



A TRAINING MANUAL FOR GROW OUT POND CULTURE OF AFRICAN CATFISH

A comprehensive guide to small-scale African catfish farming in Ghana



Implementation Agency

Western Region Coastal Foundation (WRCF)

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Cover Photos

Western Region Coastal Foundation

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PREFACE

The Western Region Coastal Foundation is a locally owned and managed independent foundation with a legal charter as an NGO in Ghana. Our governance structure includes representatives from communities, local government and companies. As the oil, gas, power (OGP) and other extractive industries increase activity in the Western Region, they are affecting daily life for residents of the region's six coastal districts. This creates risks and operational challenges - increasing expectations by government, traditional authorities and others. It also offers opportunities.

Managing these risks and capitalising on these opportunities requires local knowledge, expertise and collective commitment to local economic and social development over the long term. Through data garnered from our innovative multi-stakeholder dialogue platform, WRCF is actively identifying and designing ways to add value to new or existing initiatives in private sector development to create economic growth in the region.

WRCF promotes **inclusive economic development**, translating its wealth of data and relationships into local solutions for sustainable development. We identify and design pilot projects that strengthen social license and support community development. We also lend our technical expertise to external projects, independently assessing and evaluating the impact of Corporate Social Investments (CSI).

The Aquaculture initiative implemented by WRCF seeks to significantly increase pond productivity using demonstration ponds in the three of the six coastal districts (Jomoro, Ellebelle and Nzema East). The demonstration ponds will serve as models for pond farmers, their input suppliers, and customers what is possible when coastal farmers have improved skills (through classroom training and practical training).

This manual has been developed for the classroom training and demonstration of the aquaculture initiative. It comprises catfish farming management best practices from pre-stocking management to marketing. The structure of the manual allows for flexibility in undertaking future training opportunities, by utilising a modular format, with each module containing its own supporting information. This flexibility, therefore, facilitates targeting of groups with different levels of formal education, courses with particular emphases, and varying time availability of potential participants. This manual can be accessed at www.wrcfghana.org

ACKNOWLEDGEMENTS

The Western Region Coastal Foundation (WRCF) wishes to thank all the persons, institutions and partners that contributed in the many ways to the preparation of this manual. The shared technical knowledge, experiences, and perspectives have produced a tool that will have a significant positive impact on the capability of fish farmers in the Western Region and beyond.

We extend our special thanks to the individuals who collaborated in the preparation of the different modules: Mr Etornyo Agbeko (CSIR, WRI), Dr. Ruby Asmah (CSIR, WRI), Dr. Francis A. Anani (CSIR, WRI), Mr. Emmanuel Tetteh-Doku Mensah (CSIR, WRI).

Our sincere appreciation goes to the WRCF Governing Board for their constructive assessments of the initiative at various stages.

To our partners Kpemli Farms (Tarkwa), Raanan Fish Feed West Africa Limited (Prampram), the Western Region Fisheries Commission and Carmeuse Lime Products (Takoradi), your support went a long way to facilitate the implementation of this initiative.

DISCLAIMER

The printing and publishing of this manual is sponsored by the UKaid funded Western Region Coastal Foundation (WRCF). The contents and views are the responsibility of the authors and do not necessarily reflect the views of WRCF, the UK Government, and CSIR-Water Research Institute. This training manual is published and distributed on condition that WRCF and its funding organisation is not responsible for the results of any actions taken by users of information contained in this training manual, nor for any error in or omission from this manual.

1 INTRODUCTION TO AFRICAN CATFISH FARMING AS A BUSINESS



This training manual is to serve as a guide intended to aid facilitators in delivering practical training to beneficiaries in pond culture of African catfish under the Western Region Coastal Foundation (WRCF) Aquaculture Pilot Intervention program. This guide aims as much as possible to include practical steps towards successful pond farming of African catfish as a business enterprise. It is intended for a training manual but could be used as comprehensive material on pond farming of fish.

Objective: The objective of this training guide is to aid facilitators in delivering training in aquaculture that would build the capacity of beneficiaries in catfish farming and enhance their knowledge base from earthen pond construction to harvesting and marketing of fish.

Expected Results: After this training, beneficiaries should be able but not limited to:

- ❖ Selecting good site for earthen pond construction
- ❖ Constructing productive and efficient earthen pond with good drainage structure
- ❖ Stocking, appropriate feed and feeding strategies to minimize production cost
- ❖ Learn some best management practices (BMP) for earthen pond African catfish farming
- ❖ Treating fish farming as profitable business venture or enterprise

1.1 African catfish farming

The African catfish is a fast growing farmed fish species. It is native to most water bodies in Africa and scientifically known as *Clarias gariepinus*. The external noticeable features of the African Catfish are presence of barbels, lack of scales, presence of one long dorsal fin, and dark grey in colour with a white ventral section (fig.1.1).

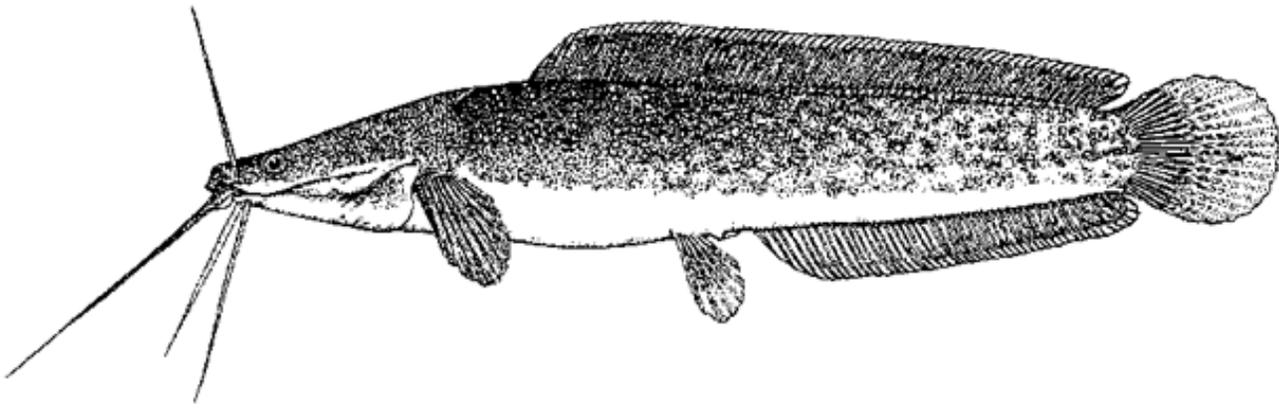


Figure 1.1: Diagram of the African Catfish (*Clarias gariepinus*)

1.2 General Characteristics of the African Catfish (Why farm catfish)



- ❖ Good Feed Conversion Ratio (FCR: 1.2)
- ❖ External air breathing abilities
- ❖ Relative tolerance of below average (sub optimal) water quality conditions
- ❖ High survival rate after the fingerling stage,
- ❖ Adaptable to poly culture with Nile tilapia based farming systems
- ❖ Good flesh quality
- ❖ low in lipid (fat) and high in protein

Other characteristics of the African Catfish are stated in table 1.1 below

Reproduction	Hormone induction estrogen. Seasonal maturation. Male doesn't produce huge quantity of sperm, it's needed to extract the gonad
Eggs production	Eggs on aquatic vegetative support. Hatch on artificial support such as mosquito nets in flow through systems and in fish hatching jars. Eggs extracted from the female by striping the abdomen
Water Quality	Very resistant after the fingerlings stage. Can survive in extreme conditions (sub optimal).
Diet	Predator; need high protein. Need more animal source protein
FCR: Kg of feed needed to produce 1 KG fish	1.2
6 month culture cycle	1000 g
Peculiarity	Air breathing
Sexual dimorphism	Male and Female are fast growing together
Fish fillet proportion and quality	55%; Red, usually smoked or cooked with spices.
*Fish Price / kg (2016)	20 Gh¢/Kg

Table 1.1 Characteristics of African Catfish

**Average prices in Akosombo area for illustrative purposes only, July 2016 (May vary based on location and other economic factors)*

1.3 Why Some Fish Farmers Fail

- ❖ **Poor Farm Siting:** This includes a place with poor water supply; poor soils for pond construction (e.g. may be rocky or sandy); far away from markets and/or supplies; among others.



- ❖ **Poor farm and facility design:** Ponds not compacted properly leak a lot, may be too shallow, and consequently construction and maintenance costs become too high, while optimum yields are not achieved. Poor accessibility to ponds, requiring workers to walk across difficult terrain to transfer fish from pond to vehicle or vice-versa.

- ❖ **Poor Investment Plan:** Several farmers assume that to be a commercial fish farmer one must have several large ponds. Hence, they construct many ponds at once, which constrain their cash flow. Because of this, it takes a while for some farmers to begin production, or they may only afford to start production in one pond after all the investment.
- ❖ **Start production** before knowing what management options are available or how to farm fish. That is, learning by the “trial and error approach”
- ❖ **Start looking for the market** for fish when the fish is ready for sale. Meanwhile, because they are still feeding, the pond attains its maximum loading and fish stop growing. The longer the fish stay in the pond after they have stopped growing, the smaller the profit margin.
- ❖ **Do not employ the right people.** Hiring family members who have little or no desire to learn proper fish farming techniques is a liability because most people find it difficult to dismiss these workers even after it has become apparent that they are the reason for the poor performance of the fish farm. Entrepreneurs must employ the right people.

❖ **Irregular and improper feeding.** This ranges from complete lack of knowledge about the nutritional requirements and feeding of catfish to attempts at saving money by using cheap feeds. Some farmers just do not feed their fish because they think fish will grow as long as they are in water. They do not realize that like all animals, best performance would be obtained if the fish have a balanced diet and that the feed needs to be eatable, easily digestible and does not disintegrate into the water before the fish can consume it. Farmers must provide fish with the correct feed of the right quality.

❖ **Do not appreciate** that different management levels have different requirements, which consequently affects stocking rates. Stocking rates are a function of the specific management regime.

❖ **Do not keep records** and do not assess performance to re-adjust management practices accordingly after each cycle. A farmer is therefore unable to tell whether he or she has made a profit or loss. Having money in one's pocket after a sale does not imply one has made a profit. Some farmers do not want to keep records because they are scared of facing the harsh realities of a loss. Unless one is able to face the bitter truth and correct his/her management practices, there will not be improvements and the business will eventually collapse.

❖ **Wrong objectives for investing in aquaculture.** Some do it simply because their friends are doing it or because they are targeting 'free' funds from donors or government. Nothing in this world is free. Always watch out for the hidden costs before making a final decision. Furthermore, pond construction is costly and is not something one should undertake for the sake of it. Changing one's mind and having to fill in ponds because you have changed your mind is even more costly. Think objectively before you embark on fish farming. Farm fish as a business; as a source of employment and income for yourself and others. Invest in fish farming only if you have identified it as a serious opportunity that can work out into a successful enterprise.

❖ **Lack of technical know-how**

Some farmers do not have the practical knowledge of fish farming before entering into the business. Those who seem to have some knowledge often have not undergone complete training on fish production. Some depend on observation and purported knowledge of fish farming,



which often is far from the reality. For example, with feeding, the feeder needs skills on fish response to feeding and quantity of feed to give the fish at a given rate, and at a given period. This requires practical knowledge from experienced and well trained personnel.

A quick reminder for farmers to treat fish farming as a business

Figure 1.2 below provides an easy way to remember important steps or processes for a successful fish farming enterprise as indicated.

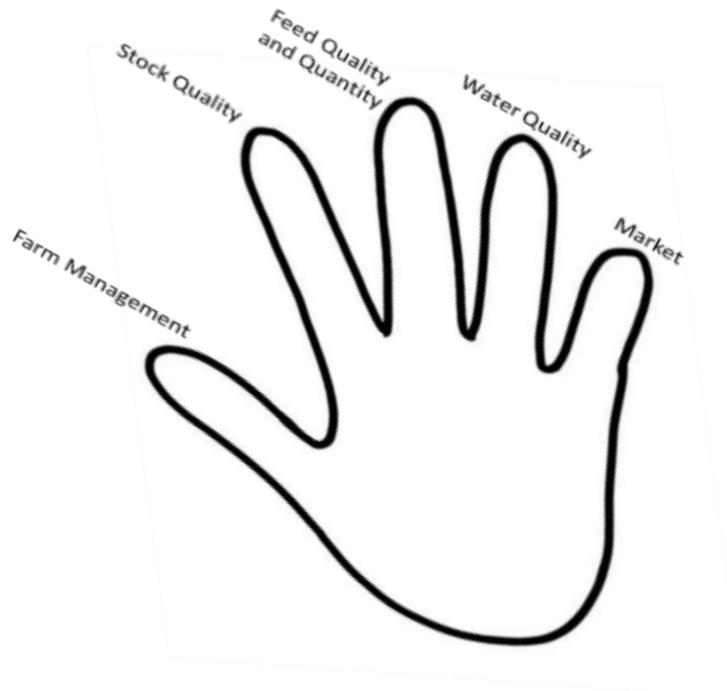


Figure 1.2: Fish farming hand indicating the important factors for successful fish business

Fish are greatly affected by the environment in which they are grown. An aquatic ecosystem is extremely dynamic, changing with nutrient inputs, weather and season. Therefore, the fish farmer must understand fully the following needs to understand following:

- ❖ Fish growth and survival are closely related to water quality. Furthermore, fish are cold-blooded animals. The temperature of the environment directly influences all of their bodily functions. Thus, while the markets determine aquaculture opportunity, the ecological and economic principles determine the choices for sustainable aquaculture practices and technology.

- ❖ Therefore, users of the manual are encouraged to understand the principles on which this catfish static water-pond-production technology is based upon. This is because the specific environment where the farm is located defines what additional opportunities and constraints in production one is likely to encounter.

- ❖ Hence, farmers and extension agents are encouraged to be observant and continue to make adaptations in order to enhance the productivity and profitability of their specific enterprises. This book is only a guide to the commercial production of catfish in ponds.

2 MODULE 1: PRE-STOCKING MANAGEMENT



For a fish farming business to be successful, major activities should be planned for and executed well with good record keeping. These include construction and/or re-construction, liming, fertilization, filling pond with water, and quality management before and after stocking ponds with fingerlings.

2.1 Fish Pond Construction

- ❖ A fish pond is a fish holding system that is essential for environmentally sustainable and profitable production of fish (fig. 2.1).
- ❖ A fish pond can be constructed as an earthen pond, concrete pond, or plastic or canopy layer pond. Earthen ponds are the most economical to build as it involves excavation of earthen materials (soil) to create dugout.



Figure 2.1: Layout of fish pond: Earthen ponds (left side) and Concrete ponds (right section)

Ideally, fish farms should have three types of ponds based on environmental and economic reasons. These are:

- ❖ **Nursery pond:** Area of nursery pond ranges from 100- 500 m² and the depth of water should be between 1- 1.5 m.

This pond covers 5% area of total productive area of the fish farm. The small size and depth of the pond simulates the natural environment for growth of fingerlings and ease for management practices. This is especially so in partial harvesting for sorting and grading (Figure 2.2).

- ❖ **Rearing pond:** Area of rearing pond varies between 500- 1000 m² and the depth of water ranges from 1.5- 2.0 m. This type of pond covers 15% area of the total productive area of the fish farm. Sometimes farmers may use this as a stocking pond also.

- ❖ **Grow-out pond:** Area of stocking pond varies between 1000- 20000 m² and the depth of water ranges from 2- 2.5 m. This type of pond covers 60- 70% area of the total productive area of the fish farm (Figure 2.2).

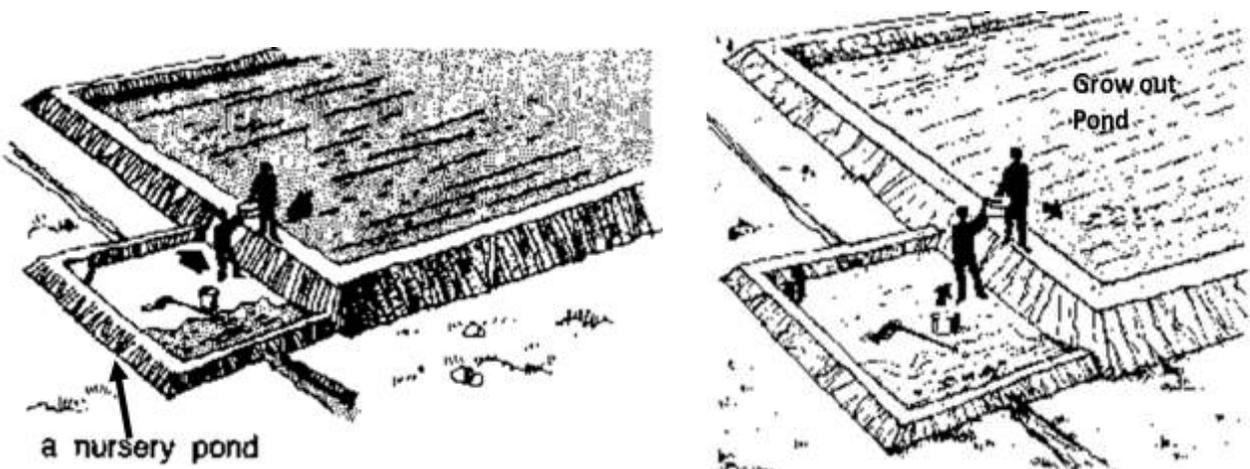


Figure 2.2: Nursery pond and grow out pond on a farm

Bio pond/Sediment pond: To ensure sustainable use of water and safe guard the environment, have a reserve pond where the water used for fish ponds in a farm is purified and/or stored for re-filling other ponds. It also acts as a large settling tank for sediment and biological breakdown of organisms. This may also be used as grow out production pond. The area covered by this type of pond is 7- 10% of the total production area of a fish farm.

- ❖ **Spawning** ponds for production of eggs and small fry;
- ❖ **Nursery** ponds for production of larger juveniles
- ❖ **Brood** ponds for rearing broodstock
- ❖ **Storage** ponds for holding fish temporarily, often before they are sold
- ❖ **Fattening** ponds, for the production of fish that will be consumed
- ❖ **Integrated** ponds that include crops, animals or other fish ponds, which supply waste materials that act as feed or fertilizer for the pond

2.2 Construction of dug-out earthen ponds

- ❖ Dug-out ponds, entirely obtained through soil excavation, are the simplest to build. Based on the type of water supply system to the pond, there are two main types of dug-out pond earthen.
- ❖ Dug-out ponds fed by rain and surface runoff, commonly found in relatively flat, well-drained terrain such as the low point of a natural depression. (Example: WRCF demonstration pond at New Ankasa, Western Region).
- ❖ Dug-out ponds fed by springs or seepage, the latter being commonly found in areas where the ground water table is close to the surface, either permanently or seasonally. (Example: WRCF demonstration pond at Kamgbunli).

2.2.1 Selecting site for dug-out earthen ponds

- ❖ To build a rain-fed or run-off earthen pond, it is essential to have enough waterproof soil at the site to avoid excess seepage losses.
- ❖ The best sites are those where fine-textured clays and silty clays extend well below the proposed pond depth.

- ❖ Sandy clays extending to adequate depths are satisfactory. Avoid sites with porous soils, either at the surface or at the depths through which the pond would be cut.
- ❖ To build a springs or seepage earthen pond, look for soils where the water-bearing layer is thick enough and penetrable enough to provide the required water.
- ❖ It is best to observe the site during a complete annual cycle to check on the possible variations of the water table elevation with the season.
- ❖ Clay soils are often best due to their capacity to retain water and their high shear strength. In theory, if a soil is good for making bricks, it is good for the construction of ponds.
- ❖ Soil areas that are clay-sand, silty-silto-clay, silty-clay, silty-sandy-clay and clay-silt are most desirable. Very sandy soils do not retain water, while pure clay soils are difficult to break apart, and do not form very stable dikes.
- ❖ A soil that contains too much sand or gravel will not retain water. Water holding abilities of sandy and clay soils are illustrated in fig 2.3. The manual test for suitable soil for earthen pond construction is illustrated in figure 2.4.



Figure 2.3: Waterproof characteristics of clay and sandy soil

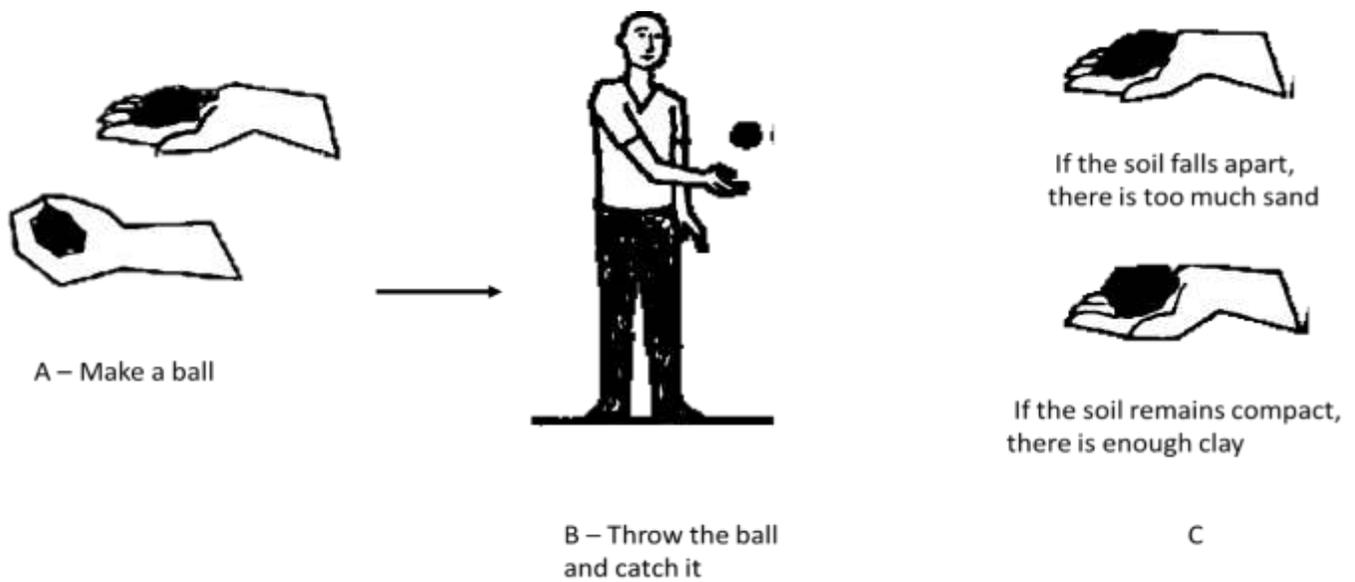


Figure 2.4: Test with a ball of soil

2.3 Procedures for constructing earthen pond (Profiling for re-construction of earthen ponds)

- ❖ Demarcate the area by profiling it to a preferred dimensions (Square or rectangular shape, later is recommended) using pegs, stakes and poles to be cleared.
- ❖ This should include the total area of the pond to the outside limits of the pond dikes and, in addition, an area of two to three metres to serve as a work space and for walkways beyond the dikes.
- ❖ Clear all vegetation from the demarcated area. Also remove all shrubs and trees within 10 metres of the cleared area (Figure 2.5).

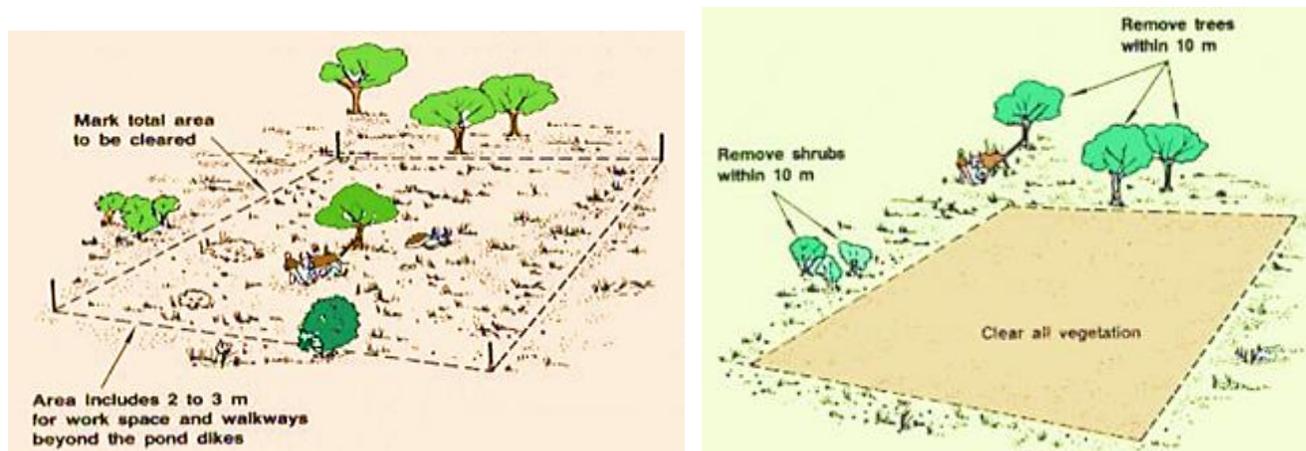


Figure 2. 5: Demarcation of pond area for pond construction

- ❖ Dig a small trench at very centre of the cleared area, mark the pond area to the outside limits of the pond dikes using heavy string or cord. Remove the surface soil from this area and store it for later use.
- ❖ Now mark the inside limits of the pond bottom using heavy string or cord. Do this on the basis of the selected side slopes (Ratio 2:1).
- ❖ When staking out the pond bottom, indicate on each pole, peg or stake the depth of excavation from ground surface to pond bottom as shown in Figure 2.6 (ie.1.5m deepest and 1m shallow section).

- ❖ Set-out the profiles for the inside slope/wet side section (2:1 or 3:1 for poor soils) and outside slope/dry section (1.5:1) as indicated in Figure 2.6(a) and (b), and 2.7

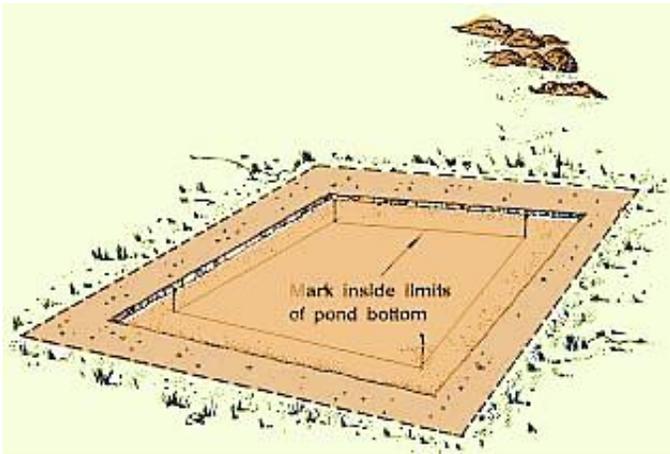


Figure 2.6a: Demarcation of pond for construction of slope

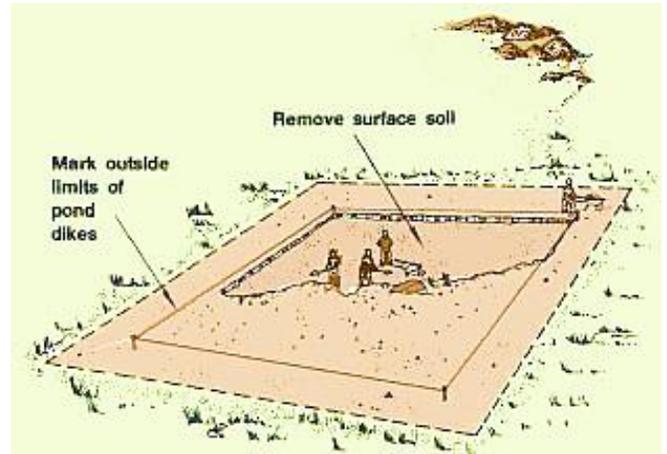


Figure 2.6b: Demarcation of pond for construction of slope

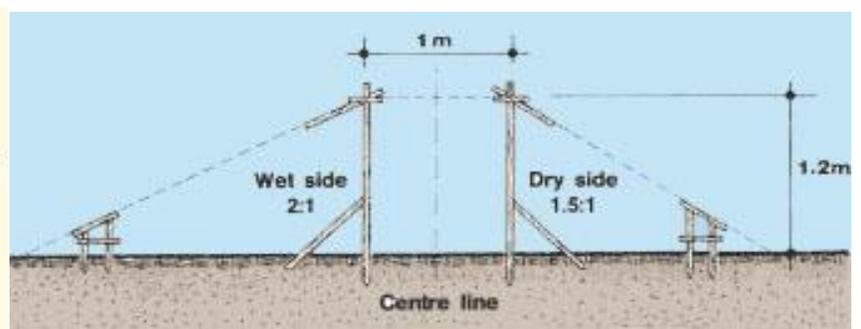
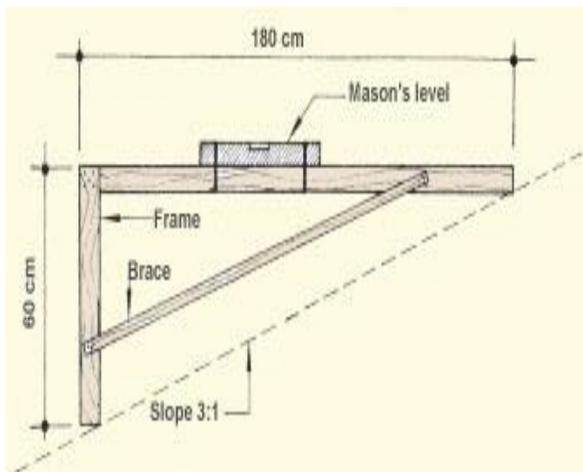


Figure 2.7: A slope gauge for the development of inside and outside of pond

Vertical (cm)	Horizontal (cm)	Slope
60	150	2.5:1
60	180	3:1
90	180	2:1
100	150	1.5:1

Table 2.1: Relationship between vertical and horizontal dimensions for slope determination

❖ There are two easy ways to dispose of waste soil material and to prevent it from eroding back into the earthen pond;

❖ If there is enough space around the pond, you can spread the waste soil there. Limit the thickness of spread soil to 1 m at most and slope it gently away from the pond (Figure 2.8).

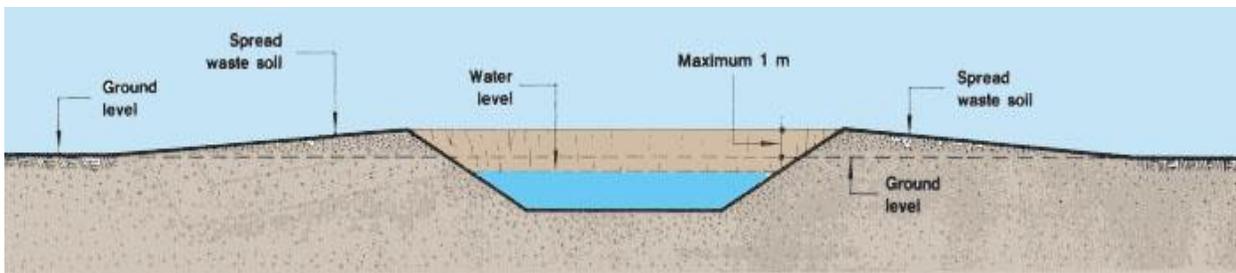


Figure 2.8: Layout and disposal of waste soil during excavation of pond

❖ Make a pile of waste soil near the pond, but be sure to leave at least 4 m between the toe of the pile and the pond. The sides of piled soil should have a gentle slope of 3:1 or more (Figure 2.9)

Note: you can use a pile of soil as a windbreak or for the cultivation of a grass or crop.

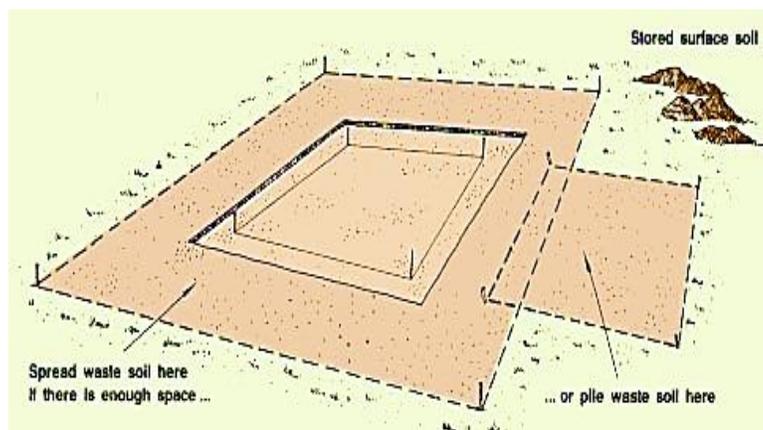


Figure 2.9: Profiling of pond site towards excavation

- ❖ Clearly mark the limits of the areas where the excavated material will be spread or piled.
- ❖ Dig to the designed depth within the limits of the pond, cutting the sides vertically. Transport the waste soil to the planned areas.

Note: Usually the pond bottom in drainable ponds (with Monk or elbow pipes) is given a one-percent slope between the inlet and outlet ends (Figure 2.10).

- ❖ *Shape the sides* of the pond to the desired slope (2:1 or 3:1) and finish the pond bottom and the horizontal dike tops with a desired slope. Remove any excess soil.

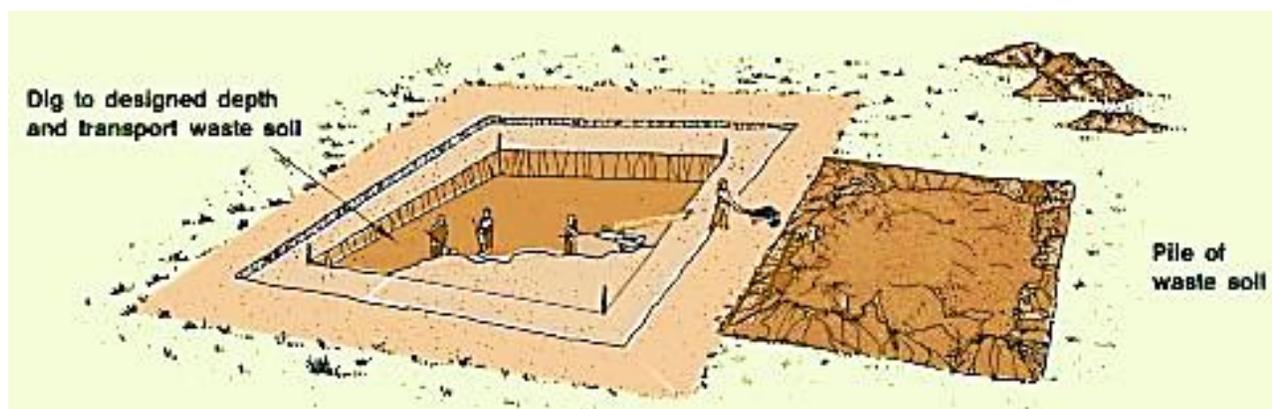


Figure 2.10: Manual excavation of pond from the deep to shallow depth

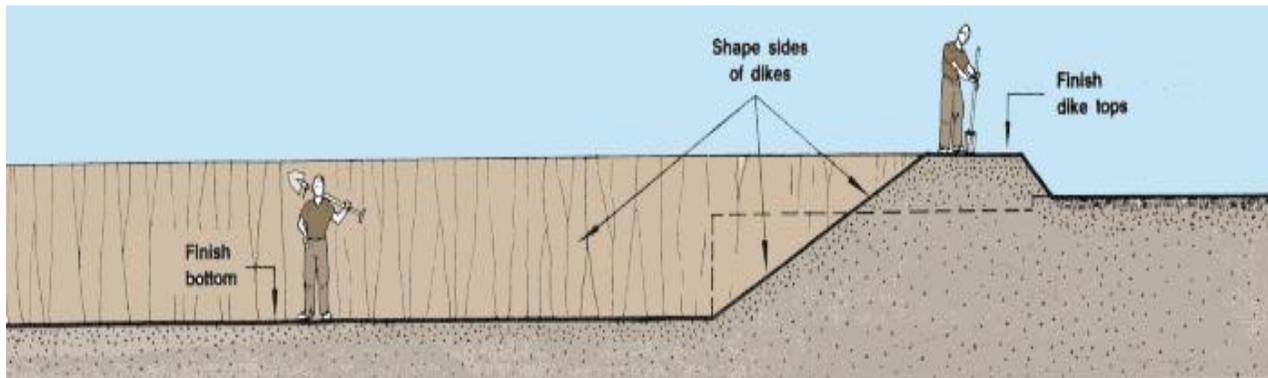


Figure 2.11: Good development of dikes

- ❖ Bring back the surface soil to cover the waste material and the dike tops. Then plant or sow grass all around the pond to prevent erosion (Figure 2.11 and 2.12).

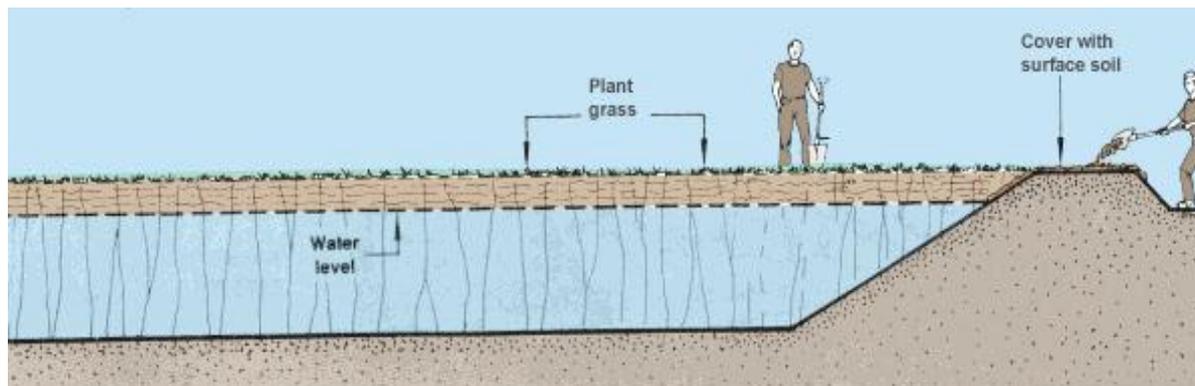


Figure 2.12: Pond dike completion and protection with grass

2.4 Compacting pond dikes and embankment / levee



- ❖ Earthen pond dikes and levee/embankment are compacted to minimize water going through, and to re-enforce for ponds dikes from sliding off or flaking out.

❖ To compact successfully, air and water are expelled from the soil so that its mineral particles can settle very tightly together. For best results, you therefore should always:

- Place and compact the soil in thin horizontal layers about 15 to 20 cm thick, so air and water can be expelled easily;
- Wet the soil material to its optimum moisture content for compaction (figure 2.13)
- Finish off the slopes of the completed dike to form a well-compacted surface.

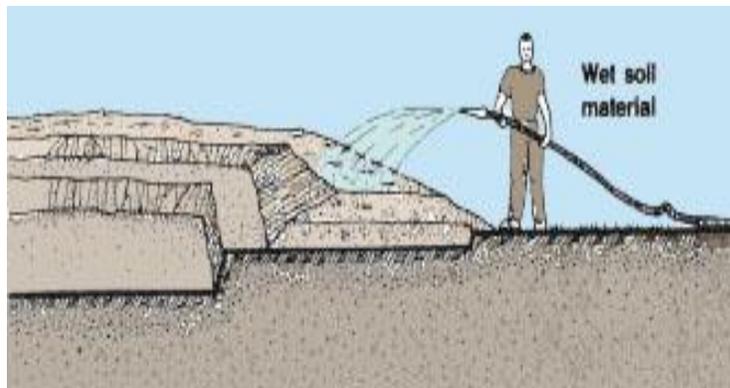


Figure 2.13: Wetting of soil material for compaction

2.4.1 Compacting pond dike, levee/embankment soil by hand

- ❖ To compact thin layers of soil by hand, you can use simple tools such as:
- a thick stick or the bottom part of a palm frond;
 - a thick stick rounded at one end for pounding vertically, for example soil in a trench;
 - a hand tamper, a metal or concrete weight (maximum 4 to 6 kg) attached to a wooden handle, with a surface area of about 150 cm², which you can make or buy cheaply from hardware stores (Figure 2.14)

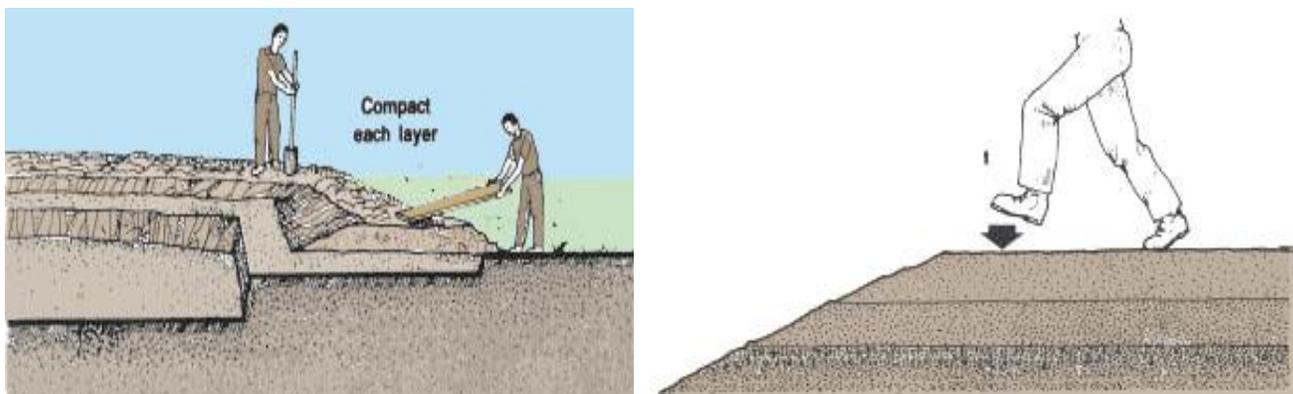


Figure 2.14: Hand and foot hampering for soil material compaction

- ❖ Hand compacting is generally suitable for small dikes, typically 1 to 1.5 m in height and up to 1m top width, or smaller if soils are not of good quality.
- ❖ For clays and similar soils, it may be better to use a kneading action, for example by using the heel of the foot.
- ❖ You can easily make a hand tamper using scrap metal fittings, a section of pipe filled with sand and a hardwood handle (Figure 2.15).

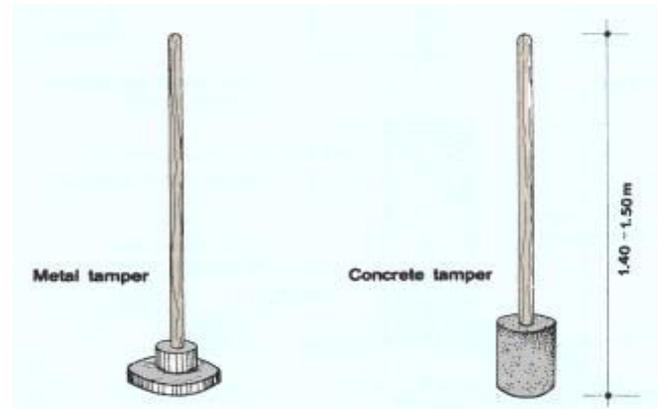


Figure 2.15: Simple types of hand tamper

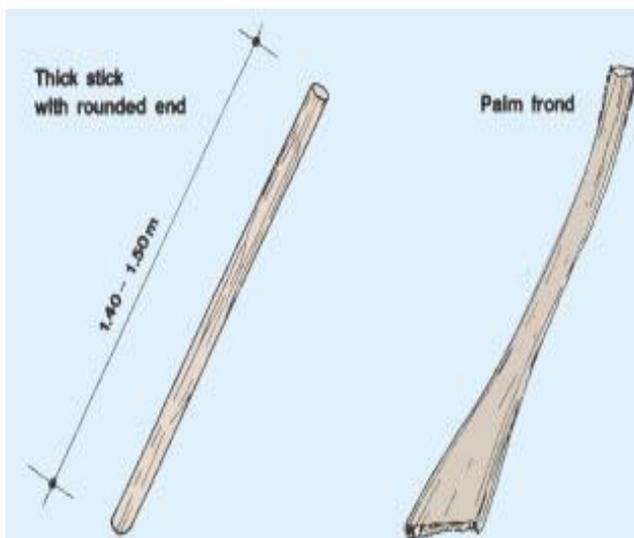


Figure 2.16: Various hand compacting tools

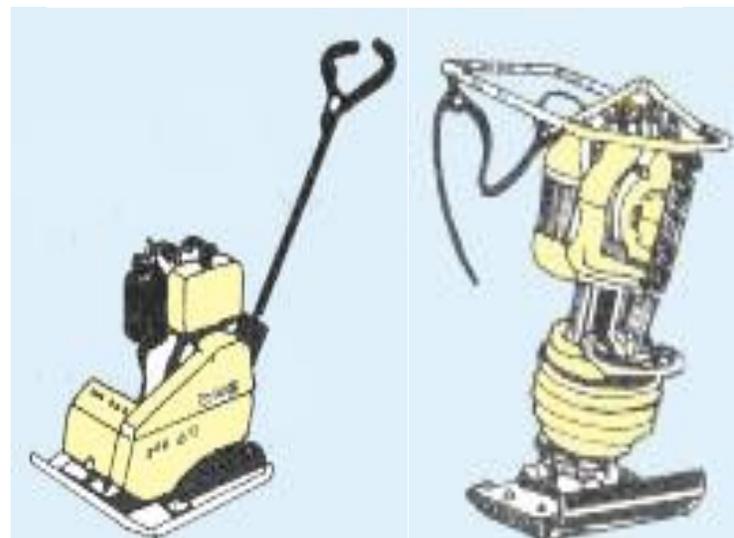


Figure 2.17: Machine compacting tools

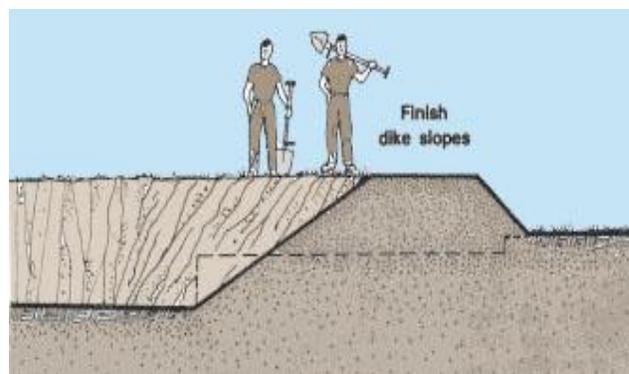


Figure 2.18: Completion and protection of pond dikes with planting of grass or vegetables

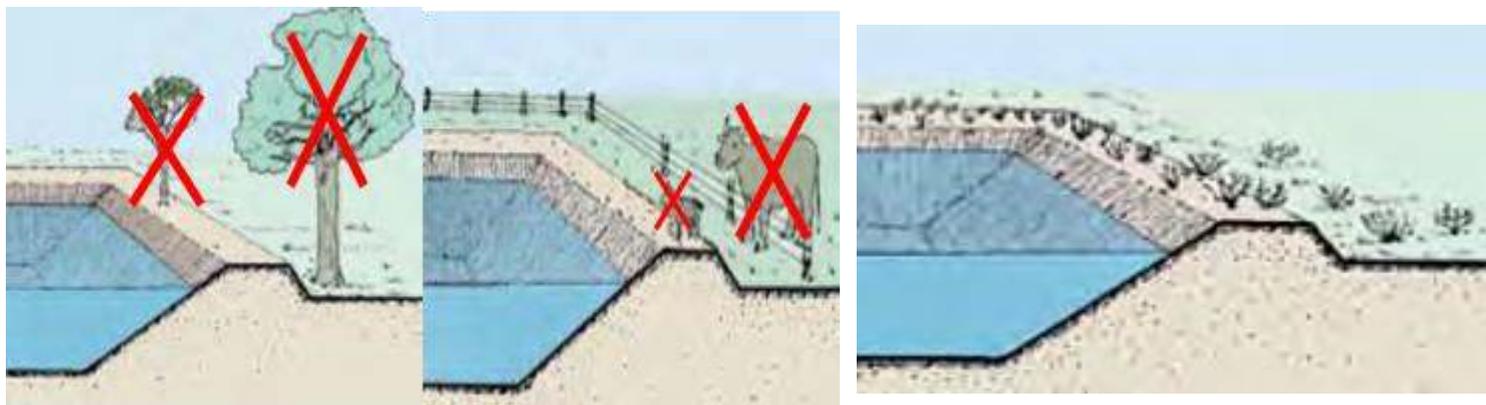


Figure 2.19: Prevent grazing and growing of trees on pond dikes

2.5 Construction of Monk (Water control structure)



A monk is a water control structure that allows impoundment (filling) of a pond to desirable water levels. Monks helps to minimize flooding, escape of fish from the pond, prevents entry of unwanted organism, allows for easy water rushing through, and aids partial or complete harvesting. Monk construction begins with creating a concrete platform and U-shaped iron mesh over it (Figure 2.20).

Monks minimizes the cost of production by eliminating the fuel cost in draining ponds through the use of water pumping machines (as it pertains in most coastal communities visited before the WRCF aquaculture intervention introduced the monk system)

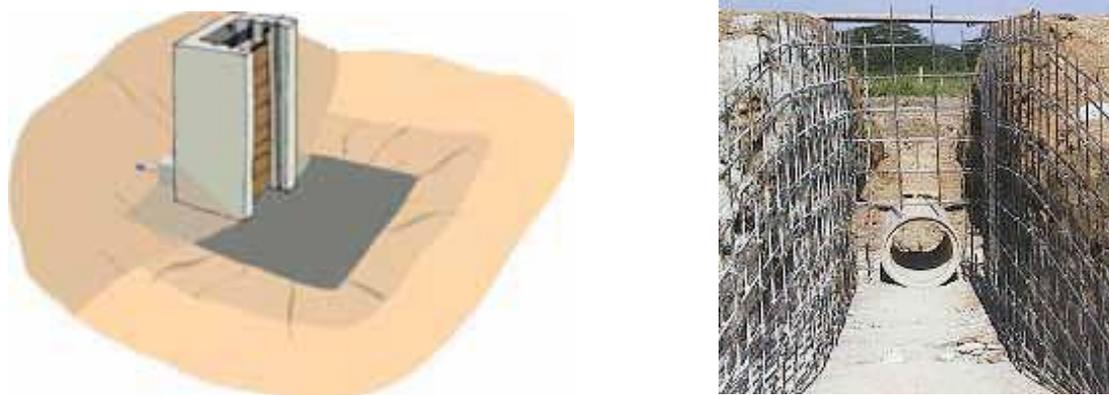
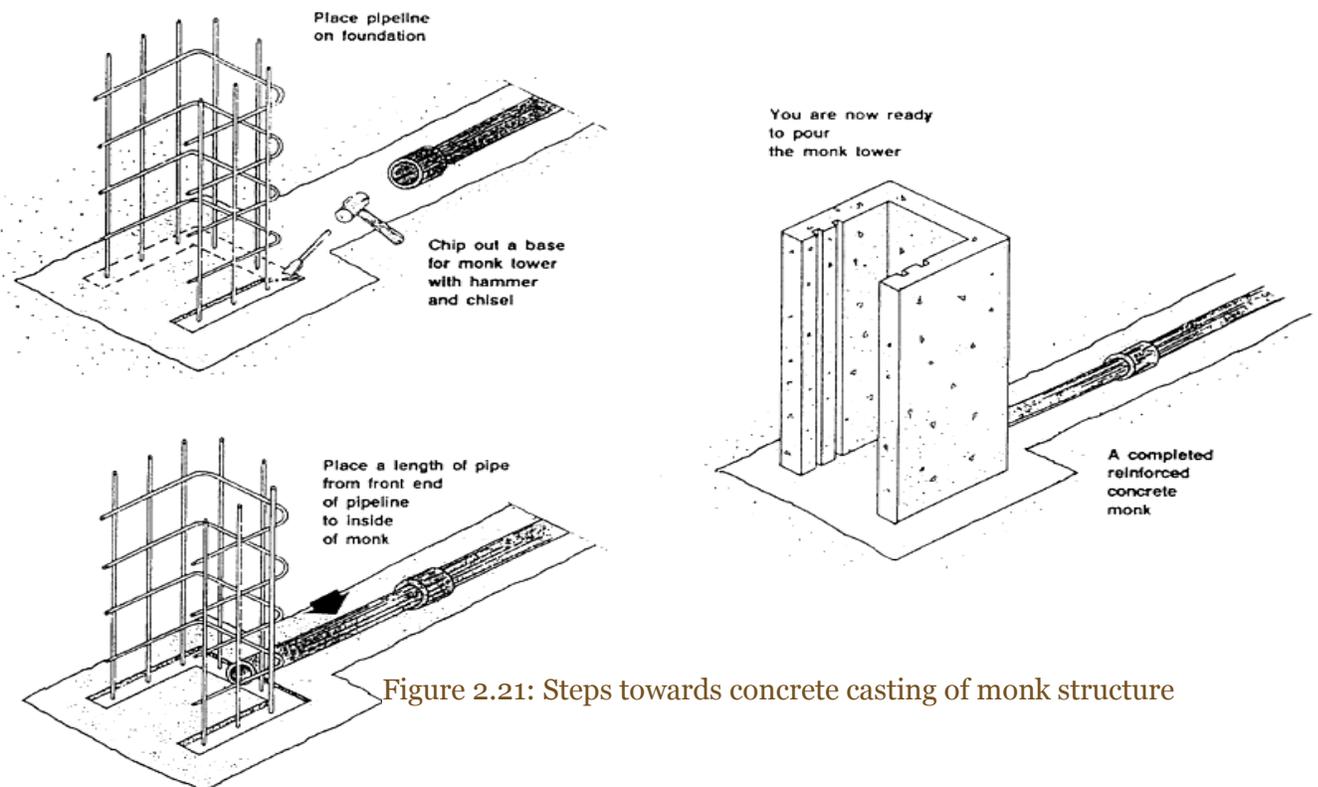


Figure 2.20: Schematic diagram of a monk and framework with iron mesh

2.5.1 Steps to construction of monk in earthen pond

- ❖ Dig an outlet trench from lower deeper section of pond through the pond dike.
- ❖ Dig an inlet trench of 0.2 meters from the top of shallow section pond dikes in the opposite direction.
- ❖ Insert inlet pipes and outlets pipes (4" inches PVC pressure pipes) into these trenches (Figure 2.21).
- ❖ Refill the trench and firmly compact dikes as it was before



- ❖ Dig a cut-through trench from the tip of dikes/dam towards the outlet pipes.
- ❖ Create a floor for the construction of base of monk (2 x 2 m²) as foundation a bit lower (0.2 m) than pond bottom.
- ❖ Prepare and set-out iron rod mesh (1/4 inches) in a U-shape over the concrete monk base.

- ❖ Fabricate a wooden monk mould with corner battens to create three gloves (3" apart and 5" from the second batten).
- ❖ Mount monk mould (to the height of pond, 5-6" thickness) over the base of monk.
- ❖ Cast the concrete constructed over the iron mesh in the monk mould. Refill the back sections and compact firmly (Figure 2.23).

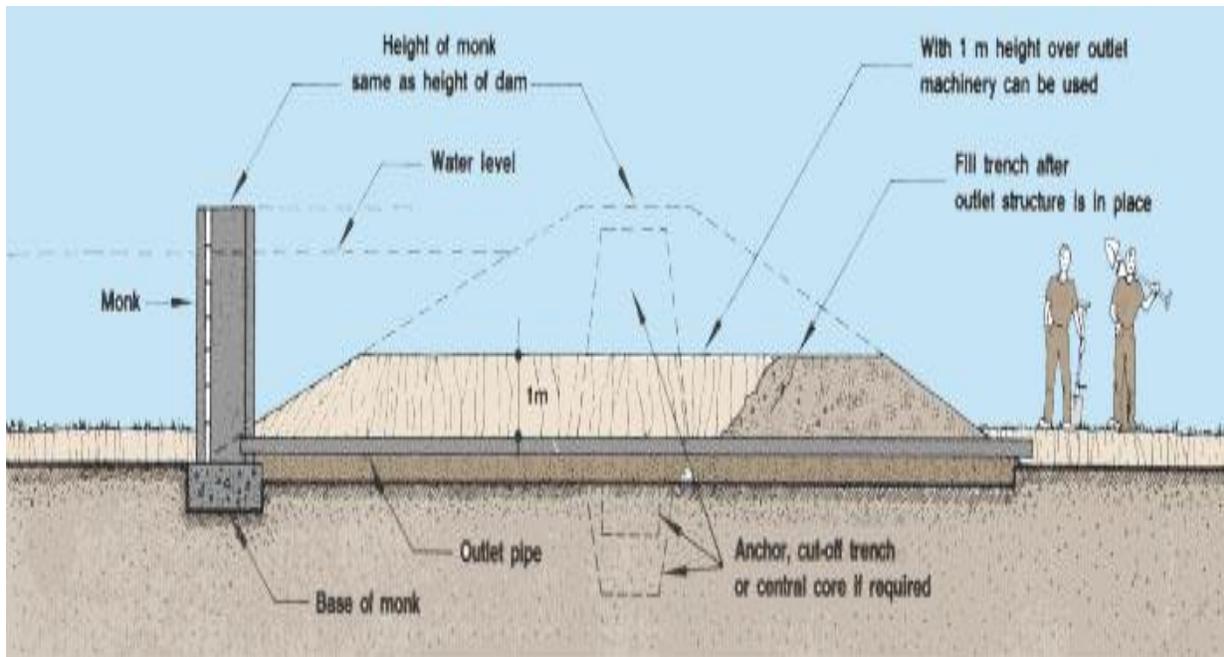


Figure 2.21(b): Steps towards concrete casting of monk structure

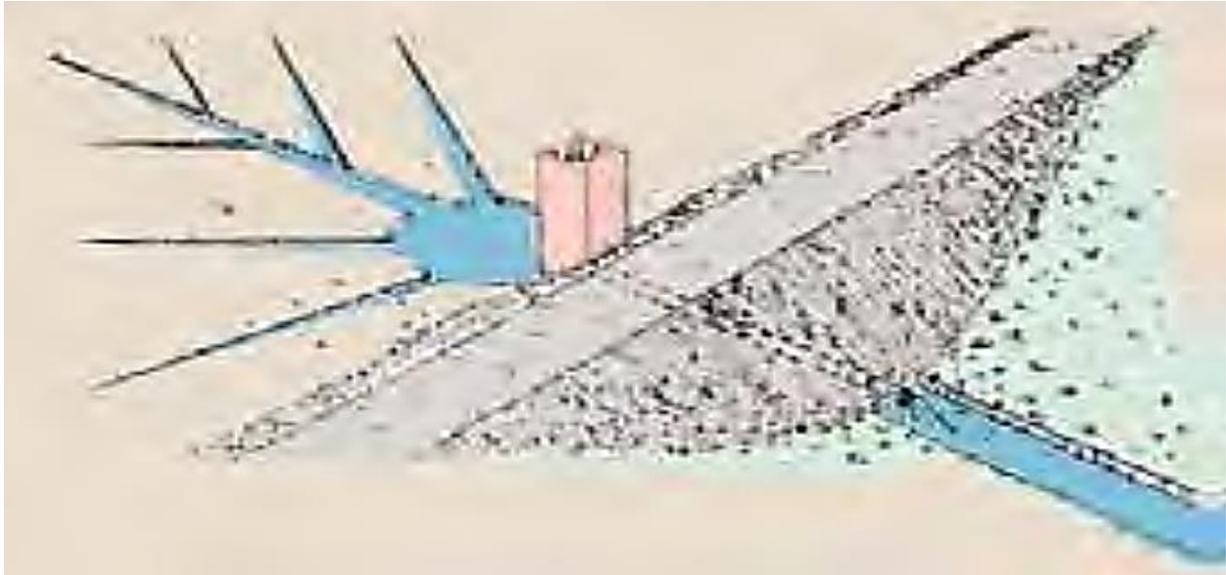


Figure 2.22: Steps towards concrete casting of monk structure

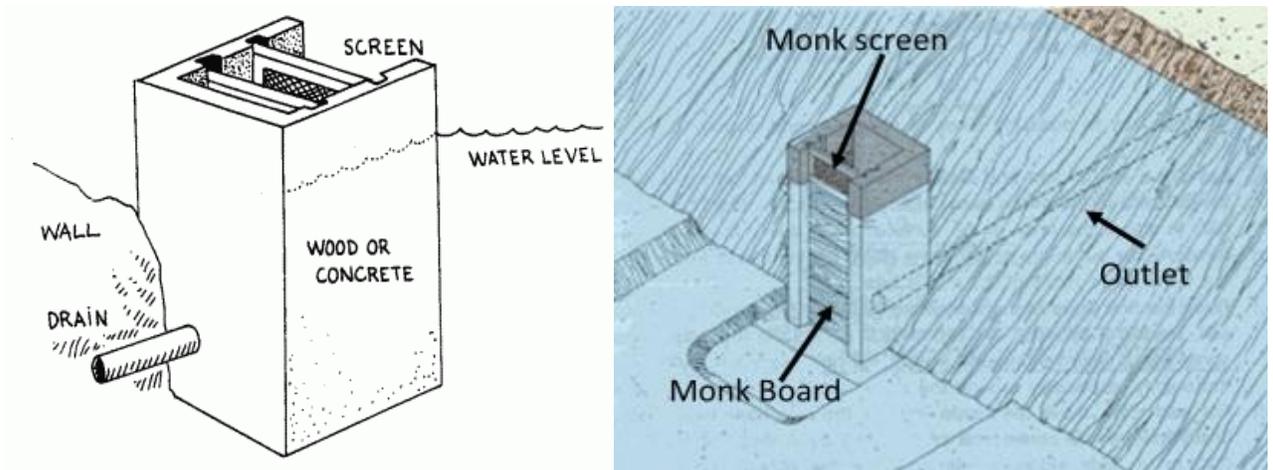


Figure 2.23: Positioning of Monk boards and Monk screen with outlet pipe

2.5.2 Installation of monk boards and monk screen

- ❖ Fabricate a suitable shape of monk boards with straight surface as slats with rivet end.
- ❖ Fabricate a suitable shape as monk screen with galvanized mesh netting over a wooden frame
- ❖ Remove the 3 pairs of wooden battens from monks to create gloves.
- ❖ Fill spaces between the boards with saw-dust, steak and compact.
- ❖ Insert boards into the second and third gloves to the required water level for fish production
- ❖ Insert the monk screen into the third glove, higher than the monk boards (Figure 2.24).

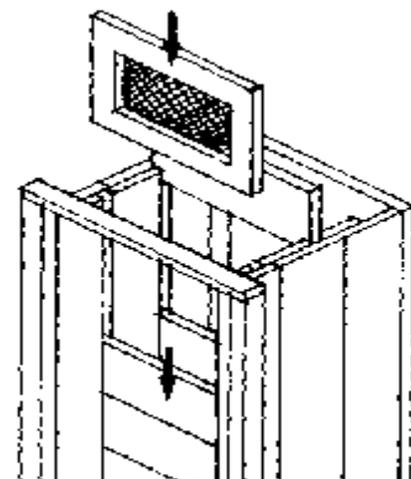
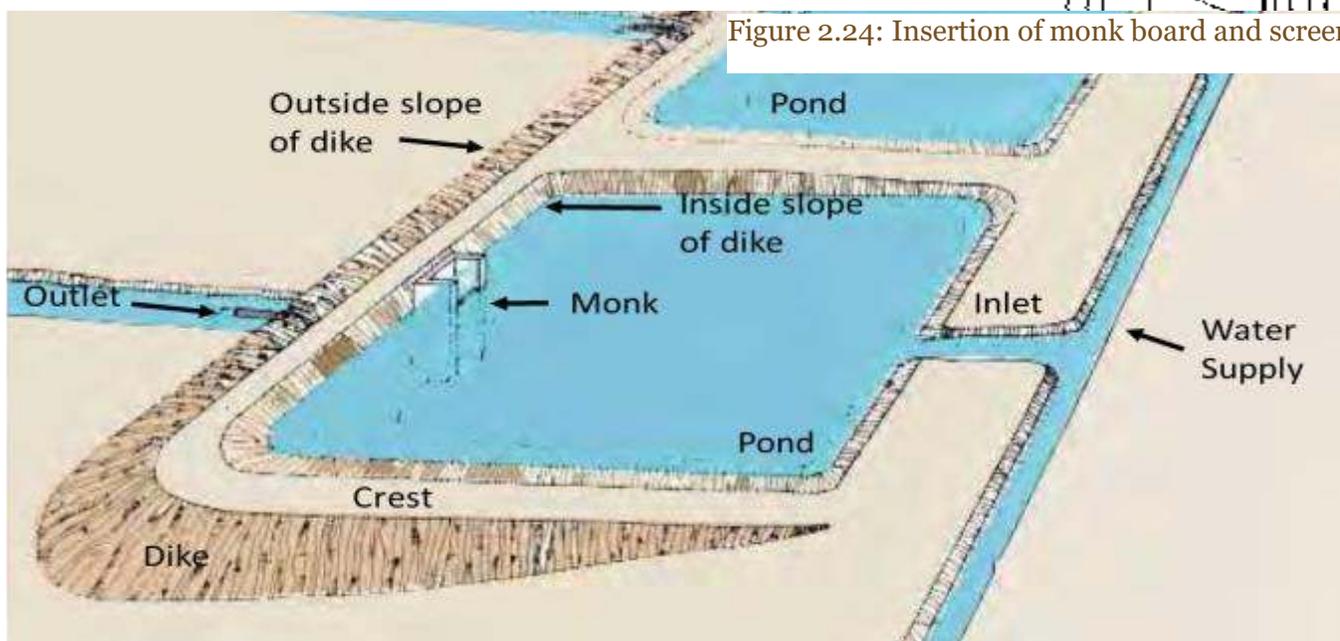


Figure 2.24: Insertion of monk board and screen



Earthen Pond Layout

2.6 Preparation of pond for stocking with fish



- ❖ Newly constructed or renovated earthen pond needs to be conditioned (neutralized) before stocking due to possibilities of exposed soil material leaching into the pond water and polluting the water.
- ❖ Liming helps in maintaining the pH of fish pond water. This helps in increasing the natural productivity of the pond. Liming also helps in maintaining the cultured fish stock disease free. It is done based on the soil and water pH.

2.6.1 Liming of pond

- ❖ Before liming, pond needs to be completely drained and dried to expose the bottom to sunlight.
- ❖ The bottom mud is removed or re-mixed and allowed to dry (Figure 2.25)
- ❖ Liming in fish farming is done to neutralise the pH of two components of the earthen pond including the concrete monk structure.
- ❖ Application of Agriculture/quick lime is based on the measured pH value of pond soil and pond water.



Figure 2.25: Complete liming of an earthen pond

- ❖ Liming of ponds is not always necessary. It can be done on a new pond or a pond that is already in use. However, in certain cases, it can be both a waste of

money and harmful to the fish. Before a decision is made, specific characteristics of the pond's water and soil should be studied carefully (Table 2.2)

Soil & water pH	Quick Lime required (Kg/ha.)	
pH value	Rate of application (kg/ha)	First maximum dose (kg/ha)
4.0- 5.0 Highly acidic	2000	666.67
❖ 5.0- 6.0 Acidic	1200	400
❖ 6.0- 6.5 Slightly acidic	1000	333.33
❖ 6.5- 7.0 Neutral	400	133.33

Table 2.2 Liming schedule depending on soil and water pH

The following points should be considered:

- ❖ If the pH of the soil at the bottom of the pond is lower than 6.5, liming is justified (Figure 2.26)
- ❖ If the bottom of the pond is very muddy because it has not been emptied and drained regularly, liming will improve soil conditions.
- ❖ If there is a risk of contagious disease or if you need to fight enemies of fish, liming can help, particularly in drained ponds.
- ❖ If there is too much organic matter, either in the soil at the bottom, or in the water, liming is advised.
- ❖ pH of the water can be determined using a litmus paper.
- ❖ Based on the pH of soil and water the required quantity of lime is determined (Table 2.2)

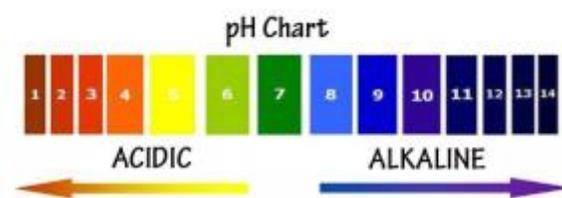


Figure 2.26: pH scale

2.6.2 Fertilization of pond

- ❖ Pond water is like agricultural land: if the ground is fertile, the plants grow well.
- ❖ To make water fertile, fertilizing elements, particularly phosphorus, must be added.
- ❖ Water will respond much more readily to fertilization if its physical and chemical characteristics (temperature, pH, dissolved oxygen, etc.) are close to the optimal ranges for selected species.

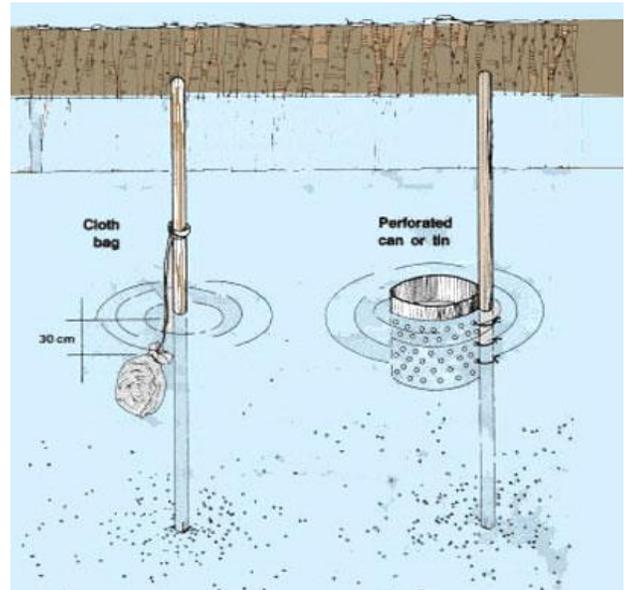


Figure 2.27: Some methods of fertilising a pond

- ❖ Fertilization increases the production of natural food in a pond, making it possible for fish to find more food.
- ❖ Fertilization provides food for the living organisms that then provide food for fish.
- ❖ After 7- 10 days of liming, fertilization of pond water is done. As fertilizer, both organic and inorganic fertilizers are used.
- ❖ From a wooden post, suspend a small bag made of cotton or burlap, about 30 cm underwater. In this bag enclose the 7 to 15-day dosage of fertilizer for the water area concerned. You could also use a perforated can or a basket (Figure 2.27).
- ❖ Organic fertilization is recommended using Cow dung and/or Poultry dropping in a bag hanging over the corner near the inlet pipe section.
- ❖ The manure should disperse easily in water. Liquid manure or solid poultry wastes are preferred, because cow or horse dung usually contains a lot of insoluble components especially if mixed with stable litter (Table 2.2)
- ❖ It should be in small particles rather than in lumps.
- ❖ Use it as fresh as possible. Large losses of nitrogen and carbon occur during storage, especially if the manure is left in the open air and in the rain.
- ❖ Make sure it has a high nutrient content.
- ❖ Manure should be easy to collect. Housed or corralled animals produce more concentrated manure than free- roaming ones. Animal housing can be designed to improve the collection and distribution of manure to the ponds.

Inorganic fertilizers that could be used are urea, single super phosphate and murate of potash after 5 - 7 days of application of organic fertilizer (to quicken fertilization, although not necessary).

Solid Manure	Kg per 100m²
Poultry (chicken)	4.8
Pigs	6.0
Small Ruminants (Goat, Sheep)	4.4
Large Ruminants (Cow)	5.0

Table 2.3: Maximum amount of fresh solid manure per 100m² pond

- ❖ Well fertilized pond water would attain a light-greenish color after a few days indicating pond productivity. With the use of the hand, level of fertilization can be determined (Figure 2.28). Fish can be stocked in the earthen pond, 7-10 days after fertilization.

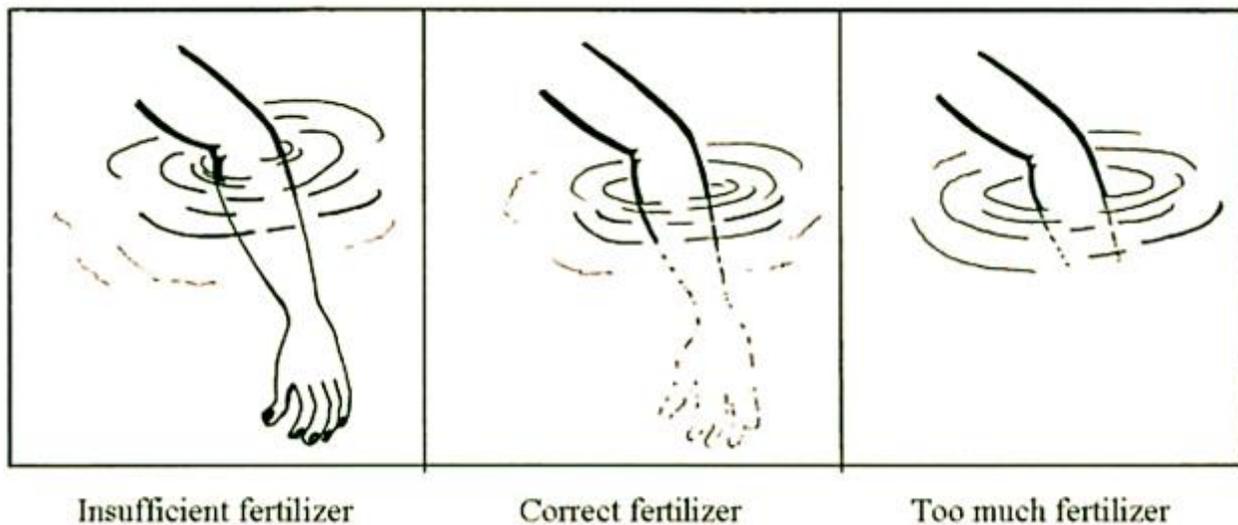


Figure 2.28: Testing levels of fertilisation in water by hand

3 MODULE TWO: STOCKING MANAGEMENT

The process of stocking referred to here, starts with the collection of fingerlings from the hatchery, transporting them to the farm and, finally, putting them into the pond. Poor stocking procedures, are among the major causes of low survival in grow-out ponds.

They result in disease, reduced growth and mortality. However, because the ensuing mortalities do not occur normally until after about three days, and many of the fish that die do not actually come up to the surface, many farmers do not recognize it as a serious factor.

For this reason, a month of nursery phase is recommended. After 1 month, the small nursery pond is harvested and the fingerlings, which by this time are larger and more resistant to handling, are weighed and counted into the larger production pond.

Successful stocking depends upon the quality of fingerling, how they are stocked and when they are stocked.

3.1 Quality fish seed to be stocked.

- ❖ Quality seed or fingerlings should be collected from certified or recognised hatcheries with good brood stocks.
- ❖ Quality seed or fingerlings of African catfish are active with uniformly dark grey-white patches colouration (Figure 3.1). Whitish-grey colour is of poor quality (Figure 3.2).
- ❖ Do not purchase fingerlings if
 - They have less than two barbels, no tail or missing fins,
 - They show signs of physical injury or bleeding,
 - They are deformed
 - They are less than 10cm in total length,
 - If fingerlings in the holding unit in the hatchery are sluggish or inactive



Figure 3.1: Good quality fingerlings



Figure 2.2: Bad quality fingerlings

3.2 Size of fingerling to stock

A uniform size of African Catfish fingerlings must be stocked. This is important to avoid and minimise cannibalism among fish cohorts (same batch of hatchling). During the advance fry stage (Less than 10g) growth rates among the same cohorts (hatchlings) often vary. It is recommended that a homogenous batch of individual weight catfish (More or equal to 10 g) should be stocked in grow-out ponds to attain table size fish.

3.3 Number of fish seed to be stocked



The stocking density depends on the species, culture period, desired individual size, intensity of management and management system. The stocking density for African Catfish ranges between 5 -10 fish/m³ or higher under intensive systems. A stocking density of 5 fish/m² is recommended for semi-intensive system in earthen pond.

For the number of fingerlings to stock, the survival rate of the fish species in the locality is considered. For example, an earthen pond with surface area of 100 m² with African catfish fingerling survival rate of 90% and using a stocking density of 5 fish/m².

Number of fingerlings to be stock is calculated as follows:

$$\begin{aligned}\text{No.to stock} &= (\text{Area*stocking density}) / (\text{survival rate}) \\ &= 100*5 (100/90) \\ &= 555.56 \\ &= \text{approximately 556 fingerlings}\end{aligned}$$

3.4 Transport of fingerlings

Transport of fingerling is a critical aspect for the survival of fish to be stock. The farmer and hatchery/nursery operator must make all materials and equipment readily available on site prior to transport (Figure 3.3)

3.4.1 *Materials and Equipment for Transport of fish*

- ❖ Polythene bags
- ❖ Ice cubes/chips in a coolant
- ❖ Water
- ❖ Equipment: buckets, bowls, scale, scoop nets,
- ❖ Oxygenated cylinder and accessories,
- ❖ Fish
- ❖ Transport (motor vehicle, boat/canoe etc.)
- ❖ Record book

3.4.2 *Procedures for bagging and transportation of fingerlings*

- ❖ The fish should be stress free, lively and active. Stressed fish start dying about three days after stocking and mortalities can continue for up to a week.
- ❖ Place the order for fingerlings from the hatchery in advance.

- ❖ Do not feed fingerlings at least a day for conditioning i.e. 24 hours to transportation otherwise they defecate to pollute the water and cause fish death

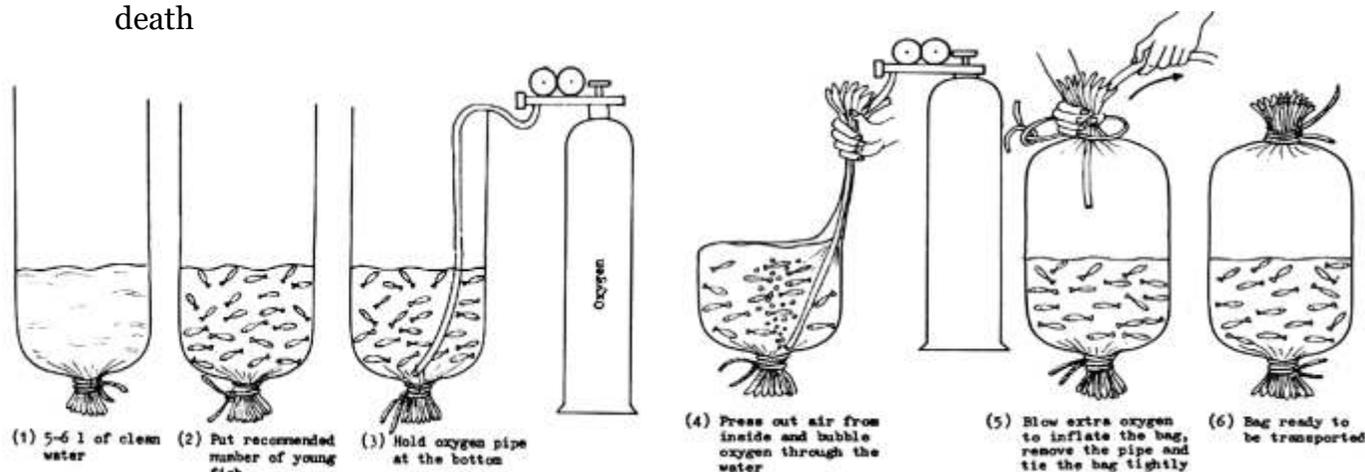


Figure 3.3: Systematic procedure for transporting fingerlings

- ❖ Obtain polythene bags (transparent) 80 – 100 cm long and 55 -60 cm width
- ❖ Put clean water in the inner bag to about 1 / 3 full (avoid chlorinated/tap water)
- ❖ Similarly put clean water into the outer bag about 1 / 8 full to serve as a shock absorbing medium.
- ❖ Put some fingerlings in the inner bag and put ice cubes/chips into the outer bag. The ice
- ❖ Cubes/chips help to gradually lower the temperature of the water to acceptable level (18 - 20°C).
- ❖ Insert the oxygen into water by bubbling it or stir water in the inner bag vigorously with your hand to dissolve air into the water in the absence of oxygen tanks.
- ❖ Tie the mouth of the inner bag securely ensuring that sufficient air is trapped above the water. Tie the mouth of the outer bags as well.
- ❖ Transport the packaged fish in insulated boxes/cartons, or sacks.
- ❖ Minimize the Amount of Physical Handling.
- ❖ The polythene bags in which fingerlings are transported act as a greenhouse. If left out in direct sunlight, the water in the bags can become extremely hot (to above 32°C) within a few hours.

- ❖ It is worth spending an extra bit of money to ensure that the fingerlings are packaged as recommended. Fingerlings are one of the major operating costs. Any losses will result in loss of profits.

3.4.3 *When Stocking of Fingerlings*

- ❖ Never stock fish that are too small in a grow-out pond because the low survival rate reduces profit margins as well as raising the costs of production.
- ❖ Survival rates are low when grow-out ponds are stocked with fish of 5 g or less, it is recommended that such fish are first stocked into a nursery pond for about a month until they get to a size of about 50g. Stocking fingerlings from the hatchery into a nursery pond prior to stocking in a production pond presents the following advantages:
 - It is easier to protect a small pond from predators,
 - The higher stocking densities in nursery ponds allow for easier feeding of the fry or fingerlings,
 - It enables the farmer avoid the situation of wasting feed for a whole cycle because when he empties the nursery pond.
- ❖ DO NOT open any of the bags before they get to the pond. This is because once a bag is opened, all the oxygen in the bag will leave into the atmosphere. The fish only have about 5 to 10 minutes before they run out of oxygen after a bag has been opened.
- ❖ Set the bags right next to the pond (keep bags in basket or box to support the bag) or just in the pond. You are going to add water to the bag, so it may be too heavy to move after that. If you have the equipment, check the water quality parameters of the pond before opening the bags and the water quality
- ❖ Within the bags as well as during the course of acclimation, especially for temperature and oxygen.
- ❖ Open one bag at a time. Begin with the bag that is least inflated. Cover these bags to shade and prevent excessive sunlight.

- ❖ If you have no tools for checking water quality, use your fingers to detect for any obvious temperature differences between the pond water and water in the bag.
- ❖ Bagged fingerlings on arrival at the final destination put the polythene bag containing the fingerlings into the pond for about 10-20 minutes to condition the fish to the pond water temperature.
- ❖ Open the mouth of the bags and check the water temperature of the inner bag containing the fingerlings and gradually dilute with pond water till a uniform/equal water temperature is achieved
- ❖ Let out the fingerlings gently, allowing them to swim out by themselves (Figure 3.4)

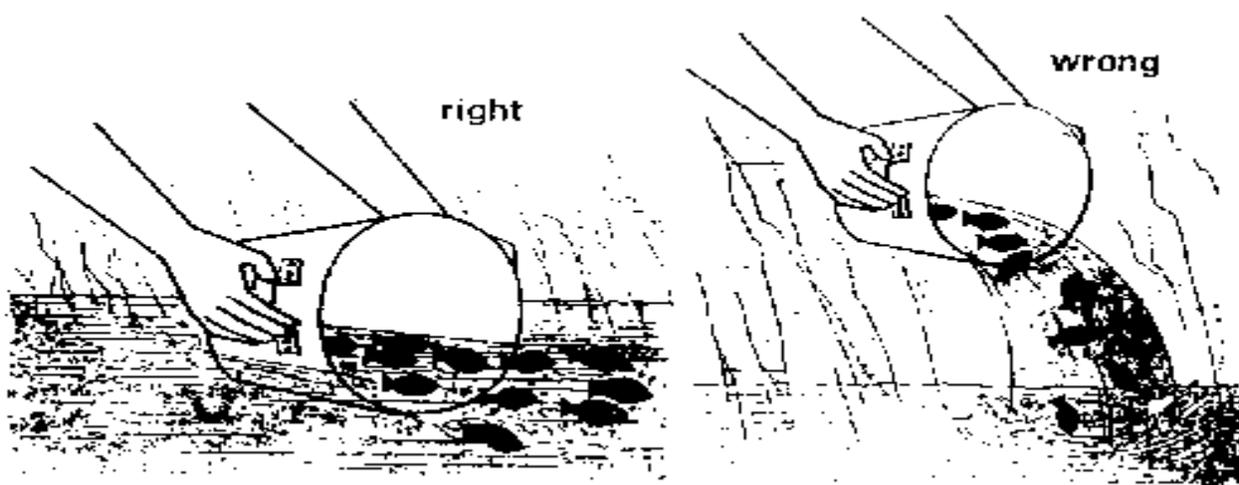


Figure 3.4: Procedure for stocking fingerlings

3.5 Sorting and grading

Due to fast growers referred as “jumpers” or shooters. Weekly sorting and grading needs to be done to avoid cannibalism until the stocked fish reaches 50-80 g. Material and equipment must should be disinfected before use. Graders should vary based on

fish sizes and should not injure the fish. Some grading equipment for are shown below (Figure 3.5).

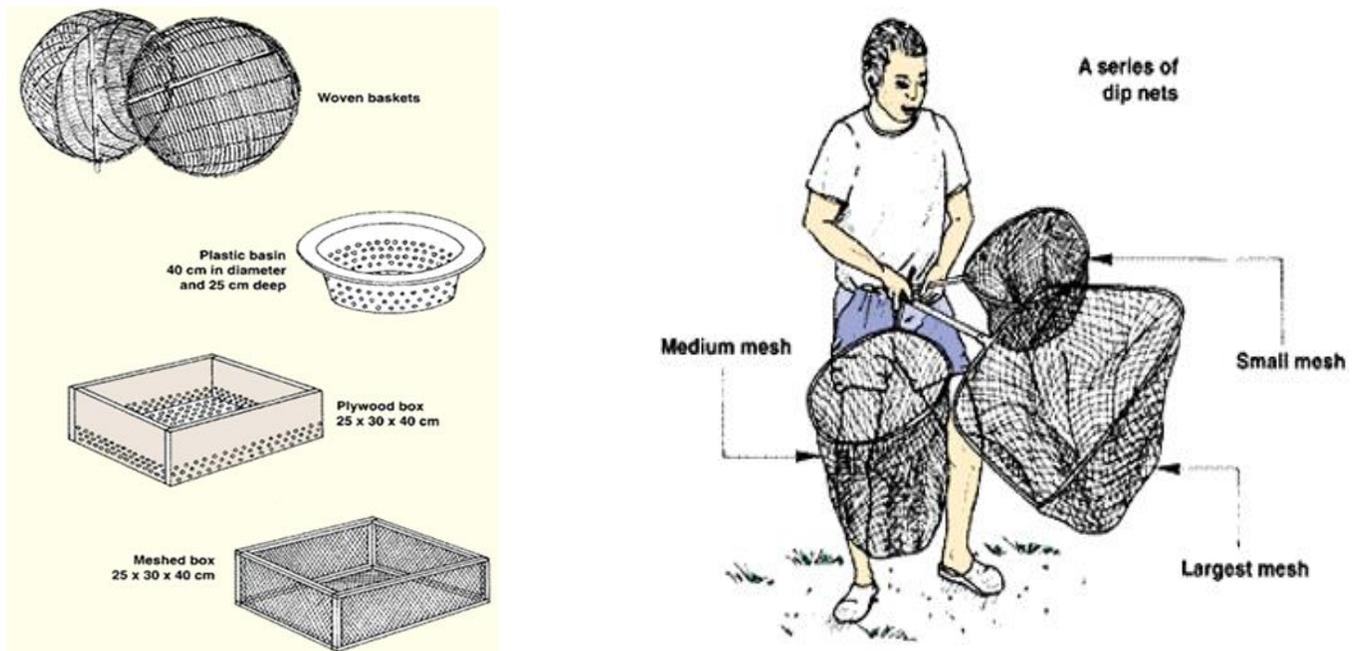
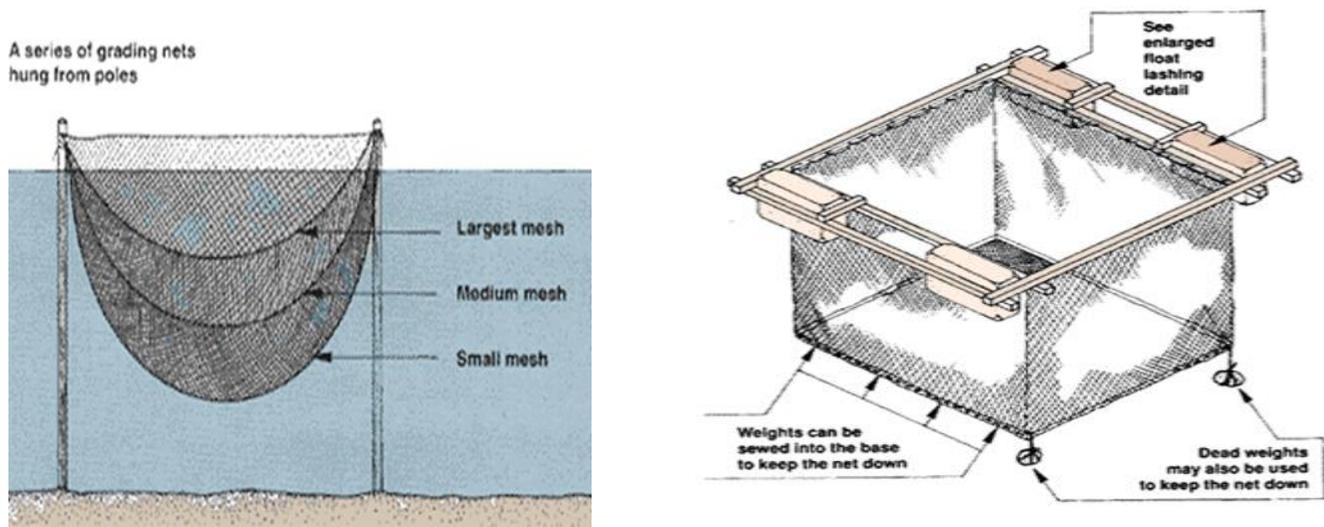


Figure 3.5: Some simple fish grading tools



3.5.1 *Advantages of grading fish*



- ❖ Reducing fish losses through cannibalism
- ❖ Improving supplementary feeding efficiency through adequate food ration
- ❖ Increasing the accuracy of stock estimates for monitoring
- ❖ Reducing the proportion of undesirable or unwanted sizes
- ❖ Increasing production, for example by increasing the proportion of faster growing males
- ❖ To improve profits in tilapia ponds
- ❖ To grade fish to avoid harvesting fish too small for marketing or processing

3.5.2 *Disadvantages of grading fish*

- ❖ Labour intensive
- ❖ Requires time
- ❖ Grading equipment
- ❖ High mortalities could occur proper grading preparation and precaution are not adhere to

3.5.3 *Precaution for grading fish*

- ❖ Should be done before sunrise (morning) or after sun fall (evening)
- ❖ All equipment and personnel's must be present and prepare
- ❖ Disinfect all equipment with saline solution
- ❖ Scoop little fish at a time to grade
- ❖ Fish must always be worked in water
- ❖ Minimize stress by avoiding excessive handling of fish
- ❖ Use gloves to handle fish

4 MODULE THREE: POST STOCKING MANAGEMENT



4.1 Liming after stocking

The second liming is done to maintaining the pH of fish pond water. This helps in increasing the natural productivity of the pond. Liming also helps in maintaining the cultured fish stock disease free.

It is done based on the water pH. Repeated doses of agriculture lime could be administered every 7 days till a neutral to slightly alkaline pond quality is obtained. Liming dose and schedule are given above (chapter 3).

4.2 Fertilization

Fertilization increases the natural food availability in the pond. Organic fertilizers/manure from cow dung, poultry dropping and compost are ideal source of enriching the nutrients in the water. At the same time fertilization creates many environmental problems like dissolved oxygen concentration depletion, excess nutrient enrichment and possibly fish kills.

Fertilization should cease or fertilisation bags should be removed when water colour begins to turns deep green. Fertilisation can enhance the growth of fish, minimise feeding cost and increase total revenue especially if done with periodic flashing of water. In pond with limiting phosphorous in the water, small dose of superphosphates fertilizer can be added cautiously .

4.3 Feeds (Diets) and Feeding Of Cultured Catfish in Ponds

The purpose for feeding fish is to provide the nutritional requirements for good health, optimum growth, optimum yield, and minimum waste within reasonable cost to optimize profits from fish farming (Figure 4.1).

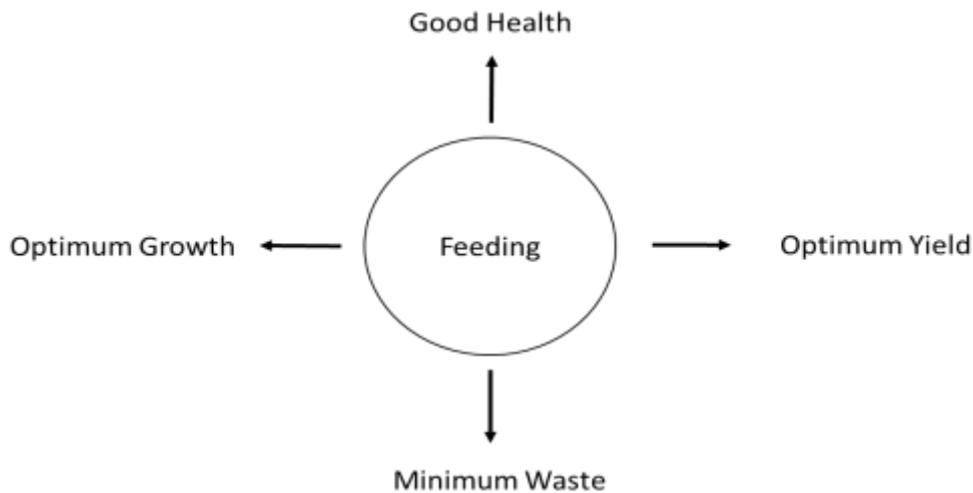


Figure 4.1: Outcome of feeding good quality diet to fish

4.3.1 Prepared/Artificial Fish Diets/Feeds

Prepared diets are also known as artificial diets or feeds. Artificial feeds are well-compounded mixture of feedstuffs and can be in mash or pellet or extruded forms that could be fed to fish (Figure 4.2). They may be either complete (containing all the required nutrients) or supplemental (meant to provide additional protein, carbohydrate, and fat but not fortified with vitamins and minerals to fish receiving some natural food) as shown in Figure 4.3.

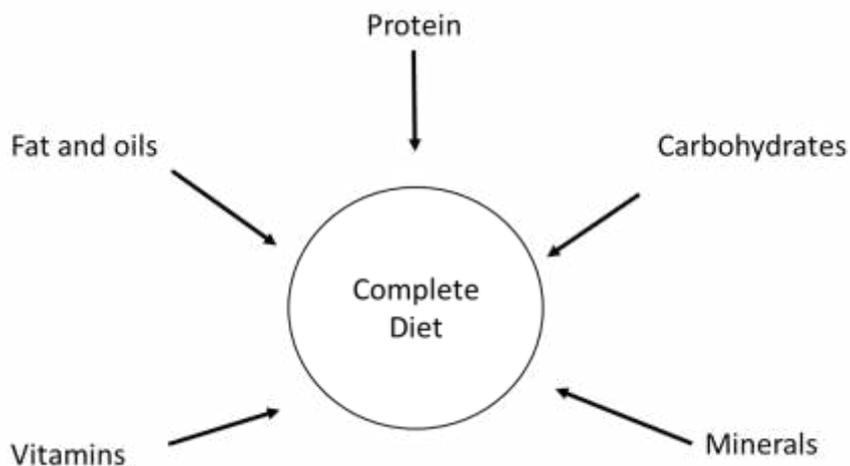


Figure 4.2: Composition of complete fish diet

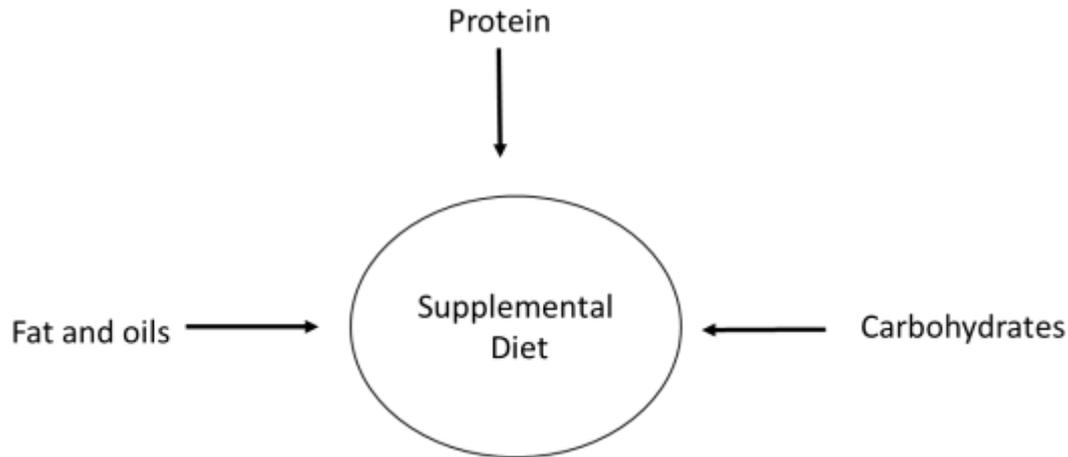


Figure 4.3: Composition of supplemental fish diet

Complete artificial diets are usually used for fishes cultured in intensive systems such as cages and raceways whilst supplemental for semi-intensive systems such as ponds. The size of the particle used depends on the species being fed, its feeding habits, and its size.

Mash (powdered) feeds are good for fry, pellets (0.8-1 mm) for fingerlings, (2-3 mm) for juveniles and (4-6 mm) for adults. Although the use of artificial feeds may be costly, especially compounded ration, they have the following advantages in fish culture:

- ❖ Enable high stocking density (stocking maximization) especially in poly culture system;
- ❖ They promote faster growth of fish, since food will always be available;
- ❖ High fish yield is guaranteed relative to the stocking density;
- ❖ Uneaten artificial feeds in pond water will be biologically degraded. These serve as fertilizer to promote plankton growth; and
- ❖ A fish farmer while feeding the fish can study the behavior of fish and monitor their health.

4.3.2 Feed Quality

The quality of feed refers to the nutritional, as well as the physical characteristics of the feed that is allowed to be consumed and digested by the fish.

The feed should contain all the nutrients required by the fish, in the right proportions for good growth and health.

The specific nutrient requirements for fish vary with the fish's size and reproductive state. The nutritional requirements of catfish are presented below (Table 4.4).

Nutrient	Uses	Desired Levels in Diet
Protein	<ul style="list-style-type: none"> -Provides the required amino acids -Necessary for the building muscle, blood, enzymes, hormones etc. -Diets lower than 28 % protein result in fatty fish. 	32 %
Dietary Energy	<ul style="list-style-type: none"> -Required to drive chemical reactions for tissue maintenance, growth and activity. -Excess energy in diet reduces diet intake resulting in fatty fish which reduces dress out yield and shortens shelf-life of frozen products. 	8.5 – 9.5 Kcal/g protein
Fats	<ul style="list-style-type: none"> -Major source of energy for fish. -Means by which fat soluble vitamins such as E and D can be absorbed by the body -Flesh texture and flavour depend on fattiness of the fish -Fats add flavour to diet and act as an attractant -Too much fat in diet results in fatty fish -Fatty diets are difficult to pellet and they spoil easily. 	4 - 6 %; increases as protein level increases
Carbohydrates	<ul style="list-style-type: none"> -Complex carbohydrates are not well digested by fish, but they are cheap fillers. 	20-35%

	-Carbohydrates are used in fish diets to provide the binder and expansion characteristics required for pelletizing and extruding.	
Fiber	-High fibre content of diets reduces their digestibility -Excess fibre in diet increases pollution of the pond water.	< 4%
Minerals and Vitamins	-Minerals are the inorganic component of the diet -They are structural components of hard and soft tissues -They are cofactors and/or activators of enzymes -They are osmo-regulators and acid-base balance	Vitamin C – 50-100 mg/kg

Table 4.4: Basic Nutrients Necessary for African catfish Growth

4.3.3 Feeding Catfish in Grow-Out Earthen Ponds with Nutritionally-Complete Diets

Better growth performance results are obtained when fish are fed correctly using the right techniques that ensure all fish have access to the diet, the fish's nutritional needs are being met and that no excess diet is fed.

Fish is fed correctly when:

- ❖ The correct nutritional quality for the specified age of fish is given;
- ❖ The right diet size for easy consumption is given
- ❖ The correct amounts of diet are given
- ❖ Feeding is done at the right time each day

When fish are fed correctly, growth rates are good and uniform across the population, feed conversion ratios (FCRs) are low and pond water quality is not deteriorated. Good feed ensure enhance growth and does not easily dissolve in water (Figure 4.4).



Figure 4.4: identification of good feed

4.3.4 *Selecting a Diet*

When selecting a diet for a cultured fish, the following must be borne in mind:

- ❖ The species of fish being cultured, as different species have different nutritional requirements;
- ❖ The age and size of the fish; juvenile fish require higher protein in their diet. For grow-out production, a diet with a protein level of 32 % is adequate;
- ❖ The quality of diet being used; and
- ❖ The cost-effectiveness of the diet being used, which is governed by the feed conversion ratio (FCR). For commercial grow-out ponds, FCRs should never go above two.

4.3.5 Feeding Rate

Feeding rate is the percentage of the body weight of the fish to be fed (Figure 4.5). For cultured fish, the feeding rate is the percentage of the estimated biomass (total weight). Feeding rate can be made on the basis of biomass estimated from measurements of small samples (at least 50 individuals) at regular time interval (not exceeding 3 weeks). Calculation of feeding rate using the fish biomass is as follows:

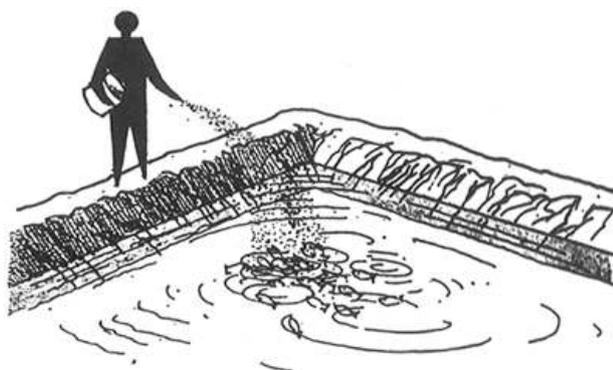


Figure 4.5: Response feeding of fish

body weight to be fed

$$FR = \frac{\text{body weight to be fed}}{100 \%} \times \text{Wt. of fish in the culture system (Biomass)}$$

The percentage (%) body weight to be fed is based on the average weight of the fish (sampled weight) and the water temperature. A recommended guide is often used as shown in Table 4.5.

Temp. °C	Fish Weight (g)					
	1-10	10-25	25-50	50-100	100-300	300-800
16 – 17.9	1.0	0.6	0.4	0.3	0.2	0.2
18 – 19.9	3.0	1.6	1.0	0.8	0.6	0.5
20 – 21.9	5.0	3.0	2.0	1.5	1.2	1.0
22 – 23.9	6.8	4.5	3.0	2.4	2.0	1.7
24 – 25.9	8.1	6.0	4.0	3.0	2.5	2.2
26 – 27.9	9.5	6.6	5.1	3.6	3.2	2.8
28 – 29.9	10.0	7.0	5.5	4.0	3.5	3.1
30 – 31.9	9.8	6.8	5.3	3.7	3.2	2.9
32 – 33.9	9.5	6.5	5.0	3.5	3.0	2.8

Table 3.5: Recommended daily feeding rates for African catfish

4.3.6 Estimating the Correct Amount to Feed

- ❖ In order to avoid over or under feeding cultured fish, the right amount of diet must be given all the time.
- ❖ The amount of diet to be provided to the fish per day, the feeding rate (*ration*), is dependent on the fish's body weight.
- ❖ Fish adjust their food consumption rates to meet their metabolic energy requirements.
- ❖ Therefore, the required ration varies with time during the production cycle depending on:
 - The fish's size (i.e. its average weight)
 - The pond water quality - notably in terms of water temperature, dissolved oxygen and pollutant levels

The amount of diet required per ration can be estimated as follows:

=Average fish size (weight) x feeding rate (%) x total number of fish in the pond.

Where the feeding rate is the percentage of the fish's average weight.

Examples on Calculating the Daily Feed Ration:

1. If an African catfish of 5 grams requires a ration of 8 % of its body weight, how much food should it be given per day?

Solution

Amount of feed to be fed per day = 5 grams x 8/100
= 0.4 grams feed per fish per day.

If there are 1000 fish in the pond, then;

= 0.4 g x 1000 fish
= 400 g of feed should be weighed out for the day.

Cultured fish should not be overfed as it results in feed wastage, deterioration of water quality and subsequently poor fish growth. Overfeeding leads to reduction of the farmer's profit margin. Likewise, substantial underfeeding results in poor fish growth and production.

2. If a catfish fish of 180 g requires a ration of 2.5% of its body weight, how much food should it be given per day?

Solution

Amount of feed to be fed per day = 180 grams x 2.5/100
= 4.5 grams feed to be fed per fish per day, so for 1,000 fish
= 4,500 g

4.3.7 Adjusting the Ration/Amount

- ❖ Feeding rations should be adjusted either weekly or fortnightly depending on the fish's size.
- ❖ Smaller fish have a much higher metabolic rate and grow at a much faster rate so their rations need to be adjusted more frequently (preferably weekly).
- ❖ At sampling, adjust the ration based on the average weight of the fish obtained, The amount of food fish takes in each day depends on the water quality, notably the temperature and any stressors (low DO, pH, high ammonia, health conditions) to which the fish are exposed.
- ❖ Feed rations should, therefore, also be adjusted on a daily basis. Therefore, on rainy, cloudy or cold days one needs not to feed if fish show no interest in feeding as a result of lower water temperatures.
- ❖ When ponds are at carrying capacity, feeding fish for growth should stop. Only maintenance feed should be applied so as to prevent the fish from losing weight.

- ❖ Fish will not grow when the pond's carrying capacity is reached irrespective of how much the fish are fed. Feeding more at this time is wasteful.

4.3.8 Administering the Diet

The way feed is administered to the fish affects their access to the feed and subsequently plays a great role in influencing growth rates, uniformity in size and FCRs.

When administering the feed, one must therefore aim at ensuring:

- ❖ Rapid and positive consumption of feed by the fish;
- ❖ Minimal metabolic energy expenditure associated with feeding;
- ❖ Ensure all the Fish have Equal Access to the Feed.

Feed can be offered to catfish in ponds by one of the following ways:

- ❖ Slow broadcasting as in Figure 4.6 (floating and sinking pellets).
- ❖ Via feeders (floating and sinking pellets).
- ❖ Applied within feeding rings (floating feeds – especially for juveniles in ponds)



Figure 4.6: A woman feeding catfish by broadcasting

When deciding what feeding technique to adopt:

The following should be taken into account:

- ❖ How much feed should be fed per day per fish (ration size)?
- ❖ How many times a day the fish should be fed (i.e. the feeding frequency)?
- ❖ When the feeding times should be?
Early morning feedings should be avoided as water temperatures and oxygen levels are usually at their lowest.
- ❖ How you intend to administer the feed as in Figure 4.7 (i.e., the feeding technique).
- ❖ Labour availability and costs.

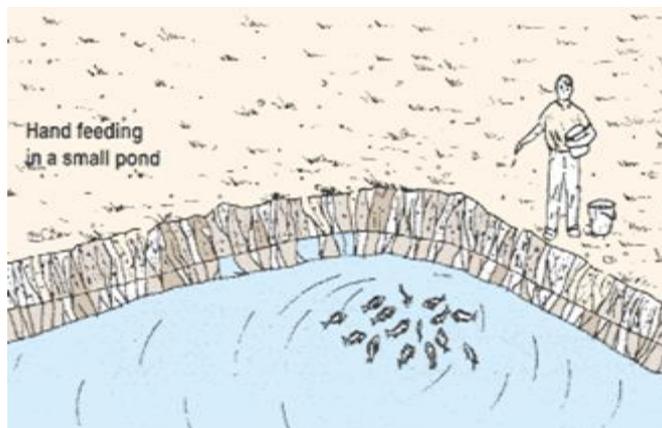


Figure 4.7: Hand feeding

4.3.9 Feeding Frequency

The feeding frequency is the number of times fish in a pond are fed in a day. The following should be taken into account, when deciding how frequently fish should be fed each day:

- ❖ In grow-out ponds, feeding 2 or 3 times a day is adequate;
- ❖ Proper feeding frequencies reduce starvation and result in more uniform sizes of fish. Juvenile catfish need to be fed more frequently than adults, because they have higher metabolic rates and their stomachs are too small to hold all the feed they require for a day;
- ❖ Catfish from 400 g can be fed once a day, because at this size the stomach can hold enough food for the day (However, twice a day is recommended for efficient growth)
- ❖ The feed administered at a meal should be consumed within the first 15 minutes of the feeding if floating diet is being used.

4.3.10 Feeding Response

The fish's feeding response depends on the:

- ❖ **Suitability of the Feed.** The more palatable the feed is, the better the feed response should be;
- ❖ **Culture (Water) Environment.** The most important water quality parameters that affect feeding response in ponds are water temperature and dissolved oxygen. The warmer the water and more dissolved oxygen it has, the more active fish will be and the better their feed consumption and FCR; and
- ❖ **Other Stressors,** such as pollutants in water, other water quality variables (notably of ammonia and pH), handling and social interactions also affect the fish's appetite. When fish are stressed, their appetite drops quickly.

4.3.11 Assessing Feeding Response

- ❖ How fast the fish moved towards the feed and how this reaction/behaviour compares with that at previous feedings?
- ❖ Whether or not the fish are interested in the feed?
- ❖ What the colour of the pond water is prior to feeding?
- ❖ What proportion of the fish comes to the feed (Figure 4.8)?
- ❖ What the weather was a few days before, and on that day? Is (was) it rainy, cold or hot?



Figure 4.8: Catfish responding to feed

Therefore, the farmer must always stay around during feeding to watch how the fish feed every single day. Simply calculating and feeding the required amount results in wastage, high FCRs and poorer water quality. Feeding based on calculations only, is therefore “dumping” the feed, or “**feeding the pond**”; **not feeding the fish.**

NOTE: As much as possible, the same person should feed the fish on a daily basis. Likewise, the person who feeds the fish should be the one who keeps the daily feeding records, not someone else.

4.3.12 Training Catfish to Feed by Response

Fish should be trained to come up, and get their feed at the water surface. In order to do this, the following steps should be followed when fish are fed by the slow broadcasting technique:

- ❖ Administer the diet at the same place in the pond and at about the same time every day.
- ❖ Broadcast a handful or plate full of the diet once most of the fish have gathered at the feeding area. If the fish come out to get the feed and immediately consume the ‘tester’, then the rest of the feed may be added slowly by broadcasting large scoopfuls or cupful’s at a time, until the fish’s response starts to slow and the fish show no more interest in coming back for more feed. Weigh any leftover feed and keep it for the next meal.

4.3.13 When Not to Feed Fish

- ❖ **The Feeding Response is Poor.** When the fish show a poor feeding response, it is normally for a reason. The water quality may have changed. For example, on a cold wet day, the pond water temperature may have dropped. Therefore, do not add more food than the fish are interested in consuming.
- ❖ **They are Feeling Unwell.** When fish are sick, they go off feed. If you insist on feeding them, they still will not eat. The feed administered will instead accumulate at the bottom of the pond, and cause the water quality to drop;
- ❖ **At least Two Days before Harvest and Transportation.** This is to allow them to empty their guts before harvest and transportation. In so doing, water quality in transport containers can be better maintained and stress levels during transportation reduced;

- ❖ **On the Sampling Day.** This is because they will be subjected a lot to stress from physical handling during seining, weighing and counting;
- ❖ **When Treatments are applied to the Pond.** When some treatments like formalin are applied to the pond, the fish get stressed because the water quality within the pond will have temporarily been altered. Their appetite subsequently drops; and
- ❖ **When Water Temperatures are Low on Rainy Days.** After a series of rainy days if the water temperatures drop below 22 °C, the fish are unlikely to be interested in feeding. Therefore, do not feed.

4.3.14 *Evaluating Diet Performance*

Feed is the most expensive input during the course of production. Therefore, it is extremely important to closely monitor the performance of feeding during the course of production, in feed-based systems.

4.3.15 *Feed Records*

Records about feed usage should indicate the

- ❖ Type of feed(s) administered;
- ❖ Amount of feed given each day; and
- ❖ Feeding response at each feeding,

Records will help assess cost-effectiveness of the feeding programme (Refer to chapter 1 for details).

4.3.16 *Feed Conversion Ratio (FCR)*

The Feed Conversion Ratio (FCR) is the amount of food required to produce a unit weight of fish. It is an indicator of the:

- Performance of a feed,
- Performance of the person feeding the fish and the fishes health
- Cost-effectiveness of using a particular feed.

$$\text{FCR} = \frac{\text{Total amount of food given (kg)}}{\text{Total amount of fish produced (kg)}}$$

Example on how to Calculate FCR and use FCR to Assess Returns to Feed

1. If at the end of a production cycle, a total of 150 kg of fish are harvested from a pond and a total of 200 kg of feed was fed to the fish during production, how much feed was used to produce each kilogramme of fish harvested?

The FCR will be:

$$\begin{aligned} &= \frac{200 \text{ kg (total amount of feed fed during production)}}{(150 \text{ kg fish harvested} - 10 \text{ kg fish stocked})} \\ &= \frac{200 \text{ kg}}{140 \text{ kg}} \\ &= 1.4 \end{aligned}$$

This means a total of 1.4 kg of feed was used to produce each kilogramme of fish.

2. If each kilogramme of feed cost GHS 5.00, how much did it cost to produce 1 kg of fish?

$$\begin{aligned} &= \text{Amount of feed required to produce 1 kg of fish (FCR)} \times \text{Unit Cost of feed (GHS)} \\ &= 1.4 \text{ kg} \times \text{GHS } 5.00 \\ &= \text{GHS } 7.00 \end{aligned}$$

GHS 7.00 was spent on the feed to produce each kg of fish.

In grow-out operations, a good FCR should be between 1.2 and 2. The FCR should never be above 2. Having it equal to 2 means 2 kg of feed is used to produce a kilogramme of fish. A feed conversion above 2 is poor and arises when:

- Poor quality diet is fed;
- The diet (size or nutritional quality) given is not suitable for the age of fish being grown;

- The culture conditions are stressful to the fish;
- Fish are 'over-fed';
- Survival rates at harvest are low; and
- Feeding for growth when the pond is at its carrying capacity.

4.3.17 Assessing the Cost-Effectiveness of a Diet

Using the cheapest diet available, more often than not, does not translate into the lowest cost to produce a kilogramme of fish as indicated in the table below:

Showing what it actually costs to produce a kilogramme of fish using different feeds

	Maize bran	Farm mixed fish feed	Complete diet/pellet
Unit cost of feed/kg	4.00	5.15	9.20
FCR of the feed	9	5	1.8
Amount of feed required to produce 1 kg of fish	9 kg	5 kg	1.8 kg
Total Cost (GHS) of feed used to produce a kilo of fish	= 9 kg bran x GHS 4.00 = GHS 36.00	= 5 kg feed x GHS 5.15 = GHS 25.75	= 1.8 kg pellets x GHS 9.20 = GHS 16.56

Note: The lower the FCR, the lower the amount of feed used to produce a kilogram of fish. Therefore, the feed which gives the lowest FCR, even though it might be more costly, is often the one that gives the lowest cost of production.

4.3.18 On-Farm Diet Handling and Storage

The following are guidelines recommended for the handling and storing of dry pelleted/extruded fish diet from time of purchase:

- ❖ Check the labels and buy the freshest diet in the store.
- ❖ Purchase only the quantity of diet that will be consumed within 4 to 6 weeks
- ❖ During transportation and handling, protect the diet from moisture, heat, and direct sunlight.

- ❖ Store the diet in a cool, shaded, dry and well ventilated room.
- ❖ Do not stack bags on feed directly against a wall or on a concrete floor. Stack them on top of pallets off the walls of the building to prevent moisture coming in contact with the bags (Figure 4.9);
- ❖ Protect the feed from rodents, bats, chickens and other animals.
- ❖ Do not use pesticides or other toxic materials near the feeds; and
- ❖ Do not keep or use diet that has been molded or spoiled.

NOTE: If you are feeding during the rain and the feed gets wet, feed all that wet feed that day or as soon as possible. Do not store wet feed, as it will get moldy.

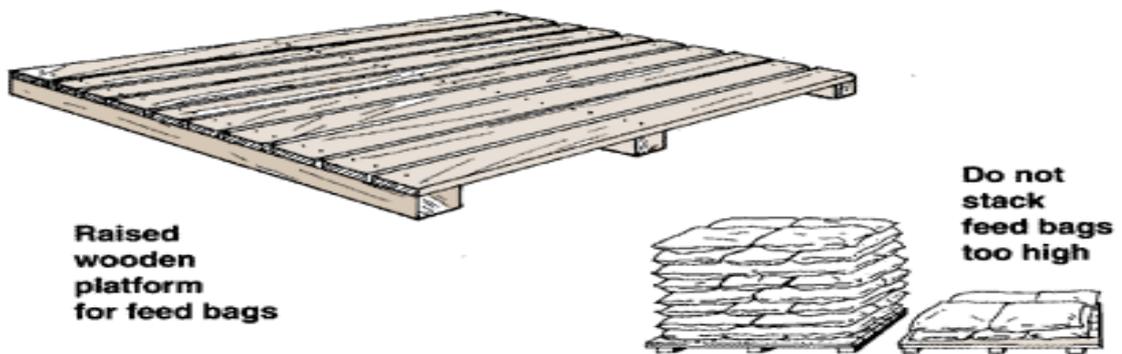


Figure 4.9: How to store feed

4.4 Growth Monitoring (Sampling) in Fish Culture

4.4.1 Sampling



Sampling is the temporary removal of fish from a culture system. The major reasons for sampling are to:

- ❖ Monitor growth and general performance
- ❖ Re-calculate feed requirements
- ❖ Determine when fish are ready for market
- ❖ Determine the reproductive stage of the fish
- ❖ Assess the health of the fish

4.4.2 How Best to Sample

The sample taken should be random and truly representative of the total population. During sampling fish become stressed because they are physically handled, suddenly confined into a small space and removed from water. In order to reduce the levels of stress one must:

- ❖ Reduce the time the fish are exposed. Execute the task at hand fast and efficiently.
- ❖ Only sample a small part of your system
- ❖ Keep the fish in water all the time or as much as possible. The only time they should be out of water is when the fish basket is lifted to the weighing scale
- ❖ If fish are stressed during sampling, mortalities can occur for up to three days after sampling.

The Day before the Sampling

- ❖ Plan and obtain the requirements for sampling in advance. This includes setting the sampling day and determining in advance what materials and personnel will be required.
- ❖ Do not feed fish the afternoon of the day before and before sampling on the day of sampling. This is to ensure that their guts are empty during sampling. Physically handling fish with full stomach is stressful to the fish and results into mortality.

On Sampling Day

- ❖ Set everything needed with personnel inclusive. Everyone should also know before embarking on the exercise, exactly what they are going to do. Practice makes perfect and saves fish.
- ❖ Sample small portions of your system with good representation from the population (Figure 4.10).
- ❖ All the fish caught in the bag should be weighed and counted. It is important to do so, in order to avoid bias
- ❖ Check their general body condition (e.g., look for wounds, discolouration, etc.).
- ❖ Weigh a basket/bowl of fish at a time (Figure 4.11).. Do not overload baskets with fish as the fish at the bottom become stressed by the pressure of those above when the fish basket is lifted out of the water. After weighing the fish, return the basket/bowl to the water and count out the fish from the basket as you gently let them swim out.
- ❖ Obtain the total batch weight and count of fish caught. From these data, calculate the average weight (total fish weight of sample/total number in sample). Do not measure and weigh fish individually, unless there is some specific need for that information and the fish are expendable.



Figure 4.10: Hauling fish sample



Figure 4.11: Weighing fish sample

Do not sample when:

- ❖ Fish are sick and show signs of extreme stress
- ❖ When there is lightning during a rain-storm.
- ❖ If it has just rained and there has been a lot of muddy water run-off especially in ponds.
- ❖ When the water quality is poor (e.g. fish gasping for air; very high and low water temperatures; low dissolved oxygen levels).

4.5 Fish Health Management

4.5.1 Some signs of Diseases in African catfish

- ❖ Erratic swimming
- ❖ Suddenly stop feeding (off feed)
- ❖ Crowding
- ❖ Continuous gasping for air over a long period of time
- ❖ Fish remain at water surface in vertical position and swim abnormally
- ❖ White spots on skin around the mouth and gills
- ❖ Wounds, red or white skin ulcers on the mouth and caudal fin
- ❖ Sluggish behaviour
- ❖ Fraying and reddening of fins; depigmentation
- ❖ Abnormal eyes, eyes resembling cotton-wool
- ❖ Skeletal deformities (lardosis and scoliosis)
- ❖ Grey/white patches on skin, fins, gills and
- ❖ Skin covered with a thin whitish grey mucus;
- ❖ Massive death

Note: For diagnosis and treatment of disease, Farmers are advised to contact the fish health management officials or government extension officers.

4.5.2 Control and prevention of fish disease

- ❖ Buy fingerlings from certified fish hatcheries
- ❖ Observe strict basis hygienic and sanitary practices for personnel and visitors
- ❖ Store fish feed supplies in the clean dry place,

- ❖ Provision of protective clothes with disinfection points for harvesters and health workers
- ❖ Routinely disinfect equipment with saline solution or recommended disinfectants
- ❖ Restrict contact of equipment - vehicles boats with culture facilities
- ❖ Maintain log of all entrants on farm
- ❖ Contain and treat effluent/organic waste at origins. Disallow re-entry
- ❖ Use pest management protocols to keep out pests, birds and other predators
- ❖ Use signage to inform visitors and personnel of bio-security measures on farm

4.6 Water Quality Management

Fish carry out all body functions in water; breathe, feed, grow, reproduce and excrete. Water quality is therefore critical in any fish venture. It affects fish growth health and performance. The quality for operation is therefore what the fish needs and not what the farmer wants or prefers.

4.6.1 Signs of Poor Water Quality

- ❖ Fish gasp at surface
- ❖ Fish groups around fresh incoming water
- ❖ Slow growth of fish
- ❖ Changes in water colour (Figure 4.12)

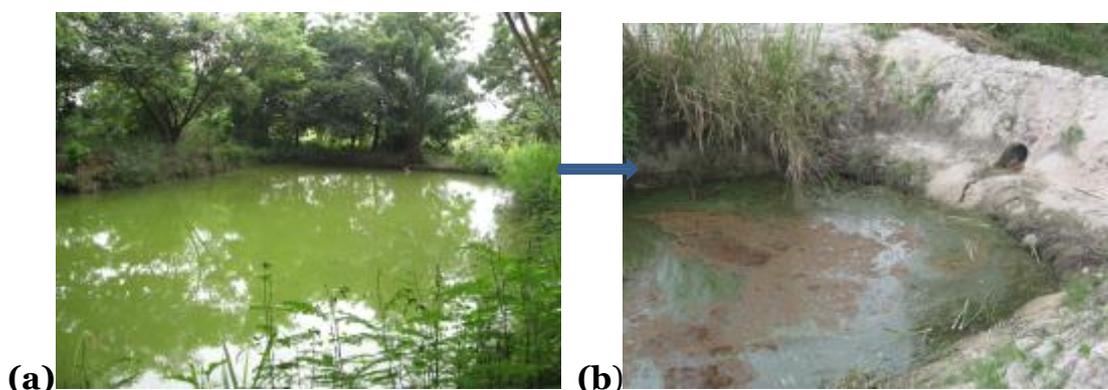


Figure 4.12: (a) Good: Greenish and (b) Deteriorating: brownish pond water

- ❖ Change in turbidity
- ❖ Build-up of nutrients such as ammonia-nitrogen
- ❖ Phytoplankton blooms
- ❖ Non-fish animals leave the water
- ❖ Repeated health problems
- ❖ Poor transparency
- ❖ Excessive growth of weeds (Figure 4.13)



Figure 4.13 Excessive weeds in ponds

4.6.2 *Causes of water quality deterioration*

- ❖ Use of poor quality feed
- ❖ Overfeeding
- ❖ Overstocking
- ❖ Decomposition of vegetation
- ❖ Increased water temperature

4.6.3 *Advantages of good water quality management*

- ❖ Good harvest
- ❖ Minimised mortalities

- ❖ Minimised vulnerability to fish diseases
- ❖ Good tasty fish – no off-flavour
- ❖ Increased profitability

4.6.4 Management of Water Quality

- ❖ Regular monitoring of key parameters (See page 4.7.2 – examples of water quality record sheets)
- ❖ Aeration of ponds where necessary
- ❖ Removal of wastes such as fish faeces
- ❖ Removal of dead fish
- ❖ Regular water change/renewal - ponds

4.7 African Catfish Farming as a business



Record Keeping

Fish farmers should keep track of all their inputs and outputs so that production costs, sales, and net income can be easily calculated to evaluate the overall economic performance of the fish farm as an enterprise.



Farm records ideally should contain details and cost of Pre-stocking activities involving pond construction and preparation, stocking activities including cost of fingerling and its stocking and Post stock management involving feed and feeding cost, water quality monitoring and its management, pond management, fish health and harvest.

Record keeping helps the fish farmers to learn from past mistakes, thus reducing risk, hazards and costs of production in subsequent cycles.

By reviewing the data in the record keeping book, fish farmers can determine the ways of increasing productivity of their fish ponds for the next crop cycle, based on the lesson learnt from the previous cycles.

4.7.1 Main Purpose for Record Keeping



Keeping farm records are important for 3 main reasons;

1. Investment Evaluation
 - ❖ Assist fish farmers to understand the economic conditions of their culture facility (fresh water fish ponds) better and accurately, i.e., how much cost (cage materials, fingerlings, feeds, medicine, etc.), sales, net profit, etc. the production requires/makes?
2. Development and Improvement Planning
 - ❖ Enable fish farmers to increase the quality and efficiency of their production and income while maintaining environmental conditions.
 - ❖ Use the record keeping book for monitoring of cage farming activities and support for fish farmers by the government extension officers.
3. Credit Support
 - ❖ Maintain production records for accessing credit, micro-finance, or insurance services from financial institutions (as these institutions often ask for the records of production, which cannot be prepared overnight).

4.7.2 Examples of record sheets

Feeding Record (Daily)

Pond Number.....

Day/Date (dd/mm/yyyy)	Feeding Record (Type, Quantity, and Source)	Feeding Time(Write feeding time)		
		Morning	Noon	Afternoon
Monday				
Tuesday				
Wednesday				
Thursday				

Friday				
Saturday				
Sunday				

Water Quality Monitoring Sheet (Monthly)

Month & Year

Pond number.....

Week	Water quality parameters							
	Temperature (°C)	Dissolved Oxygen (mg/l)	pH	Water level (m)	Transparency (cm)	Nitrate (mg/l)	Ammonia (mg/l)	Phosphate (mg/l)
1								
2								
3								
4								
5								
Average								

**Could sample monthly or quarterly per production cycle of 6 months*

Basic Accounting and Economic Record Keeping

Form A: Fish Stocking Record Sheet

Pond #	Date of stocking	Source of Fingerlings	Species stocked	Status of fingerling stocked	Standard fingerling size (cm)/Average weight(g)	Number of fingerlings stocked

Pond #	Date of stocking	Source of Fingerlings	Species stocked	Status of fingerling stocked	Standard fingerling size (cm)/Average weight(g)	Number of fingerlings stocked

4.7.3 Water Quality Monitoring Sheet (Yearly)

Year.....

Pond number.....

Month	Water quality parameters					
	p ^H	Dissolved Oxygen(ppm)	Temperature(°C)	Water level(m)	Water colour	Transparency(cm)
Jan.						
Feb.						
Mar.						
Apr.						
May						
Jun.						
Jul.						
Aug.						
Sep.						
Oct.						
Nov.						
Dec.						
Average						

Form B: Fish mortality record sheet after Stocking

Date	Pond # 1		Pond # 2		Observation/ Remark (s)
	Number of dead Fish	Estimated No. of Fish Remaining	Number of dead Fish	Estimated No. of Fish Remaining	
Total					

Form C: Input/Operational Records

Pond Number.....

Year.....

Date	Item/Input Description	Quantity	Unit Cost	Total Cost	Remarks
	15g fingerlings	2,000	1.00	2,000.00	30kg initial total weight
	Pelleted Starter Feed				
	Lime				
Total					

Form D: Farm Assets; Tools etc

Date	Item Description	Quantity	Unit Cost	Total Cost	Remarks
	Hapa				
	Water pump				
	Wellington boots				

Date	Item Description	Quantity	Unit Cost	Total Cost	Remarks
	Harvesting/scoop net				
Total					

Form E: Pond Farming Record Sheet (Monthly)

Month & Year.....

Date	Activities/ Actions Taken	Money Spent	Fish Harvest/Loss			Remaining Fish Balance in Cages	
			Sales		Non-Sales	Pond 1 (#)	Pond 2 (#)
		Total cost (GH¢)	Quantit y (# & Kg)	Income (GH¢)	(eg, family use ,given free, loss) (#)		
Total							

4.7.4 Fish farming Revenue Sheet (Yearly)

YEAR.....

MONTH	A. Expenditure Money Spent	Fish Harvest/Loss			Remaining Fish Balance in pond			Net Profit/loss {B-A} (GH¢)
		B. Sales		Non-Sales	Pond 1 (#)	Pond 2 (#)	Total (#)	
		Quantity (# & Kg)	Income (GH¢)	(eg. family use ,given free, loss) (#)				
Jan.								
Feb.								
Mar.								
Apr								
Jun.								
Jul.								
Aug.								
Sep.								
Oct.								
Nov.								
Dec.								
Grand Total								

Net Profit/loss = Sales- Money Spent

5 MODULE FOUR: HARVESTING AND MARKETING



5.1 Harvesting techniques



- ❖ Harvesting African catfish in ponds is done by draining the water to an appreciable level.
- ❖ Hauling seines is then used to complete or partially harvest the fish with those burrowed in the pond bottom/mud are harvested by hand picking (Figure 5.1).
- ❖ At this time fish are manually sorted; those that appear significantly larger than average are separated and stocked separately to prevent cannibalism.
- ❖ At the end of the rearing cycle ponds are completely drained and the pond bottom cleaned in order to catch all the fish hidden in the mud.

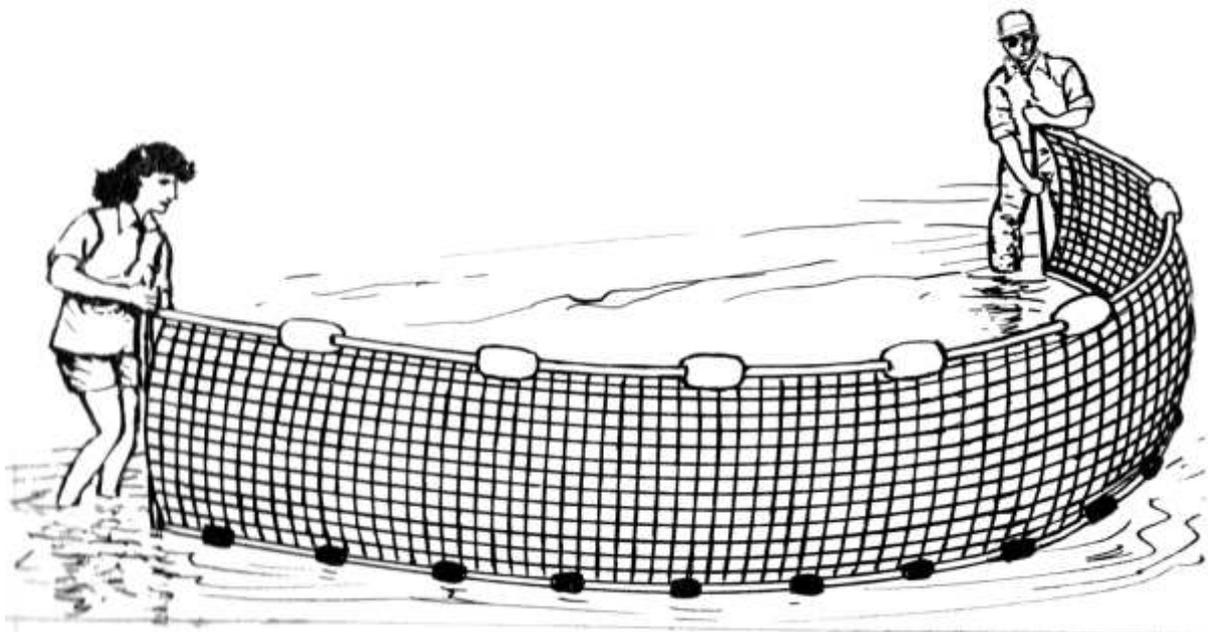


Figure 5.1: A hauling seine

- ❖ To harvest your fish by draining the water, usually you need to have a drainable pond.
- ❖ Start early in the morning when it is cooler and stop before it becomes too hot.
- ❖ Keep your fish in clean water as much as possible

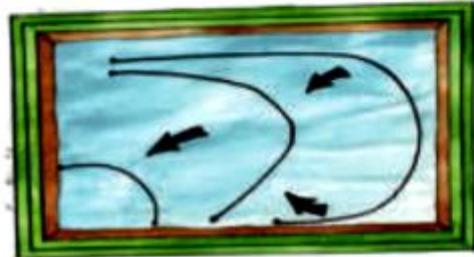
- ❖ Avoid walking into the pond more than necessary (Figure 5.2)
- ❖ Bring in additional clean water from outside the harvested pond;
- ❖ Rinse muddy fish well, before storage
- ❖ It is recommended that grading and sorting into size categories (per kilogram) should be done.
- ❖ This will help in the pricing and marketing of harvested table-size fish in more profitable and understandable way. Size 3 is often preferred for life fish market for the “point-kill” restaurants.
 - Size 3, big fish (greater than or equal to 1000 g)
 - Size 2, medium fish (<1000-700g)
 - Size 1, average fish (<700-500g)
 - Economy size, small fish (< 500 -300)
 - The remaining lower sizes < 300g would be retained or transferred to small earthen ponds for further fattening to attain an appreciable size category for marketing.
- ❖ Do not feed fish for a day or two prior to major handling (sampling and harvesting). In cases where fish have been fed offals, do not feed for a minimum of four days prior to harvest.

How to harvest the fish using a seine net

1. Use a net with a mesh size of 3 to 3.5 cm



2. Start at the deep end of the pond and move slowly to the shallow end



3. Pull the net along between two or more persons



4. Remove and replace all young fish



Figure 5.2 Steps towards harvesting of fish

5.2 Handling and processing



- ❖ Handling live African catfish is easy because, as long as the skin remains wet, they can stay alive for few days out of water.
- ❖ Harvested fish are loaded live into hauling vehicles (trucks/pick-ups) and taken to city markets. The fish are either sold directly to consumers or most frequently to fish mongers (Figure 5.3).
- ❖ Fish may be packed into baskets with ice cubes/chips loaded in-between fishes, and sent to the marketing centers.
- ❖ A minority of producers process the fish before they are sold. Depending on fish size and market demand, the fish may be smoked; filleted; or sold headed, gutted, and skinned.
- ❖ Male African catfish exhibit the best dressing and fillet percentage. Spreading some ground salt on the skin may kill the fish in a few minutes; or using vinegar to soak the skin.

- ❖ These fish are remarkably resilient. In restaurants, these days, live fish are sold through “point and kill” and cooked for valued customers by chefs (Figure 5.4)



Figure 5.3: Fresh catfish being weighed at the market



Figure 5.4: Fresh catfish ready for consumption

- ❖ Smoked African catfish are also in high demand because they can be stored for longer periods without power while retaining nutritional quality (Figure 5.5)



(a)



(b)

Figure 3.5: (a) A smoking facility and (b) smoked catfish

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Sustainable Solutions, Locally Informed



The Water Research Institute Ghana

