



Key Principles of Sustainable Household-based Pond Aquaculture



Sustainable Aquaculture and Community Fish Refuge Management Project (SAFR)

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Introduction

Small-scale household based fish farming in Cambodia: principles for successful farm management intends to provide small-scale, household based fish farmers in rural Cambodia with some key guidelines for managing their fish production successfully.

These guidelines are largely based on the **Training Manual on house-hold based small-scale pond aquaculture in Cambodia** that was produced by the SAFR - Aqua project and has been used to train over 400 farmers in Cambodia's Kampong Thom province in sustainable small-scale fish farming practices.

Ideally, these guidelines will be used by the farmer as a supplement to the training received based on this training manual. However, it also can be used independently by farmers, who are seriously interested in fish farming to supplement their income and augment their livelihoods. These farmers can also refer to a series of "How to videos", which explain these key principles of fish farming in simple and easy to understand ways.

These videos can be found at https://youtube.com/playlist?list=PLBR1SLE8M5JD9I72I0GwfjwoczIEk_0oW.

or scan this QR Code



01 What is aquaculture and why should you engage in it

What is aquaculture?

Aquaculture is growing of water-based animals and plants such as fish, prawns, frogs and turtles in enclosed water bodies such as ponds, tanks and cages. It provides business and income generating opportunities to rural households by raising and selling aquatic animals.

For the purpose of these Key Principles, aquaculture refers to fish farming in small earthen ponds. This means the process of stocking small-juvenile fish or fingerlings into ponds, grow them to a desired size at which the fish will be harvested for consumption or sale.

Why should you engage in fish farming?

- Fish farming can contribute to your family's well-being by providing additional healthy food and income
- Fish is an important source of proteins and micronutrients
- You can harvest and eat fish not only during the rainy season, but all year round
- You can produce your own fish and don't have to buy fish from the market
- You can sell fish that you do not eat yourself and generate some additional income
- Fish farming helps to protect wild fish stocks by reducing catching fish

Can you afford to engage in fish farming?

Before you start engaging in fish farming, you need to consider whether you have sufficient resources for farming fish. Just having some land with a pond in which you keep fish is not sufficient. Like other animals you may raise on your farm, you need to feed fish and take care of your fish, and the more fish you keep in your pond, the more feed you need.

To assess how much you are able to invest and spent on aquaculture, you can do the following simple exercise and fill in the table below. The sources of income, and expenditure items given here are just examples, which you replace with your own, actual ones:

Your sources of income and livelihood	Income (KHR)	Expenditure Items	Expenditure
A1 Rice Production		E1 Food	
A2 Daily Labour		E2 Clothing	
Vegetable Production		E3 School/Education	
A4 Livestock (Chicken, pig, cattle)		E4 Land lease	
A5 Cassava Production		E5 Transportation	
A6 Cashew production		E6 Loan repayments	
A7....			
A8....			
Yearly total		Total Expenditure	
Amount you have for available for fish farming = Total Income - Total Expenditure			

FEEDING FISH IS THE MOST CRITICAL COST FACTOR IN FISH FARMING. THE FARMING SYSTEM YOU CHOOSE WILL DETERMINE THE FEEDING REQUIREMENTS AND THUS THE COSTS

If your total income is greater than the expenditure, you have financial reserves to spend on fish farming. Think about, how much this you want to use for fish farming.

If the income is lower than the expenditure i.e. the balance is negative, you can consider

- In which areas you may be able to reduce your expenditure or in which areas you may be able to increase their income.
- Whether a temporary increase of your income may lead to an increase of income that in the medium and long term can reduce the deficit and even lead to a profit.

02 Key factors of farming costs: Pond Size and Stocking Density

Carrying Capacity

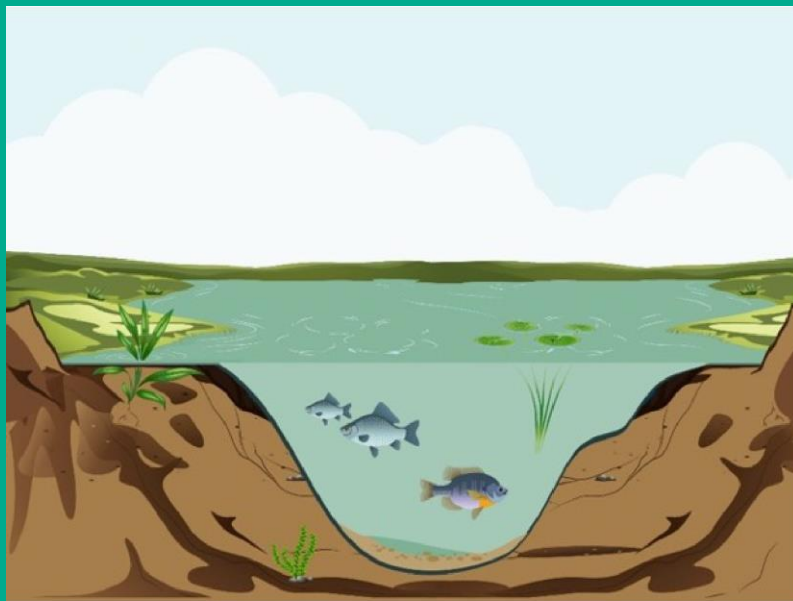
Imagine your pond to be yard in which you keep chicken. You can keep only very few chicken, which can survive on the food that they find in the yard. If you increase the number of chicken, you have to provide them with additional feed, so that they can grow and produce eggs. Also, as the space in the yard is limited, you can add only a limited number of chicken to the yard before they run out of space

A pond with good water quality and that has sufficient natural feed can only sustain and produce a limited amount of fish. This **Carrying Capacity** of the pond can be expressed as kg of fish per square meter (kg/sqm). For example, the pond has a carrying capacity of 1 kg/m³, you can have 2 fish of 500 g per m³ or 4 fish of 250 g each per m³. If you stock more fish, they can only grow to a total of 1 kg per m³, like 8 fish of 125 g each.

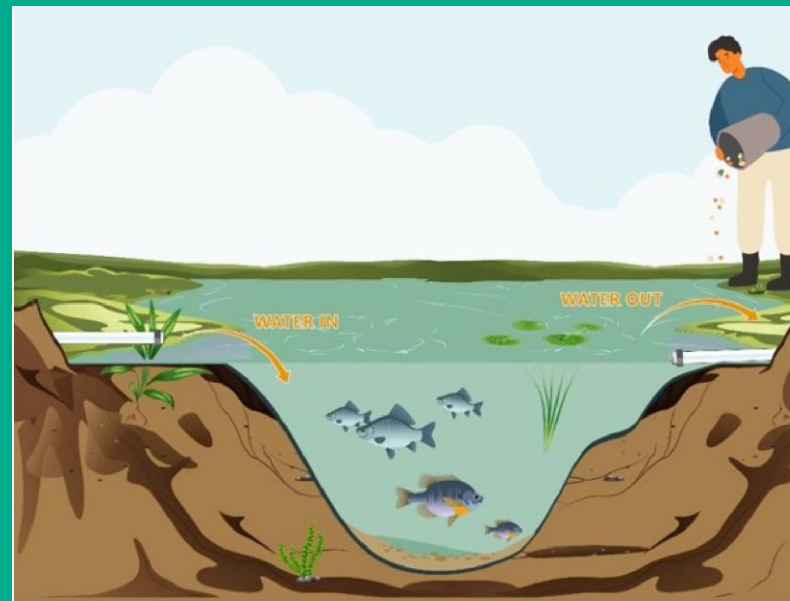
You can increase the carrying capacity, by adding feed so that you can raise more fish of greater weight per m³.

Another limiting factor for increasing the number of fish is the availability of oxygen - if you keep increasing the number of fish and even if you provide sufficient feed, they will eventually reach a number at which there will not be sufficient oxygen for them to breath and they will die.





Low stocking density, between of 0.5-2 fish/m² Management effort focused on using the natural productivity of the pond through fertilisation to supplement the available natural feed and make use of its high protein content, carbo-hydrate rich agricultural by-products such as rice bran can be used to feed the fish



Stocking density between of 3-5 fish/m² Management requires application of fertilizer for creating natural food exchange, occasional change of water if water quality is reducing.
Regular feeding with formulated feed, which can be home-made or commercial



Stocking density between 6-50 fishes/m² or more depending on technical inputs **and spices**.

Regular exchange water is required, observe & monitor fish health and use water-treatment & medicine if infection, mineral vitamins, install aeration system depend on fish species

Feed (regular and daily feeding fish with sufficient nutrients and amounts, usually commercial formulated feeds for fish)

Low investment
Low stocking density
Low production cost
Low risk

High investment
High stocking density
High production cost
High risk

03 Choosing the right species

Commonly farmed fish species in Cambodia

Cambodia has a rich fish species diversity, that can be farmed. Some species are easy to farm but may not have a good market. Other species may promise good market rates, if you want to sell, but they may be more difficult to culture. Carnivorous fish, that is fish that eat other fish, may be popular, but they require feed of higher protein content, which makes feeding them more expensive.

Explore the market before you decide, which species to culture. Look at the market price for that species: For how much does a fish of a certain species sell at 300g, 500g or 1 kg. Trey Pra (Pangasius) is a very popular species, which is very easy to culture. So is Walking Catfish. But both have very low market prices and most farmers struggle to sell them at cost or make a profit.

Tilapia, on the other hand, is a fish that is easy to farm too, but a little less tolerant to poor water quality such as low oxygen. But it has a comparatively high market value.

Here is an **overview of some of the most commonly farmed fish species in Cambodia from which you may choose the species you want to farm**

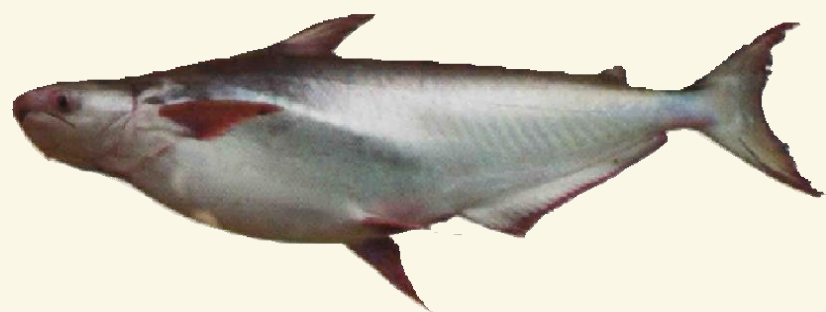


Tilapia/ត្រីទីប្រាជ្ញា

Tilapia is an exotic species with a good market value. Marketable weight of 0.3-0.5kg per fish can be achieved in 8-10 months, depending on culture system.

Tilapia is tolerant to water quality fluctuations such as pH, temperature and low oxygen levels. As an omnivorous species, it can easily be farmed extensive and semi-intensive systems based on natural feed and supplementary feed, such as planktons, algae, worms, termites, snails, crabs, insects, duckweeds, Azolla, vegetables, tree leaves, meat composition

- Growth performance of 0.3-0.5kg/year, depending on culture system and feeding regime;
- Intensive pond culture (pond depth: 1.5-2.5m).



ត្រីប្រាប្រាប៊ី (Max. 130 cm)
Pangasius mekongensis

Striped Catfish (Trey Pra) is an indigenous species. Marketable weight of 0.5-2kg per fish can be achieved in 6-10 months, depending on culture system. It is tolerant to water quality fluctuations such as pH, temperature and low oxygen levels as well. As an herbivorous species, it can easily be farmed in semi-intensive and intensive systems with feeding commercial feed and home-made feed (rice bran, maize, soybean meal, fishmeal, wheat Flour, etc.) with optimal protein from 26 to 30%

- Growth 1-1.5 kg/year;
- intensive pond culture with pond depth: 1.5-4m.



Silver Barb ត្រីគីង

Silver Barb is an indigenous species with a good market value. Marketable weight of 0.3-1kg per fish can be achieved in 6-10 months, depending on culture system.

Silver Barb is low tolerant to water quality fluctuations such as pH and temperature and does not take low oxygen levels as well. As an herbivorous species, it can easily be farmed in extensive systems and semi-intensive based on natural feed and supplementary feed such as plankton, earthworm, termites, algae, vegetable leave, tree leave, morning glory, duckweed

- Growth 0.2-0.5kg/year;
- In pond culture with pond depth: 1.3 to 1.8m. In polyculture system is better than monoculture system.



Walking Catfish/ត្រីអណ្តែង

Walking Catfish is an indigenous species. Marketable weight of 0.1-0.2kg per fish can be achieved in 5-7 months depending on culture system. It is tolerant to water quality fluctuations such as pH, temperature, low oxygen levels and polluted water as well.

- Growth performance of 150-250g per year;
- In intensive culture with pond depth: 1.8-2.5m.



Silver Carp/ត្រីកាបស

Silver Carp is an exotic species with a good market value. Marketable weight of 1-2kg per fish can be achieved in 6-12 months, depending on culture system.

Silver Carp is low tolerant to water quality fluctuations such as pH and temperature and does not take low oxygen levels as well. This fish is the herbivorous species and it is the filter feeder. In nature, fish can eat zooplankton and phytoplankton, which is the main foods. It prefers to eat phytoplankton at the surface feeder

- Growth 0.5-1kg/year;
- In pond culture, pond depth: 2 to 3m.



Climbing perch/ត្រីក្រញ៉

Climbing Perch is an indigenous species that has high market demand. Climbing Perch is predominantly carnivorous and consumes protozoans, crustaceans, insects, worms, and fish larvae.

It prefers to live at the low level of water, sometimes they move to upper, middle, and bottom of the water level;

It can be farmed in extensive systems, but because of its feed requirements semi-intensive and intensive culture systems, using formulated feed are recommended.

- Required pond depth: 1.2 to 1.5m;
- Climbing Perch is highly tolerant to water quality fluctuations such as pH, temperature, and low oxygen level, as they can breathe air.
- This fish can walk out or escape the pond if farmer does not fence their fishpond with net. Especially in the rainy season fish will try to get out of the pond.

04 Choosing an appropriate site for a fish pond

Key criteria for pond site selection

There are a few key considerations for selecting an appropriate location for your pond. The location of the pond can significantly impact farming costs, as, e.g. distance to the pond influences transportation costs, water availability impacts the costs for management, as the need for pumping water will require additional expenditure.

1. Ponds should be close to the homes of the farmers and easily accessible. This reduces costs for communicating that is needed for daily management, such as regular feeding and checking fish. It also improves security and reduces the risk of theft.
2. Ponds should be away from agricultural land where pesticides and fertilisers are used and protected from water flow from such areas.

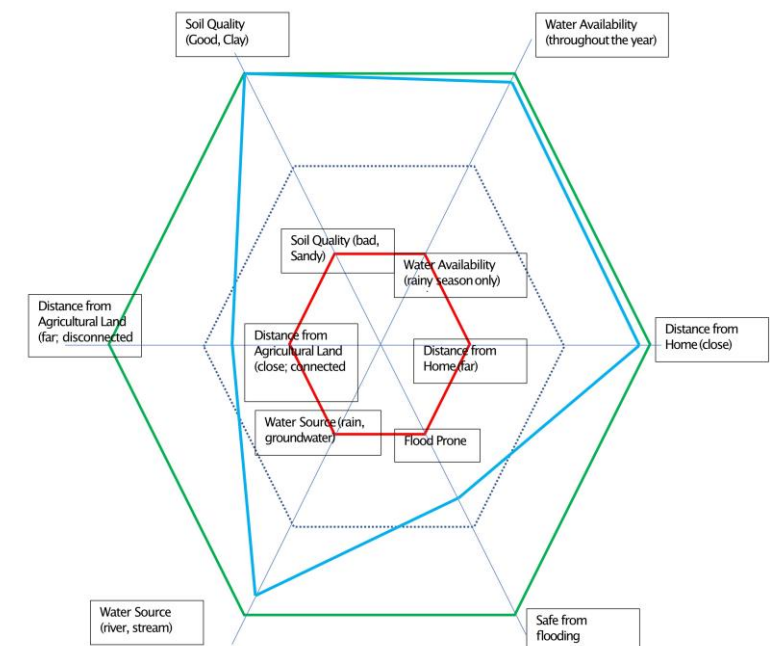
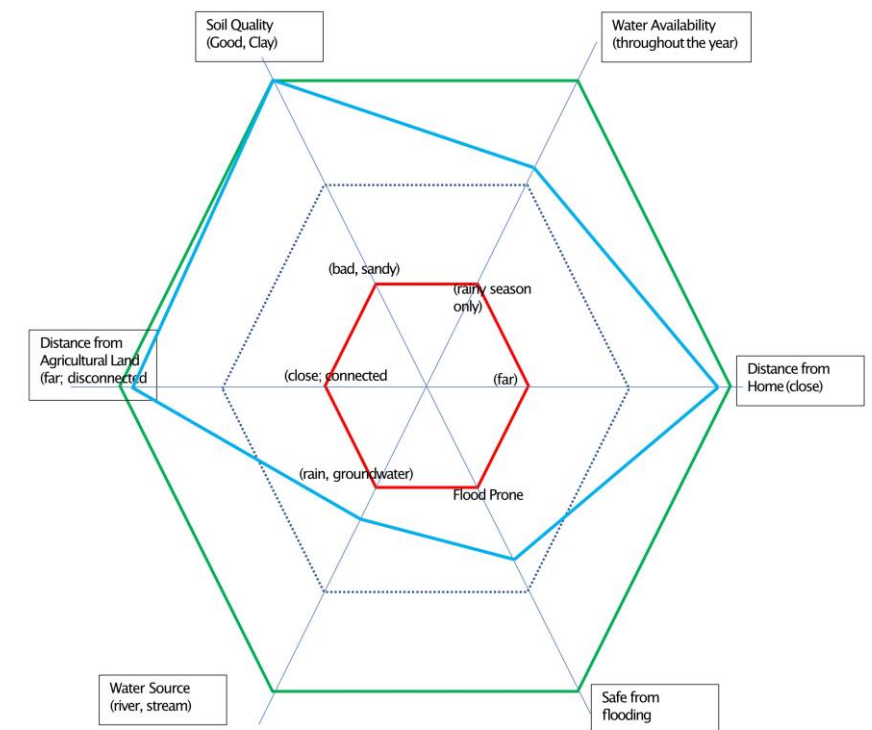


3. Ponds should have a reliable water source, with water being available throughout the year
4. The water should be free from pollutants
5. Ideally, the water source is higher than the pond, so that water can flow naturally into the pond without the need for pumping
6. The soil of the pond must be clay, as clay can hold water. Sandy soil is not suitable, as water will leak and pond banks easily erode
7. Ponds should be in areas that are safe from flooding. This reduces costs as fish cannot escape during floods and wild fish and predators cannot enter the pond during flooding
8. Ideally, ponds should be built on slightly sloping land, so that gravity can be used for filling and draining the pond

Here are two examples for how you could assess the location of your pond. The green line indicates a very good location, the red line a bad location, where you probably should not build a pond. The blue line reflects the assessment of your location. The closer the blue line is to the green line, the less investment is needed and production cost will be lower. Conversely, the closer the blue line is to the red line, the higher expenditure for setting up and/or managing the pond.

In the first example, you would need to invest more in water supply, probably through pumping. You also need to invest in measures to protect the pond from the risk of flooding, such as higher dykes.

In the second example, you also need to invest in measures to protect against flooding. You also need to take care to protect your pond from impacts of agriculture, as it is closer to agricultural land. In this example, your water source is a stream. If this stream runs through the agricultural land, it may carry agricultural fertiliser and pesticides into your pond, negatively impacting your pond's water quality and your fish.



05 Farm and production planning

If you

- have identified a suitable site for a fish pond that meets the criteria outlined above,
- know which species you want to culture,
- and have sufficient capital to start operations, make a plan and assess its economic viability
- Use the template on the right and add your own answers. Try various options for desired fish size and stocking densities
- Use real market costs for the species you want to culture and for feed.
- The examples given are just examples and do not reflect real prices

		KEY PLANNING QUESTIONS	ANSWERS	EXAMPLE
1	Size of fish for market/ consumption	What size will you harvest your fish?		500 gram
2	Growing period (months)	How long will grow the fish to this size?		8 months
3	Size of pond	Total area of the pond		600 sqm
4	Stocking density/ number of fish	# of fish per sqm of pond		3 fish/sqm
5	Total number of fish stocked	How many fingerlings will you buy? (answer 4 * answer 5)		1800
6	Survival rate	What is the expected survival rate (90% - 80%) - how many fish you expect tot survive (line 5*90/100)		90 %, 1620 fish
7	Harvest goal (total kg to be harvested)	How many kg in total is the expected harvest (line result line 6 * answer line 1)		810 kg
8	Amount of feed needed	Pelleted commercial feed, Assume FCR 1.5		810kg * 1.5 = 1215 kg
9	Cost of feed	As per the option chosen above (result line 8*feed cost/kg)		1215 * 3.500 = 4252500₺
10	Cost of seed	What is the expected cost of fingerlings? Line5 * cost of fingerlings/head		1800 * 220₺ = 396,000₺
11	Other costs	Transportation, equipment (nets for fencing, lime for pond preparation etc.) (Green net, lime, transportation, electricity, labor etc.)		400,000₺
12	Total cost	Cost of feed + Cost of seed + other cost		5,048,500
13	Expected Price	Price you expect your fish to sell for per kg		8000₺
13	Potential sales	Expected market price/value per kg of fish * total expected production		6,480,000₺
13	Potential total profit	Potential sales – total costs		1,431,500₺

06 Key principles of pond construction

The layout of the ponds should be aligned with the topography of the land, water source and drainage.

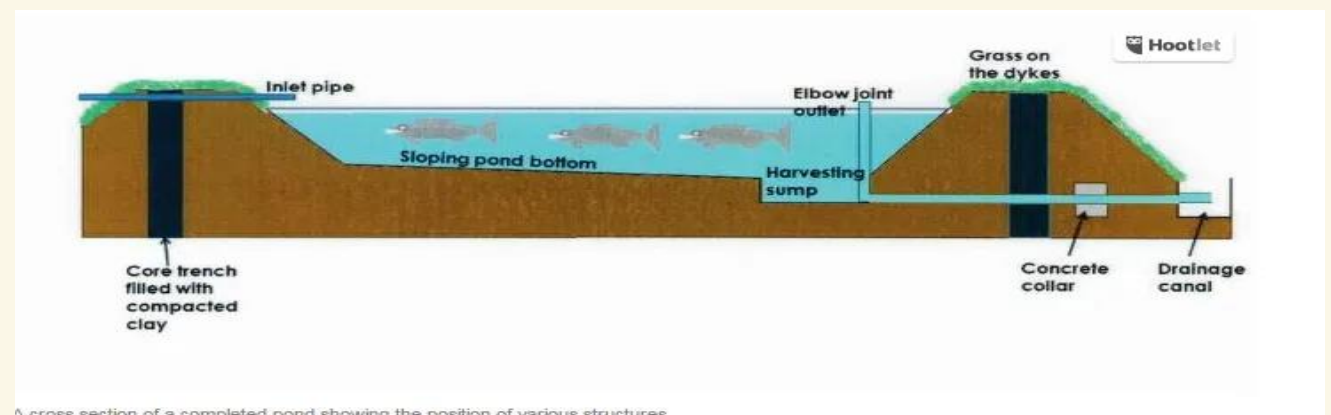
Arrange the pond in ways that would be ideal for independent supply and drainage of water. This requires an inflow higher than the anticipated water level and an outflow lower than the pond bottom. Build dikes around ponds to ensure water retention and to provide protection against flooding. The ability to maintain an appropriate water level is important to regulate key parameters such as water temperature, control the growth of aquatic plants and to keep dissolved oxygen at appropriate levels. The ability to drain a pond is helpful to harvest the fish and important to dry the pond bottom as preparation for the next production cycle.

Preferably, pond water depth should be around 1.5m at the shallow end and increase gradually to 2.5m at the deep end, with 0.5-1m of freeboard. Ponds that depend on seasonal rains and/or ground water should be deeper to be able to hold water into or throughout the dry season.

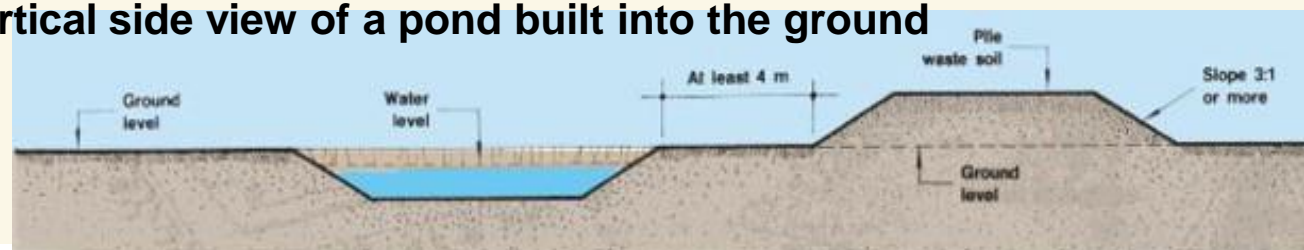
The picture on the right depicts a good pond, that has all the basic features: Inlet and Outlet pipes with filters, dikes and a sloping bottom.

However, in rural Cambodia, these basic principles are often not applied, and ponds are built without inlets and outlets, often into the groundwater table and in flood-prone areas.

A cross section of a good completed pond



Vertical side view of a pond built into the ground



If your pond is in an area that may flood during the rainy season and/or is dug into the ground-water level, apply these minimum standards as good pond construction practices

- Ensure the height and width of the pond walls (dikes) are sufficient to prevent flooding and breaking during the rainy season. Wide dikes also reduce seepage from one pond into the next.
- Ensure that excess water can flow out of the pond (overflow), If the water level in the pond gets too high during the rainy season, removed, dikes can erode and collapse, specifically if they contain sandy soil.



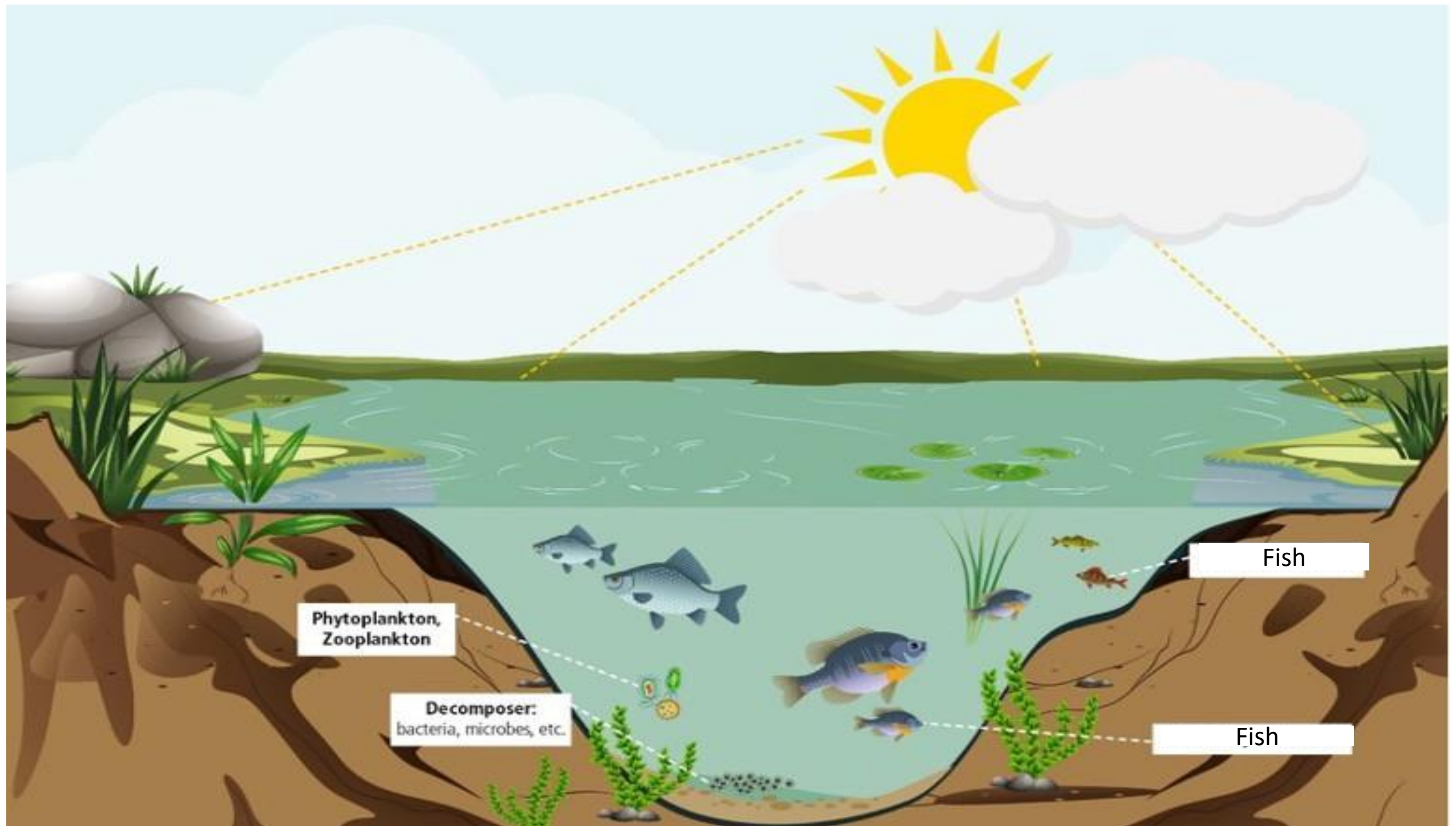
Recommendation for Fish Pond Slope Rate		
Soil Type	Slope Ratio	Slope (Depth*Slope rate)
Clay	1:1	Depth 1m= Distance 1m Depth 2m= Distance 2m Depth 4m= Distance 4m
Clay loam	1:1.5	Depth 1m= Distance 1.5m Depth 2m= Distance 3m Depth 4m= Distance 6m
Sandy loam	1:1.5-1:2	Depth 1m = Distance 1.5m-2m Depth 2m = Distance 3m-4m Depth 4m = Distance 6m-8m
Sandy	1:3	Depth 1m = 3m Depth 2m = 6m Depth 4m = 12m

It is also important to:

- Stabilise the dikes by planting grass on their slopes. This will reduce erosion and prevent dike collapse if the water levels in the pond are high.
- Fence the pond with a fine-mesh net on top of the dike. This will prevent stocked fish from escaping in case of flooding and predators such as frogs and snakes getting into the pond.

07 Creating and maintaining a healthy and productive pond ecosystem: Key Principles of pond preparation

Pond preparation aims to create conditions that provide a healthy environment with natural feed for the fish.



1. Pond preparation starts with a dry pond. If your pond is new, these are the steps to be taken before filling the pond with water.
2. If you have an existing pond, drain it and let it dry for at least a week. This improves soil properties and removes organic matters aquatic animals such as frogs, snails, snakes etc.



3. If your pond is not fenced yet, this is the time to fence the pond to prevent predators coming in. Check existing fences for holes and gaps
4. After fencing and securing your ponds against predators and other animals it is time for lining the pond.



5. On the dry pond bottom apply lime. If your pond is new and for preparing a new production cycle, use quicklime. If you apply lime during production cycle for water quality management, use agricultural lime. If you use quicklime, ensure to wear gloves and a face mask to protect yourself. **Liming is important to**



improve the soil conditions by reducing its acidity and increase the efficiency of the fertiliser, that will be applied in the next step. Liming also kills any organisms that are harmful to fish. If you use quicklime, make sure to wear gloves and a face mask to protect your skin and your lungs from burns.

After lime application, wait for about a week to 10 days to let the lime work. Then follows probably the most important step in pond preparation: **Application of fertilizer.**

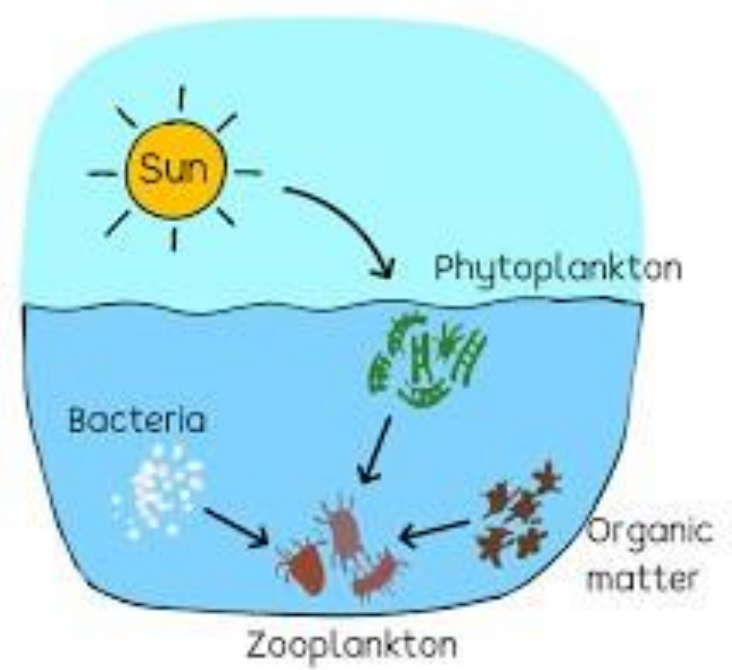
6. Application of fertiliser

How fertiliser is applied depends on several factors, such as **type of fertiliser, costs and availability** and whether you can fully drain the pond or you apply it to the water.

Pond fertilization is essential to increase the productivity of the pond by creating a natural food chain.

Fertiliser stimulates the production of plankton, which is a natural food for fish. Small fish will mainly feed on plankton in a fertilised pond. Plankton comes in two forms: plant form, called phytoplankton, and animal form, known as zooplankton.

This natural food is difficult to see, but the water color and turbidity are usually good indicators of natural food in the pond.



Inorganic Fertiliser	
ADVANTAGE	DISADVANTAGE
Easy to store, long storage possible, easy to apply and distribute, consistent mineral content, no decomposition	Cannot be directly consumed by the fish, no improvement of soil structure only commercially available, high price. Not to be applied during production

Organic Fertiliser	
ADVANTAGE	DISADVANTAGE
Low price, can be produced by farmer, can improve the soil, can serve as food for fish	Difficult distribution and application, low and variable mineral content,

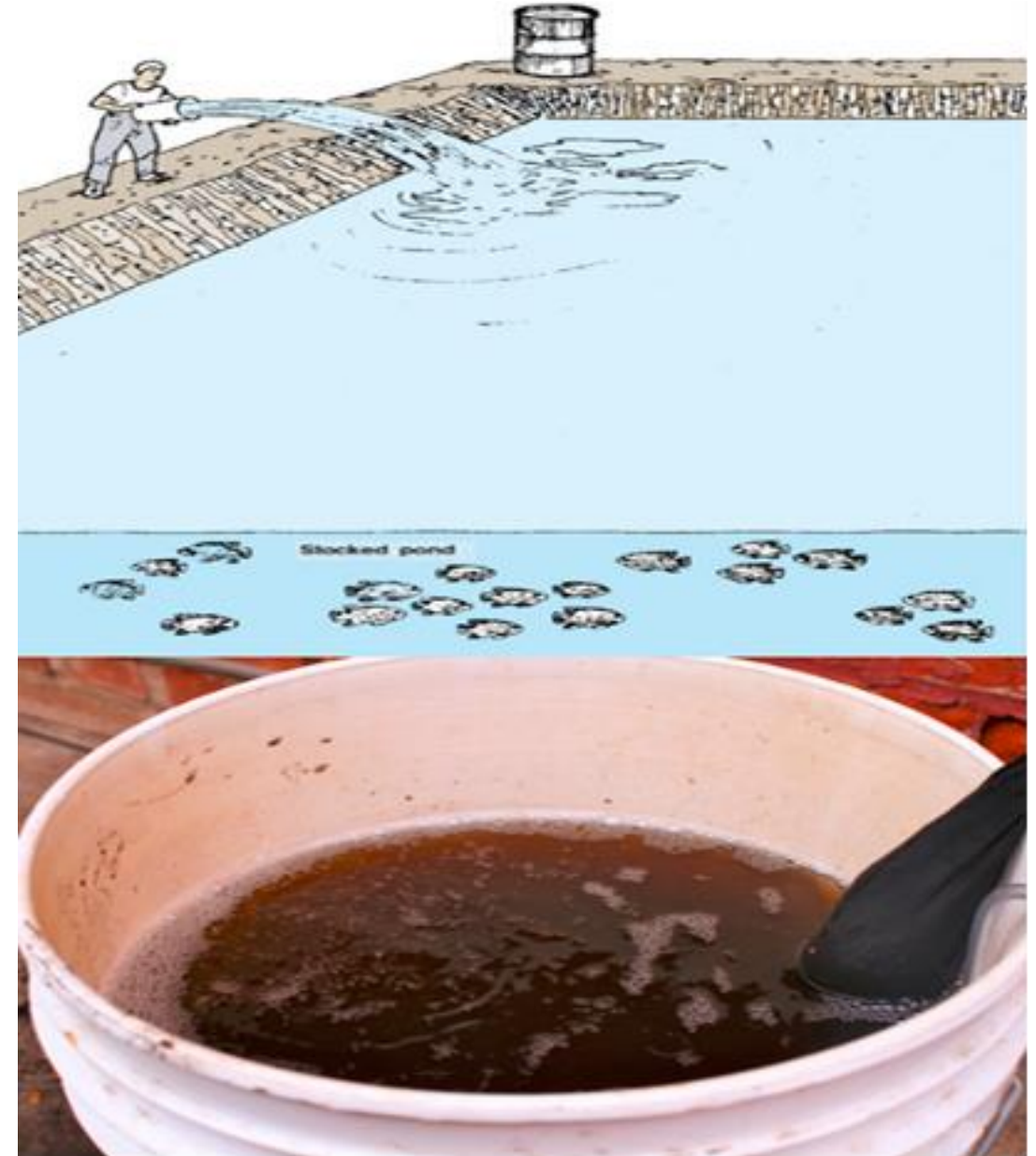
Application of animal manure

Spreading the animal manure on the pond bottom before filling the pond with water will support a long-term fertilisation effect. When mixed with the soil the nutrients are released by the soil, depending on the concentration of the water. Chicken manure is more effective, because it is high in nitrogen.



Application of animal manure or compost to the water

Do **NOT** put organic green matter directly into the pond, for composting. **INSTEAD**, compost should be prepared on land. Only **AFTER decomposition** apply it into the water. If you use animal manure, put manure into a bucket with pond water and stir into liquid solution; Distribute the liquid fertiliser evenly over the pond surface. During production, observe the pond closely. You may need to add compost or manure, when amount of natural feed decreases (see below for details)



Only apply chemical fertilisers after filling your pond with water, and never during production

08 How to select good seed?

Now that your pond is ready, it is time for stocking. But where do you get good quality fish seed and fingerlings? How do you identify fish seed of good quality?

1. Seed should be bought from a reliable source.

Before deciding on buying seeds or fingerlings, visit the hatchery. Observe the hatchery facilities and surroundings and check:

- Are they kept clean?
- How are waste and effluents disposed?
- Look for production schedules and tables, probably on white boards. If no white boards ask for breeding plans and schedules.

Ask questions such as:

How old (how many weeks) are these fingerlings? (Are they at a size that is to be expected at this age?)

How often is the brood stock changed?

How many family lines are maintained to ensure genetic diversity?



Good quality and healthy Silver Barb fingerlings
5g about 6 weeks and 8g for 8 weeks.



Good quality, healthy Striped Catfish fingerlings
5g about 6 weeks and 8g for 8 weeks.



Good quality and healthy Tilapia fingerlings
5g about 6 weeks and 10g for 8 weeks.



Good quality and healthy Climbing Perch fingerlings
3g about 4 weeks and 7g for 7 weeks.

Broodstock should not be recruited from their own fish production to avoid inbreeding, if there is only one family line

2. Fingerlings should be healthy, about the same age and size and free of injuries and deformities

Indicators of good health:

Proper skin color, no injuries and no missing scales (if scaled species);

Looking for and buying larger fingerlings is better, as they are more robust: Survival rates of smaller fish often is 50% or less compared to 90% for the larger fish and thus requires higher management efforts.



When your pond is well fertilised and productive, it is ready for stocking.

After stocking and during the production cycle, **it is important to maintain the natural productivity of the pond by adjusting fertilisation.**

The table below provides some guideline on how to adjust pond management to maintain productivity

POND COLOR, STATUS	MANAGEMENT ACTION
Muddy	Use lime or organic fertilizer, or Alum (depending on the availability and cost of materials)
Dark green	Reduce fertilizer, reduce feeding. If possible, i.e. external water source exists, exchange 20-30% of the water with clear, unfertilized water and safe (free from pesticides)
Red	Reduce fertilizer, if possible exchange 20-30% of the water with clear, unfertilized water
Clear	Add more fertilizer. If a pond with well fertilized water is nearby, add fertilized water from this pond.



Muddy pond because of dyke erosion



Pond water with green scum



Red algae in pond

It is important to NOT Over-fertilise the pond

One indicator of the pond being appropriately fertilised is the water color and turbidity. Green colors indicate the presence natural food. Brownish green indicates more zoo plankton that the and yellow and bluish green show the presence of phytoplankton. If the water is very brown, it is usually caused by suspended soil particles. Brown water and transparent water indicate that the pond is not well fertilised and less productive.

A simple way to check the turbidity of the water is the so called “hand method”:

1. **Stretch one arm and immerse it vertically into the water until your hand disappears from sight.**
2. **Note the water level along your arm:**
 1. **If it is well below your elbow, plankton turbidity is very high;**
 2. **If it reaches to about your elbow, plankton turbidity is high;**
 3. **If it reaches well above your elbow, plankton turbidity is low.**



The pictures above and below show farmers collecting and concentrating plankton by using a cloth and a transparent glass to observe the presence of natural foods available in the pond.



09 Transporting and releasing seed

Transportation can cause a lot of stress to the fish and even mortality, particularly on some rural roads. Make arrangements with the hatchery a couple of days before the planned stocking date, so that the fish can be prepared for transportation.

- ★ Fish must not be fed for at least 24 hrs so that they can empty their stomachs prior to transportation. With full stomachs they would use more oxygen and their feces can contaminate the water.
- ★ Make sure that the containers or bags used for transportation are shaded and transport the fish during nighttime or early morning or with shade and cool transport during daytime
- ★ Keep water temperature low (18-22°C). Fish is less active in cool water and thus needs less oxygen. If you are using poly bags, avoid exposing them to direct sunlight to avoid overheating.
- ★ During transportation, regularly check the fish. If they are gasping for air, add fresh water or air. If you use open containers, you can add air/oxygen by splashing water or using an air pump.
- ★ Fish can be transported in plastic bags (most common) or open containers such as tins, plastic boxes etc.



Preparing oxygenated plastic bag transport



Short-distance transport of fingerlings by small-scale household-based farm



canister with cut-out prepared for fingerling transportation



Open container transport (30L-gasoline can

Releasing the fish into the pond

- ★ Fingerings and seed need time to adjust to their new environment. A sudden release can cause shock and lead to mortality.
- ★ If the mode of transportation is bags, let the bags with the seed or fingerlings float on the pond for at least 15 minutes.
- ★ Mix pond water into the bag slowly. Let the fish get used to the pond water.
- ★ Open the bag and sink the open side into the water so the fish can swim out by themselves.



Nursing and grading

★ If you got seeds that are smaller than 5 gram, it will be good to release them into a hapa for nursing and grading, and to ensure efficient feeding.

Ensure that the pond is appropriately fertilised and
★ can provide natural feed. Small fry and fingerlings feed well on natural food and do not need additional feeding at the initial stage. Additional feeding is required, if you use a hapa.

Hapas with a water depth of 90 - 120 cm can
★ accommodate about 100 fingerlings/sqm, with additional feeding.

Hapas make it easier to count the fish and grade
★ them by size. Grading by size is important as bigger fish will consume more feed and smaller fish may not get sufficient feed. If you have stocked carnivorous fish, bigger fish may eat the smaller fish.

Thus, **grading ensures uniformly sized fish**
★ **and consistent growth rates.**

Grading fry by size is achieved by sieving fish
★ through netting of different mesh sizes, e.g. using scoop nets plastic mesh. Several sizes of graders will be necessary depending on the species and size of fish that will be graded.



10 What type of feed should I give to my fish?

The success of your farm critically depends upon how you feed your fish

- ★ Fertilise your pond well to foster production of phyto- and zooplankton as natural feed. Natural feed contains all the key ingredients your fish needs to be healthy and grow.
- ★ For herbivorous species at stocking densities between 2 - 5, you should supplement the natural feed by adding carbohydrate-rich agricultural byproducts such as rice bran.
- ★ For omnivorous and carnivorous species you can add insects, termites, worms as additional sources of protein.
- ★ At higher stocking densities you need to add formulated feed. Formulated feed can be either home-made or commercial, pelleted feed.
- ★ If you want to use home made feed, choose ingredients that are freely or cheaply available at your farm, or else home made feed can be significantly more expensive than commercial feed.

COLLECTED FROM THE WILD	AGICULTURAL PRODUCTS FOR HUMAN CONSUMPTION	AGRICULTURAL BY PRODUCTS	LEFTOVER
Azolla	Fruits	Maize bran	Kitchen leftovers
Termites	Leafy vegetables	Rice bran	
Grass, leaves	Soya bean flour		



- ★ If you produce your own, home-made feed, make sure to boil the ingredients. This will allow the fish to take up the feed more efficiently.

If you use commercial pelleted feed:

- ★ **Purchase only feed from a reputable manufacturer.**
- ★ **Feed should be fresh.** Check the expiry date printed on the bag before buying.
- ★ **Pellets should be of the right size.** If pellets are too big, fish cannot swallow them, and if they are too small, fish takes more effort to get the amount of feed it needs.
- ★ **Use the right feed for your species.** Protein is the most expensive ingredient in fish feed. If you have a herbivorous species, do not feed high-protein feed intended for carnivorous species.
- ★ **Follow the feeding instructions provided by the feed producer.**

Do not overfeed: Uneaten feed will go to waste and decrease the water quality. It is also a waste of financial resources, as the farmer spends a significant amount of money on feed that is not used by the fish.

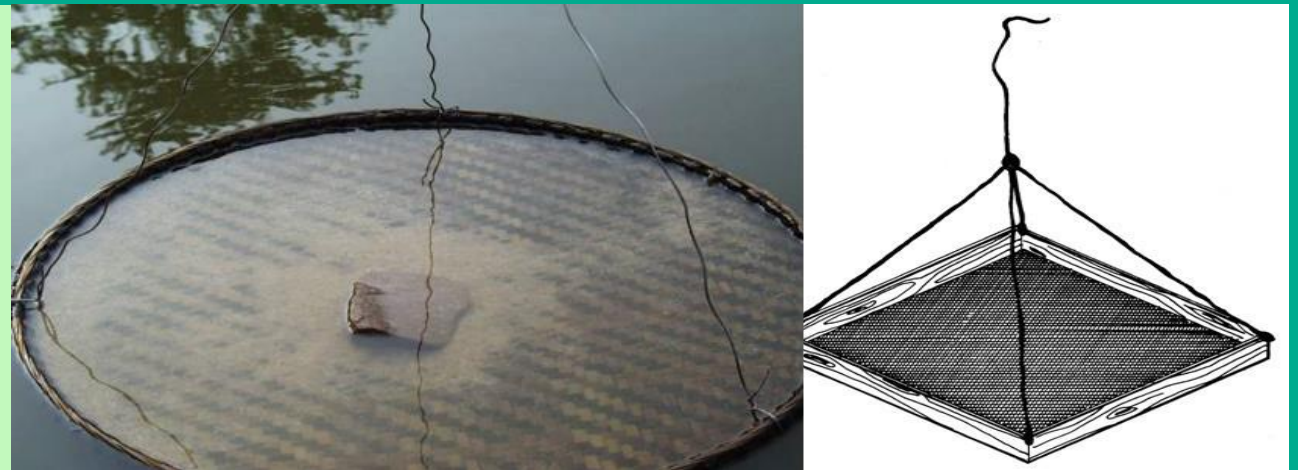


Do not underfeed: Insufficient feeding will lead to poor growth. When using floating feeds, a floating hose ring or pipes can be used to contain the feed and stop it floating away to the pond margins where it attracts birds and is harder for the fish to consume.

11 How to feed the right amount of feed?

OBSERVE THE FEEDING BEHAVIOUR OF YOUR FISH!

- ★ **Use tools such as feeding trays.** These allow you to observe the uptake of feed by the fish.
- ★ **Observe the fish and its feeding behaviour for at least 15 to 20 minutes.**
 - ★ If the feed is not consumed after 20 minutes, you have given too much feed. Reduce the amount of feed accordingly
 - ★ If the fish continues to feed vigorously, add more feed
- ★ **However, as fish tend to consume more feed than they actually need, you can reduce the amount of feed determined by observation by 15 - 20 %**
- ★ **Also, if you follow the feeding instructions provided by the feed producer, you can reduce the amount of recommended feed by 15%, as commercial feeds often contain attractors that make the fish feed more than they actually need**



12 How to raise healthy fish

Happy fish are healthy fish

Sufficient and good feed is one of the preconditions of raising healthy fish.

Creating and maintaining an environment, that provides the fish with good living conditions, is the second important factor, that supports the growth of healthy fish.

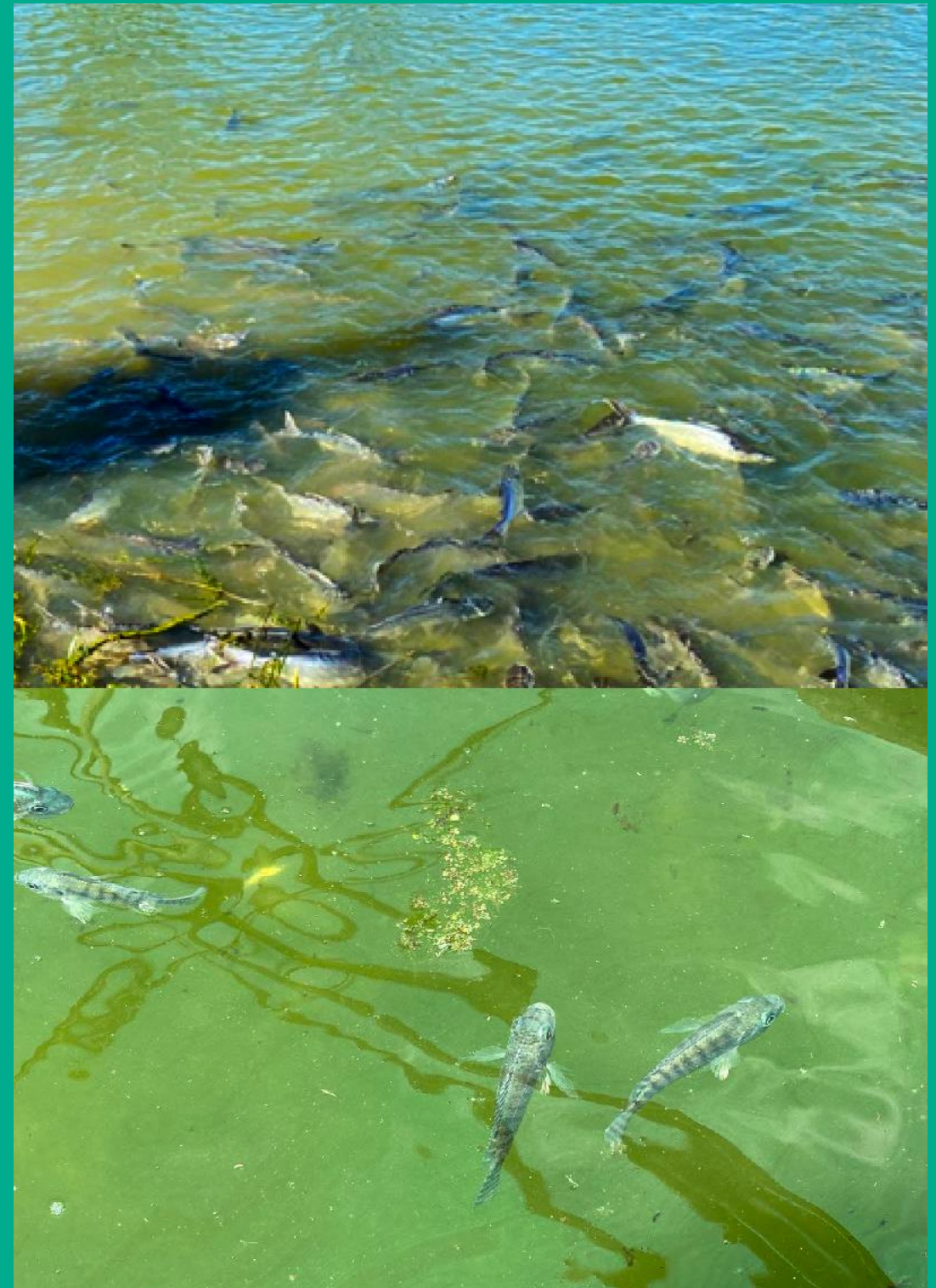
Observe the fish, their behaviour and the water quality on a daily basis.

Next to the availability of food, oxygen levels are most critical for fish growth and survival.

Observation of fish behavior and water transparency and color can signal low oxygen levels:

- ★ Gasping fish at surface
- ★ Fish swim sluggishly
- ★ Some dead fish with mouth and gill cover opened
- ★ Too much algal bloom, i.e. very dark green water.

Observe the fish in the morning - this is the most critical time with low oxygen levels.



What to do if oxygen levels and water quality are low?

- ★ If the cause is too many algae (dark green water, algae mats on the surface), reduce nutrient levels, reduce feeding.
- ★ If you have a pump, exchange 20 - 30% of the water with fresh water. The water pumped in should be sprayed or splashed on water surface to add oxygen.
- ★ In a small pond, “paddle” or “whirl” the water manually by hand.
- ★ Stop or reduce feeding temporarily.
- ★ Reduce the number of fish by partially harvesting fish biomass.



What to do if oxygen levels and water quality are low?

OBSERVATION OF THE FISH BEHAVIOR	POTENTIAL REASON	POTENTIAL ACTION
Little to no feeding, heavy breathing or gasping for air	High water temperature (>30 degrees)	Partly water exchange with colder water Add aquatic plant partially Install a coloured plastic net above the pond to provide shade
Gasping for air, no feeding	Low dissolved oxygen (<3.5 ppm AM, <5 ppm PM)	<ul style="list-style-type: none"> ★ Stop feeding until corrected. ★ Increase water exchange with higher oxygen content; ★ “spray” or “splash” the water into the pond, to add oxygen ★ Paddling/stirring of water - moving water increases DO
Little feeding, apathetic	Low pH (<6)	Reduce feeding rate Add agricultural lime(CaCO ₃) 20-25g/m ³
	High ammonia (TAN >0.25mg/L) or pH higher than 9	<ul style="list-style-type: none"> ★ Reduce feeding rate ★ Exchange water ★ Lower pH ★ Watch for symptoms of parasites/disease
	Transparency too low (<30cm)	Stop fertilisation Exchange pond water with clear water 20-30% Provide shade to reduce sunlight, e.g. by adding floating plants
	Transparency too high	<ul style="list-style-type: none"> ★ If available, partly exchange water with well-fertilized from another pond ★ Increase fertilization
	Dark green or brown color	Stop fertilization; Reduce feeding rate or nutrient inputs; Exchange water Use filter-feeder fish to graze plankton

13 How to harvest, handle and transport your fish

Key Principles of harvesting and handling your fish

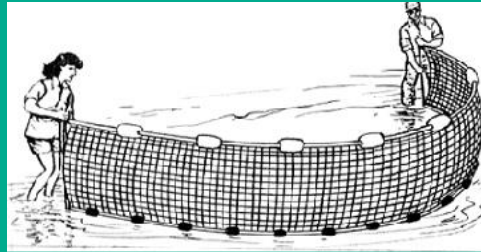
- ★ Plan your harvest well in advance:
Make prior arrangements for transportation and selling your fish.
- ★ Explore the market:
 - a) Where, in which location, is demand for the fish you are producing?
 - b) Are there fish-traders who are interested in buying my fish?
 - c) How much they are willing to buy? How much can they buy?
 - d) At what price are they willing to buy?
 - e) Do they expect me to harvest and transport the harvested fish or will the trader be responsible for the transport?
 - f) Does the trader expect/want to buy live fish or dead fish?
- ★ Make an advance agreement with the buyer Choose a buyer and agree on
 - a) amount of fish to be harvested
 - b) average weight of fish to be harvested
 - c) price at which the fish will be bought
 - d) date and time of harvest

- ★ Stop feeding fish before harvest
Do not feed the fish for 2 days before the harvest. This prevents fish feces being released during transportation
- ★ Choose the right equipment
Depending on the purpose of your harvesting (full or partial harvest, live fish or dead fish etc.) you can choose seine net, cast net, gill net or traps.
- ★ Handle the fish with care
 - a) Take care not to injure or damage the fish, as cuts and bruises may speed up spoilage
 - b) Check fish quality during and after harvest
 - c) Make sure that everybody handling the fish observes basic hygiene measures, such as wearing clean clothes, washing hands and using clean equipment
 - d) Do not expose the fish to sun and wind
- ★ Transport the fish under conditions that reduce the risk of spoilage and contamination from surroundings
 - a) If you can, chill your fish as soon as possible and keep it chilled during transport.
 - b) Transport the fish during night time or early morning to avoid the hot times of the day

What equipment should you use for harvesting fish?

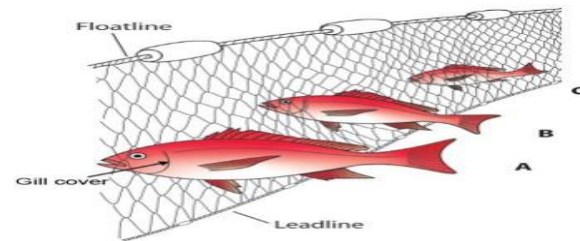
The choice of equipment depends on the purpose of your harvest. You can choose equipment that is most suitable for a full harvest, i.e. harvesting all fish in your pond. Or you choose to harvest only some of your fish, i.e. partial harvest. Do you want to sell live fish or is it ok to harvest dead fish?

Seine Nets



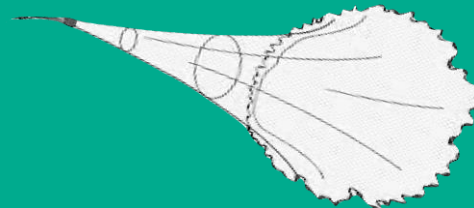
You can use a seine net for fully or partially harvesting your fish. You need at least 2 people to handle the net, which can become quite heavy and difficult to handle if your pond is large and you have many fish. With a seine net, you can herd your fish towards one side of the pond and scoop them up into baskets or other containers by hand or scoop net.

Gill Nets



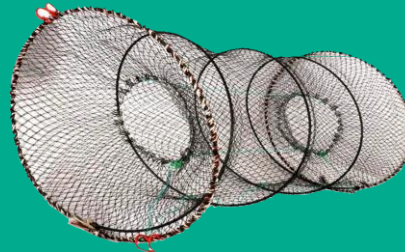
Gill nets are good for continuous, regular harvesting of fish of a specific size. They are stationary nets in which the fish is caught by its gills. You determine the size of the fish that you want to catch by choosing the appropriate mesh size. You can set the net harvest the fish once a day. If you want to harvest live fish, however, you should not use gill nets, as the fish usually dies in these nets

Cast Nets



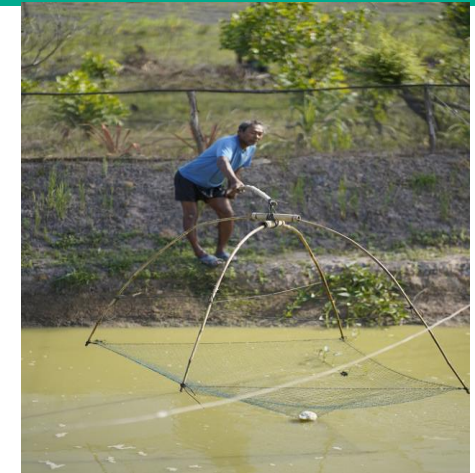
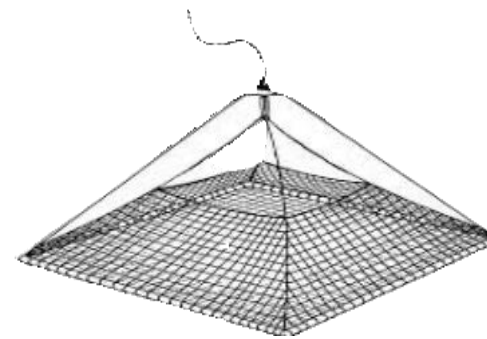
Cast nets are good for partial harvesting fish. They are not size selective and require some skills to operate them. As you catch different size fish with them, you need to grade and sort out unwanted fish by hand, thus causing stress and risking injury to unwanted fish.

Traps



If you want to do size-selective, regular harvesting of live fish, traps probably are your best choice. Traps have the advantage, that you can easily make them yourself with wood, plastic pipe, bamboo or wire frames, with netting, bamboo slats or wire mesh surfaces. They allow only fish of a specific size range to be trapped, as fish smaller than the mesh size can escape and fish too big for the entrance cannot enter.

Lift Nets



Lift nets are also good for partial harvest. They are suitable for collecting live fish and quickly sort the desired fish size. Like traps, they are good for harvesting fish for your own consumption, as often fish cannot be caught in sufficient quantity for selling. Lift nets can easily be made from bamboo or wire frame with netting.

Should you partially or fully drain your pond for harvesting?

If your pond has an outlet and you wish to harvest all your fish, partially or fully draining the pond will make the harvest easier, as you could harvest the fish at the outlet. Draining the pond is also the only reliable form for harvesting all your fish.

Partially draining the pond would make handling of a seine net easier. However, if you need to pump out the water, you need to consider the cost of pumping.

If your pond cannot be drained, a seine net would be suitable for harvesting 70 - 90 % of the harvestable sized fish.

14 How to transport your fish

Whether you want to sell live fish or dead fish, the way you transport the fish is critical for your fish to reach the market in a good condition. You do not want your live fish to die during transportation, nor do you want dead fish to spoil on the way to the market. Thus, fish needs to be handled with care to avoid any injuries and damage.

Transport of live fish

Cambodian consumers prefer live fish. To ensure that your fish reaches the market alive, you obviously need containers that allow the fish to be transported in water. During transport, it is important that the fish have sufficient oxygen to survive:

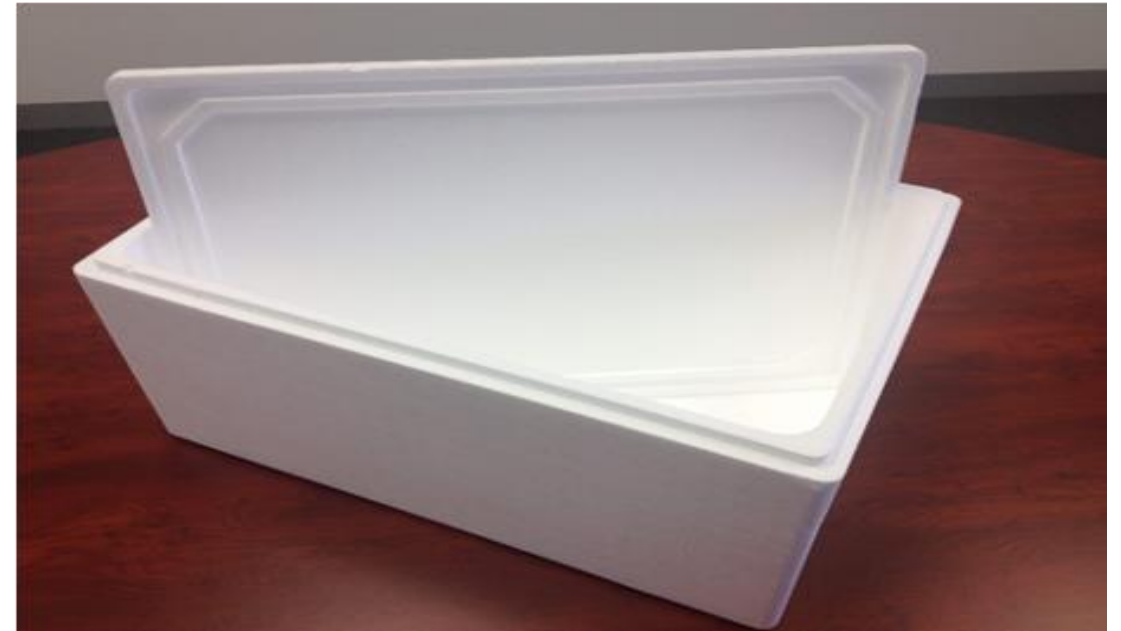
- ★ You can transport some air-breathing fish such as striped catfish, walking catfish, snakehead, climbing perch, alive in open containers without additional aeration.
- ★ Add about 1 kg of salt per 1000 L during transport of water.
- ★ Keep the water temperature low between 18 to 25°C during transportation. This keeps fish quiet and lowers their metabolic rate.
- ★ Other fish like Tilapia, silver barb and silver carp can be transported in open containers with an addition of aeration, specifically over longer distances.



Transport of dead fish

When transporting dead fish you need to keep it fresh as long as possible after harvesting and during transport to the target market. The most critical factor for this is maintaining a low temperature. Ideally, fish should be transported at temperature below 4 degrees:

- ★ Immediately or as soon as possible after harvest, put the fish into bucket or container with ice slurry and salt
- ★ In the buckets or containers, fish should be properly arranged between layers of ice.
- ★ If you use ice slurry, the fish ice ratio should be 1:1 for long distances and 1:1/2 for short distances.
- ★ Get ice (flake, tube, or crushed) from a reputable supplier, who produces ice from clean –de-chlorinated potable water.
- ★ Salt should be used and mixed with ice at the ratio 1:1000 (1g of salt for every 1000g of ice).



15 Is you fish farming worth the effort?

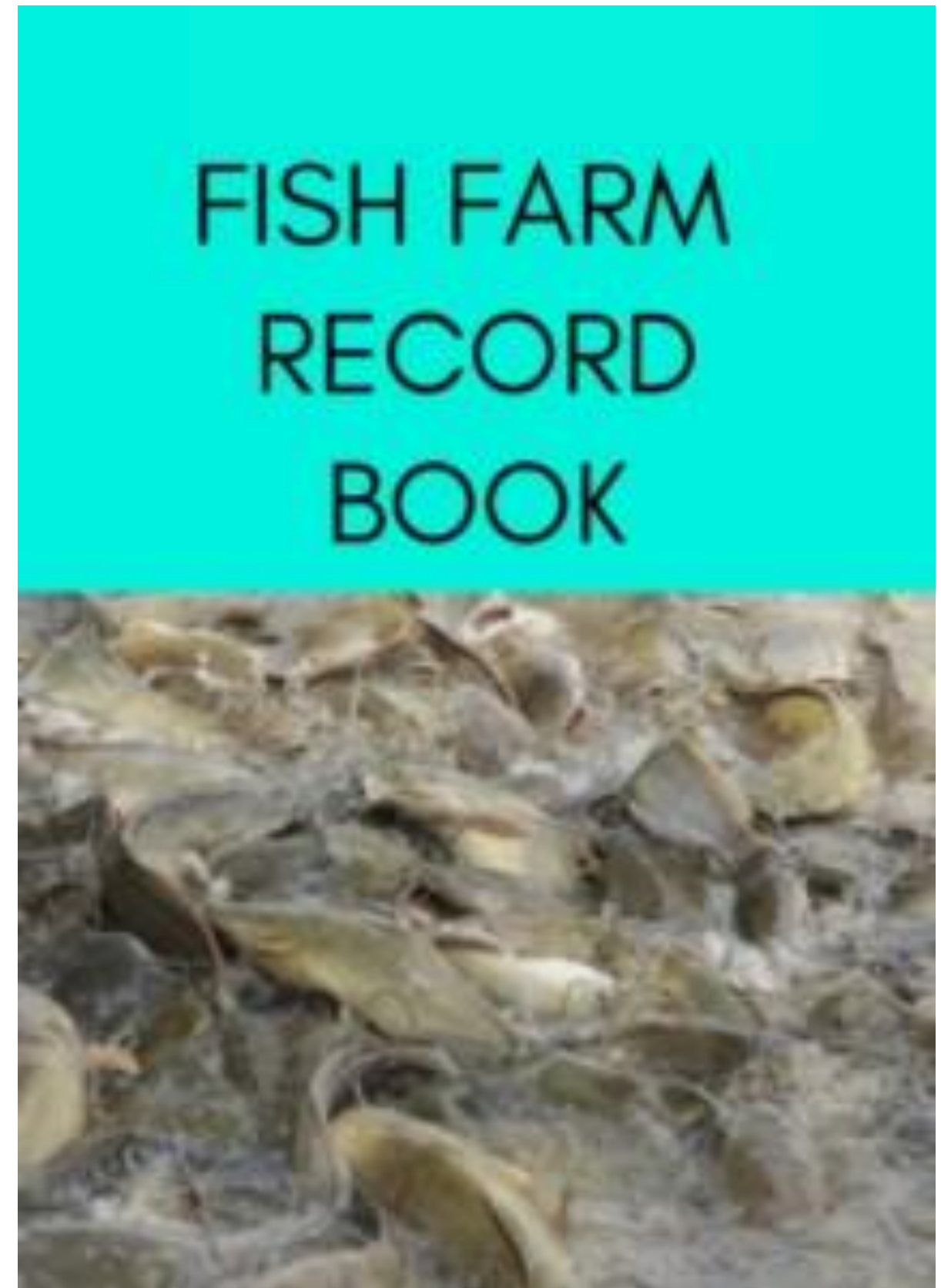
Economic analysis of your fish farming

Whether you are raising fish mainly for your own consumption or for the market - in both cases you do not want to loose money. If your production cost is higher than what you get for your fish in the market, you are loosing money. And if your home-farmed fish is more expensive than fish in the market, it is more economical to buy fish than to farm it for your own consumption. Keeping track of your expenditure on production, consumption and sales is critical for assessing the economic viability of your farm.

Keep records of **all expenditure and income** for your farm:

1. How much did and do you spend on pond construction?
2. How much did you spent for fingerlings?
How much did and do you spent on feed?
3. How much do you spent on fuel for pumping water and transportation?
4. How much fish did you harvest for your own consumption?
5. How much fish died?
6. How much fish did you sell?

Keeping regular records of these data will help you to determine the economic viability of your farm.



Daily monitoring and record keeping

You should visit your pond at least once every day, early in the morning and observe fish behavior and presence of natural feed in the pond. This allows you to assess the water quality and take corrective action, such as adjusting feeding, fertilization, aeration, as explained above.

Take note of your management actions such as adding fertiliser, pumping water, collecting dead fish (if any) etc. and note these in a table like the one to the right.

Also take note of

- Amount of money spent on fish farming;
- Total number of fish harvested;
- Weight of fish harvested for family consumption or given away to neighbours;
- Number or weight of fish sold for cash.

You can compile these daily records into a monthly overview, which will show the

- Total value of the fish sold or consumed per month;
- Total expenditure on management per month;
- Amount gained (net profit) or lost (net loss) through fish farming.

By recording the costs of various management measures and inputs daily, you can monitor and identify the greatest cost factors in your farming system and take action to reduce some of these costs by adjusting management to reduce losses and/or increase profitability.

DATE	DESCRIPTION / ACTIVITY	EXPENDITURE			INCOME	
		COST/MONEY SPENT (KHR)	DEAD FISH / MORTALITY (KG = KHR)	FISH GIVEN AWAY (KG = KHR)	FISH CONSUMED BY FAMILY (KG = KHR)	FISH SOLD (KG = KHR)
2	Add fertilizer to the pond	-	-	-	-	-
3	Buy ingredients for making fish feed; take fish for neighbor	20,000	-	0,8kg = 4,000KHR	-	-
5	Repair fence; eat fish	6,000	-	-	1,2kg = 6,000KHR	-
6	Take fish for selling	1,000	-	-	-	4kg = 20,000KHR
....						
8	Some dead fish early in the morning		0,6kg = 3,000KHR			
8	Pump fresh, clear water					
9	Buy fuel for water pump	8,000				
10	Take fish for selling					3,5kg = 17,500KHR
16	Take fish for eating				1kg = 5,000KHR	
Total		35,000 KHR	3,000 KHR	4,000KHR	11,000 KHR	37,500 KHR
Total expenditure		42,000 KHR				
Total income					48,500 KHR	
Balance					6,500 KHR	

Yearly overview of production by month

MONTH	EXPENDITURE (៛)	INCOME (៛)			BALANCE (៛)
		FISH SOLD	FISH CONSUMED	TOTAL	
January	42,000 KHR	37,500 KHR	11,000 KHR	48,500 KHR	6,500 KHR
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
Total					