Remove aquatic plants from the bottom of the pond, as they can get tangled in the fishing nets.
- Fix a net at the end of the ditch to help collect the fish.
- When the water level lowers to the level of the ditch, provide a clean water source to harvest the fish while they remain active and clean, as shown in Plate 11.
- Harvest and transport fish to the washing and sorting facility as soon as possible. Make sure that the fish grading is done according to market requirements (established grades). Ensure that equipment used in fish handling is clean and that the sorting area is prepared to handle the number of fish expected for the harvest.
- Wash fish well before grading and packing to produce a high quality product.
- Use the appropriate fish boxes according to the needs of different markets.
- Use the necessary equipment, such as oxygen tanks and pipes, for selling live fish.

Plate 11. Fish harvest: using clean water to wash fish (left) and seining from ditch (right).

Farmers should take into account the following when packaging fish in boxes for marketing:

• Place fish in the box straight without bending the body.

• Do not overcrowd fish in the box.

• As much as possible, do not let the fish touch the walls of the box, and put ice on the sides around them.

• Handle fish carefully to avoid damaging them.

• When marketing fish live, weigh the fish and quickly place them in clean water tanks equipped with aeration, such as an oxygen cylinder or compressed air.

Plate 12. Fish sorting, grading (top) and package facility (bottom.

- When selling fish to traditional markets, put ice in the box to maintain the freshness of the fish.
- Increase the amount of ice in the summer, when the temperature is high, or when transporting fish over long distances.
- Cover the boxes in the truck with a clean tarpaulin to avoid exposure to direct sunlight and to prevent the ice from melting quickly. Transport fish to the market in a vehicle with an insulated or refrigerated container.
- Transport the fish at night or early in the morning and as soon as possible to the trader or wholesaler.
- Cool the fish immediately after harvesting to increase the shelf life. If using ice for transporting and storing fish, the ratio should be 1:2 of ice to fish, though the ratio of ice can be reduced in cold weather.
- Another useful postharvest treatment is to sink the fish directly after harvest in very cold water to cool the body surface to almost 0oC. This allows the fish to be transferred in refrigerated vehicles to the market without adding ice and will increase their shelf life during marketing.

Plate 13. Adding ice to fish at the market.

11. Marketing

For the marketing stage, farmers should consider the following:

• Be aware of the different markets and seasonal changes in prices.

• When planning the harvest, consider the market needs and consumer seasonality.

• Produce fish sizes that meet the requirements of the target market.

• Make sure that the fish are of adequate quality in terms of size and freshness, and consider consumer preferences.

• Sort and handle the product properly at the farm.

• Follow appropriate pre-harvest practices (section 10).

• Select the appropriate containers for packaging the fish according to the needs of various markets.

- Use the necessary equipment for selling live fish, such as tanks, oxygen, pipes and valves, as well as ice in the summer.
- Follow appropriate methods to ensure the product remains fresh until it reaches the market.
- Communicate with marketing associations or encourage groups of farmers to participate in the marketing effort and to provide supplies.
- Fish producer associations can provide information on the market and help with product promotion.
- It is necessary to building good relationships between producer associations and the management of various fish markets.
- Ensure good quality tools are used in fishing, packaging, preservation and refrigeration, and use good ice to ensure that the product is safe for consumers.

Photo credit: Ahmed Nasr-Allah/WorldFish

Trcuk for life fish sales.

12. Recordkeeping

Keeping records of farm operations is an important part of the daily business of running a fish farm. This is done to collect and record all data relating to every part of the farm operation, whether financial or technical. This allows farmers to recheck their records when needed. Records can also help farmers to estimate expenses and annual return or help them to figure out resource use efficiency of farm inputs such as seed and feed. They can also be useful for interpreting any unusual changes in any production unit yield.

Financial and administrative records

These records are kept for detailing purchases, daily farm expenses, fish sales, staff wages and salaries, and cash flow, as well as any other financial transactions.

Technical records

These records keep data for all farm operations, including cultured fish species, stocking rates, feeding rates, nutrition and fertilizer rates, fish samples, water quality measurements, water replacement, aeration and machine operation, as well as the incidence of fish disease and treatment doses.

Models for recordkeeping required for fish farms

a. Pond stocking record

Fish Species	Tilapia				Mullet				Catfish			
Pond #	# (1000)	Avg. Wt. (g)	Age (day)	Date	# (1000)	Avg. Wt. (g)	Age (day)	Date	# (1000)	Avg. Wt. (g)	Age (day)	Date
1												
2												
3												
4												
5												

b. Fish sampling record and monitoring feed performance

Date	01 /04/20XX			15/04/20X			01/05/20X		
Pond #	Avg. Wt. (g)	FCR	Feed (g)	X Avg. Wt.	FCR	Feed (g)	X Avg. Wt.	FCR	Feed (g)
1				(g)			(g)		
2									
3									
4									

c. Pond feeding record*

	Week starts	Saturday		Sunday		Monday		Tuesday		Wednesday		Thursday		Friday		Total	Notes
		am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm		
1																	
2																	
3																	
4																	
5																	

*Note: For each pond, feed data is recorded daily: type, source of feed, protein percentage, pellet size.

d. Labor record
This includes the names of workers, monthly salaries, days of attendance and absence, incentives and sanctions, as well as any seasonal and temporary laborers.

e. Machinery record
This includes the date of purchase as well as maintenance and operation.

f. Fish mortality record
This is kept to report the number of fish that died in each pond, any clinical signs, and the date and cause of death (if known). Farmers should record the number of fish at harvest to calculate the loss ratio.

g. Storage record
This includes records of items such as feed, chemicals, fishing nets and tools, and are shown by the balances and dates.

h. Fish disease record
This documents all cases of disease and symptoms associated with mortality, and any treatments and doses used.

i. Expenditure record
This is used for keeping daily records of all expenses during the season.

j. Revenue and expenses record
This details data regarding revenue and expenses.

13. Social responsibilities

Social responsibility here means strengthening the relationship between the farmers and the surrounding community, including individuals, residential areas and other activities in the area.

Farmers should consider doing the following to strengthen their reputation within the community:

- Contribute to the social needs and health care requirements of staff and their families.
- Contribute as much as possible to local charities and community development projects in the surrounding areas.
- Label products when marketing to explain that buying this product will provide jobs and improve the lives of low-income workers.
- Do not permit children to work in farms, except for training only.
- Allocate a portion of the fish yield to sell to residents in the surrounding area at wholesale prices.
- Employ poor people from the surrounding area of the farm.
- Encourage the consumption of locally produced fish and reduced consumption of imported fish by showing the differences between fresh and frozen fish.
- Contribute to promotion campaigns in the media that highlight the safety of farmed fish for the consumer and the safety procedures followed during production in the farm.
- Show the benefits of using wastewater from aquaculture for irrigating field crops.
- Cooperate with surrounding farms to maintain facilities, water canals and drains in good condition.
- Provide appropriate living facilities for staff working in the farm.
- Make sure staff are given the proper supplies, such as protective clothing.
- Train personnel on safety procedures for using chemicals and drugs in the farm.

Photo credit: Ahmed Nasr-Allah/WorldFish

Pond fertilization.

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