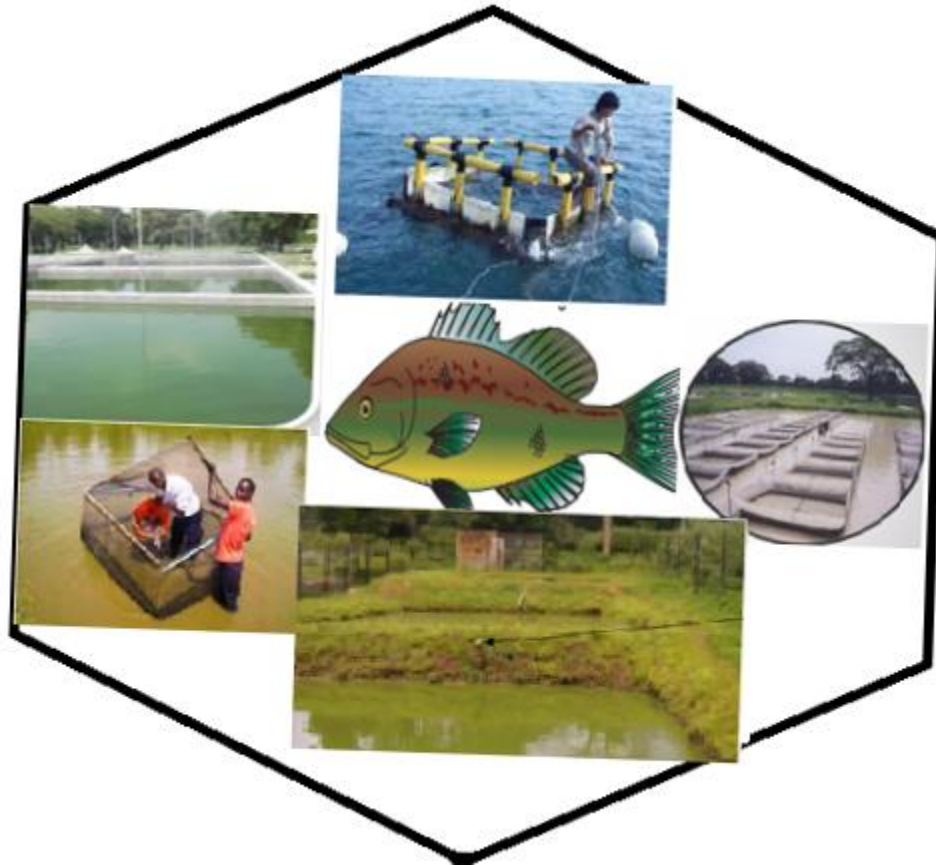


Fishery and Aquaculture

Level-III

Based on July 2022, Version-1 Occupational standard



Module Title: - Establishing Fish Farm

LG Code: AGR FAQ3 M02 LO (1-4) LG (6-9)

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Introduction to the Module

This module covers the required knowledge, skills and attitude to select site, establish fish farm and construct infrastructure facilities based on production plan of fish farm.

Aquaculture is the rearing of aquatic organisms (fish, molluscs, crustaceans and aquatic plants) in enclosed water bodies such as ponds, dams, cages, raceways, tanks, reservoirs. Fish farming is a part of aquaculture but sometimes the two are used interchangeably because majority of output from aqua cultural production comes from fish farming. Fish farming/culture is the growing of fish in a controlled environment (concrete or earthen ponds), vats (wooden or fibre glass) and plastics.

Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. Aquaculture has the potential to become a sustainable practice that can supplement capture fisheries, eliminate fish importation and significantly contribute to feeding the world's growing population.

LG #6 LO #1- Select site for fish farm establishment

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- **Understanding and identifying site selection criteria**
- **Performing site selection**
- **Identifying Legal requirements and constraints**
- **Assessing and determining site preparation**

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- **Understand and identify site selection criteria**
- **Perform site selection**
- **Identify Legal requirements and constraints**
- **Assess and determine site preparation**

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 1

1.1. Understanding and identifying site selection criteria

Site selection is the process by which various factors indicated are considered to enable one to decide on the right site for a specific production (culture) system.

The success of a fish farming project largely depends on your project site conditions. Site conditions determine whether your fish farm will competitively produce. Correct selection of the site, and correct design of your fish farm in this site, can ‘make-or-break’ your new business. Site selection process takes into account the biological traits of the target fish or Shrimp crop, the intended production capacity, the facilities required to achieve optimal and cost effective production.

There are several factors to be considered in site selection among these are;

- Water availability (adequate quantity and good quality);
- Land topography;
- Accessibility;
- Soil type;
- Vegetation cover;
- Proximity and size of market;
- Availability of inputs; and
- Bio-security.

Site selection is the process by which various factors indicated are considered to enable one to decide on the right site for a specific production (culture) system.

There are several factors to be considered in site selection among these are;

A) Water Supply (availability in terms of quality and quantity)

Adequate supply of good quality water must be available year round in the site for fish culture.

- The water sources must be reliable and adequate
- Good quality water is rich in oxygen, nutrients and free from pollutants. The most important sources of water for fish ponds are; Perennial streams, Lakes, Rivers, Springs and wells, and, Water reservoirs and dams.

- If there is no enough water all the year round, it is no good making ponds, as they will dry up and the fish will die. And also the water loss due to evaporation, leakage and percolation should be considered in determining the amount of water required.

B) Soil Type and Quality

A good understanding of soil and its characteristics is one of the most important of the many factors which must be considered for successful freshwater fish culture. What is soil? Soil is a complex mixture of living organisms, organic matter, minerals, water and air.

Soil is made up of:

- Organic particles of decayed plant and animal materials which come from living plant and animal bodies;
- Mineral particles such as sand, clay, stones or gravel which were once parts of larger rocks.

Many soil characteristics, especially those related to texture, determine its suitability for fishpond purposes.

Soil texture refers to the relative proportion of sand, silt and clay content of the soil.

Types and characteristics of soils

- **Sandy soil** - this soil can't be used for constructing fishpond, because it can't keep water. Its clay content < 12.5%, sand content > 87.5%.
- **Clay soil**- This soil can be used for constructing fishpond, but it has much poor aeration. Clay conserves water well. It can be used on the pond bottom; however, because it cracks when dry, it is unsuitable for dike construction. Clayey soils are preferable because they are superior material for diking and holding water. They have good compaction characteristics and low permeability. A very simple general rule can be followed: As a clay content of the soil decreases, its suitability for fishpond construction also decreases.
- **Loamy** soils are also recommended. They have good organic matter content which favors the culture and growth of natural fish food.

i. Desirable soil texture for ponds

Soils belonging to the following textural classification are desirable for fishpond development: clay, clay loam, silty clay loam, silty loam, loam and sandy clay loam. These types of soils are characterized by;

- High water retention (holding) capacity

- Good aeration
- Adequate nutrient
- Favorable chemical properties.

Soil characteristics greatly affect the quality of pond construction and influence fish yields. Therefore, soil quality should be carefully determined. In determining soil quality, it is insufficient to just examine the topsoil. Enough samples must be taken from various representative spots. The sampling depth should be 1 m. The soil should ensure that pond dikes would not leak or collapse.

ii. Soil Quality Testing

There are several methods to test the quality of soil for pond construction, the most easy and practical methods includes;

a) The ball method

- Dig about 50cm deep pit, take a handful of soil from the bottom of the pit, and moisten it with some water. And squeeze it into a ball (**figure 1.1**)
- Throw the ball of soil into the air and catch it (**figure 1. 2**).

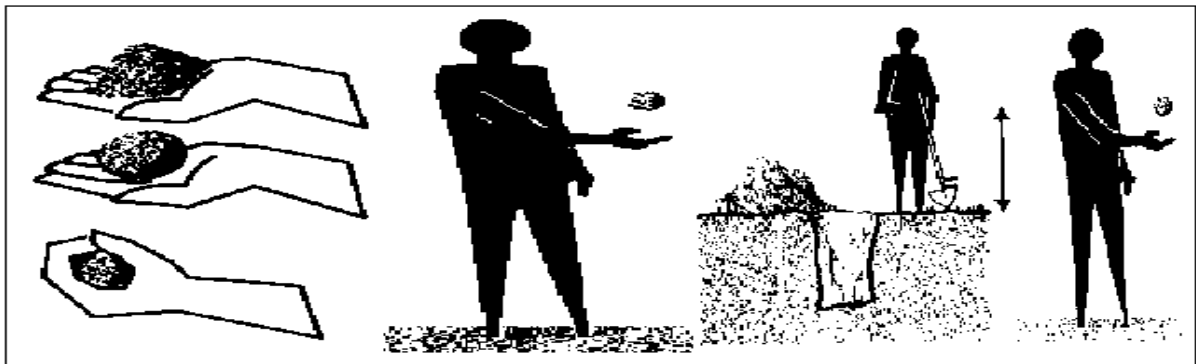


Figure 1.1A: Soil sample Figure 1.1B: Throw ball of soil Figure 1.1B: Testing soil

- If it sticks together it is good soil and will held water well.
- Bad soil with sand or gravel in it will not stick together and will not hold water.
- Now dig a hole as deep as your waist and test the soil from the bottom of the hole in the same way as before.

Conclusion: Bad soil with too much sand or gravel in it will not stick together and the ball will fall apart then reject the site. If the ball sticks together well the soil maybe be good, but you can't be sure. Now you should make a second test to be sure that the soil is good.

b) The pit method

- Dig a hole as deep as your wrist early in the morning fills it with water to the top.
- By evening some of the water will have sunk into the soil
- Then fill the holes with water to the top again. Cover the hole with boards or leafy branches
- The next morning if most of water is still in the hole at least 60%, the soil hold enough water, therefore the soil is suitable to build fish pond. If there is some or no water remaining reject the site.

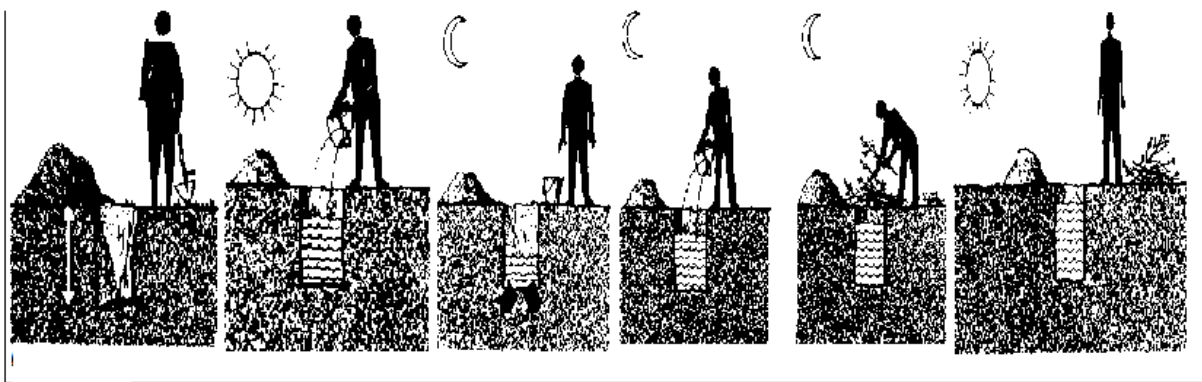


Figure 1.2: Procedures in soil checking for pond by pit methods

C) Topography of the site

Topography refers to the “lay of the land” or the changes in the surface elevations of the ground whether flat, rolling or sloping, undulating, and hilly. Fishpond design, layout and specifications are made largely in accordance with the land topography.

A suitable site for fishpond has a topography that can be converted into a pond economically. The cost of construction can be greatly reduced if the surface features of the land are used to advantage.

It is desirable or ideal to construct a fish farm on flat land with moderate slop. However, there is no problem in setting up a farm on sloppy side of hills or valley areas.

The topography should be suitable for;

- Gravitational flow of water can be exploited (water can easily enter into the pond)
- Reduce soil excavation and energy consumption, and
- Easy to drain water from the pond

D) Other criteria

There are other factors which are significant in fishpond site selection. These are equally as important as those previously mentioned and likewise require the same careful evaluation during the survey.

- i. **Accessibility:** This is important for the transport of construction equipment and material, and for production inputs required for daily operations. Transporting costs can considerably increase if materials are manually carried through long distances. It is better if the site is accessible throughout the year by means of land and water.
- ii. **Availability of labor:** The cheapest sources of labour are those which can be provided by the local residents, or people living within or near the area. It is important that the customs and tradition of local laborers are known. The pattern of labour distribution and utilization should be considered as this is important in preparing the calendar of activities.
- iii. **Availability and cost of material:** In fishpond production, it is important that critical production inputs such as fish seeds, fertilizers, pesticides and other related materials are readily available when needed. For some inputs, especially inorganic fertilizers, the supply is restricted and the cost is uncontrolled for non-agricultural uses. Other inputs like organic manures are difficult to obtain, or may be available only at certain times of the year.
- iv. **Availability of marketing outlets and prices:** Aquaculture products are highly perishable. Immediately upon harvest, products must be disposed of to maintain good quality and for better prices. If marketing outlets are located at a distance, larger quantities must be harvested and transported requiring some post-harvest marketing practices. If so, then the required support facilities especially ice-making plants must be available.
- v. **Availability of credit and technical assistance:** Fishpond operations require high initial capital investment. In this respect, credit at reasonable terms play a major role in providing the needed cash outlays. Technical assistance may be obtained from government extension services, public or private university research stations and lending institutions. The services rendered by these agencies are important especially in cases of emergency.
- vi. **Pattern of land and water use:** It is important to assess the pattern of land and water use in the area to determine the impact of this on the project. Activities such as navigation, fishing, industries, public utilities, and recreation and nursery areas must be included in the overall assessment. It is best that a complementary rather than competitive relationship between these various uses and the project be established.
- vii. **Peace and order situation:** Good peace and order conditions at site are favorable for both public and private interests.

- viii. Assess site infrastructure (e.g. roads, utilities):-** Infrastructures refers to the background facilities, which are needed for the development of aquaculture in a determine regions. Operational concerns are important factors in determining the location of an aquaculture facility
- ix. Biosecurity Plan:-** importance of Security Aquaculture facilities need the implementation of security against damage and poaching. Aquatic farmers face enormous pressure from native and exotic disease-causing organisms, or pathogens. Infection and disease can invade from multiple sources—water, wild fish or shellfish, newly-introduced farmed fish or shellfish, contaminated equipment, predators, human visitors—and can interfere at all stages of production. A proper waste management plan is needed to maintain the legality, profitability and environmental soundness of any aquaculture facility. Typical wastes from an aquaculture facility may include feces and nutrients from excretion by aquatic animals, as well as uneaten feeds and chemicals such as therapeutant and cleanser residues.

1.1. Performing site selection

Site selection is the process by which various factors indicated are considered to enable one to decide on the right site for a specific culture system (**Refer information sheet 1.1. Understanding and identifying site selection criteria**).

In site selection for a pond, the ecological factors to be considered include soil, water, topography and climate.

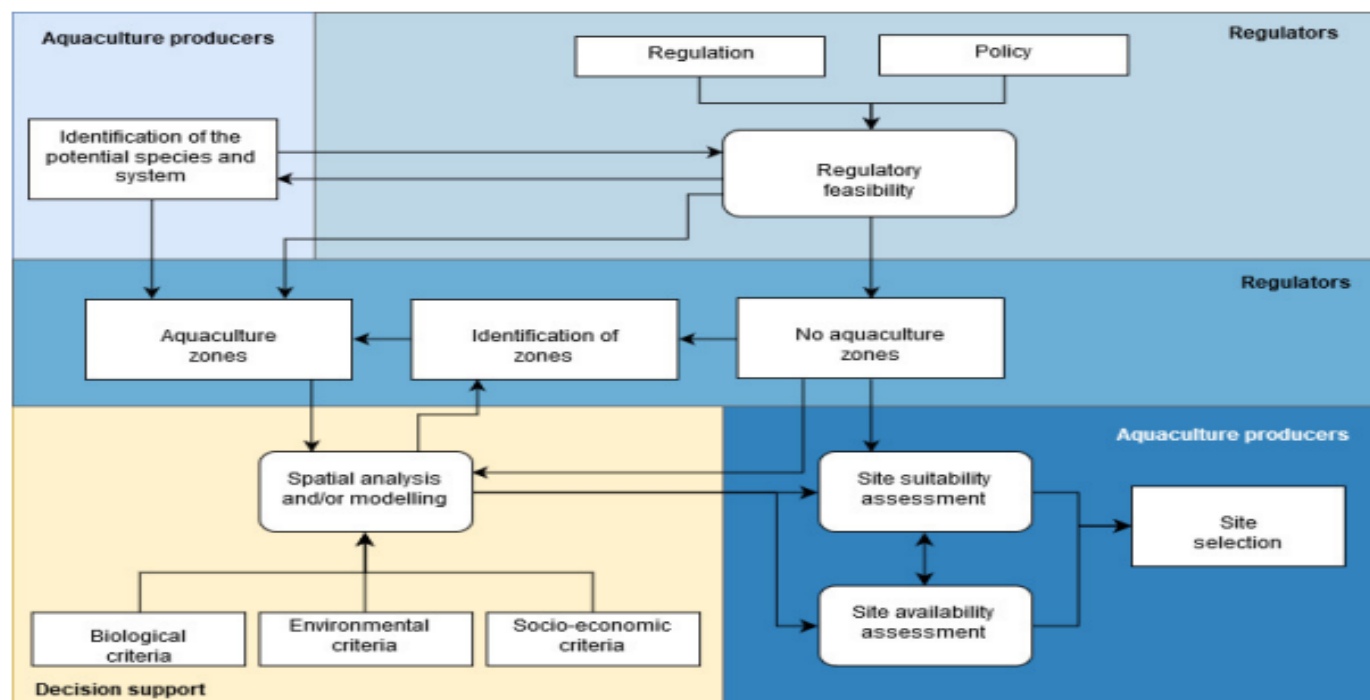
1. Soil: A good understanding of soil and its characteristics
2. Evaluation of soil suitability: testing water holding capacity of soil
3. Water: availability in terms of quality and quantity
4. Topography: refers to the “lay of the land” or the changes in the surface elevations of the ground whether flat, rolling or sloping, undulating, and hilly
5. Site preparation: clearing, excavating and designing
6. Construction of dyke
7. Digging the pond and construction of dyke
8. Introducing water/filling water to the pond
9. Stocking fish

1.1. Identifying Legal requirements and constraints

There may be restrictions or moratoriums in place that prevent aquaculture from being established, or regulations may prohibit or specify types of aquaculture, which can influence species and technologies that will be used. Consequently, the first step in assessing site suitability and the potential for aquaculture development should be to consult national and regional regulations to ensure such systems can be established. There are different considerations depending on the type of aquaculture.

For multi-user areas or locations where the environment may be particularly sensitive, there may be a need for more co-ordinated planning. The use of designated zones for aquaculture development can be useful. These are usually identified and established by government and regulatory authorities, and then the aquaculture producers will select sites within these areas. Some countries have management areas, where farms will work together on farm strategies and disease control within an area and coordinate activities such as treatment or fallowing.

When selecting a site for aquaculture development, aquaculture producers must consider the regulations and policies of that area and adhere to any conditions that must be met in order to establish a farm. Likewise, for site selection, it is important to be aware of existing management agreements within areas of interest, which may affect the establishment of farm, but also the operation of a farm once developed. Discussion with the regulatory authorities and perhaps even local stakeholders may be useful at this stage.



Info graph 1.1: Overview of the broad spatial framework for site selection and regulation.

1.2. Assessing and determining site preparation

Each potential site should be evaluated in the field through a series of quick *reconnaissance surveys* to ensure that the major requisites are met:

- availability of water supply
- quality of water supply
- adequacy of soil quality
- suitability of topography

A Simple Test of the Suitability of a Soil for Pond Construction: (Refer information sheet 1.1. Understanding and identifying site selection criteria).

- (a) Dampen a handful of soil with water. Use only enough water to dampen the sample (Do not saturate it).
- (b) Squeeze the sample tightly in your hand.
- (c) Open your hand:
 - (i) if the sample keeps its shape, it is probably good enough for building a pond (i.e. sufficient clay present).
 - (ii) if the sample collapses and does not keep its shape, it is probably not good enough for building a pond (i.e. too much sand present).
- (d) The site should be in a region or area that is suitable and allowed for aquaculture production.
- (e) Well drained and away from flood-prone areas or at least having potential for flood control.
- (f) Allow for acceptable effluent disposal as required by Environmental Management Authorities.
- (g) Have a climate suitable for production of the intended species.
- (h) Have accessibility to a good and all-weather market.
- (i) Have easy access to services and technical assistance.
- (j) Have adequate room for intended investment and possible future expansion.
- (k) Not in a pollution prone area.

Steps of selecting aquaculture farm establishments based on criteria

- Soil: A good understanding of soil and its characteristics
- Evaluation of soil suitability: testing water holding capacity of soil
- Water: availability in terms of quality and quantity

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- Topography: refers to the “lay of the land” or the changes in the surface elevations of the ground whether flat, rolling or sloping, undulating, and hilly
- Site preparation: clearing, excavating and designing
- Construction of dyke
- Digging the pond and construction of dyke
- Introducing water/filling water to the pond
- Stocking fish

Self-check – 1	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Multiple choices

1. Which one is factors to be considered in site selection of fish farm establishment

- A. Water availability
- B. Land topography and Soil type;
- C. Proximity and size of market;
- D. Availability of inputs
- E. All

2. -----is the process by which various factors indicated are considered to enable one to decide on the right site for a specific production (culture) system.

- A. Site selection
- B. Pond construction
- C. Clearing
- D. Pond lay out

3. -----is a complex mixture of living organisms, organic matter, minerals, water and air.

- A. Soil
- B. Water
- C. Culture
- D. All

Test II: Short Answer Questions

1. Write the most important sources of water for fish ponds.
2. Write characteristics of desirable soil texture for ponds.

Test III: Say true or false based on the statements

1. Soil characteristics greatly affect the quality of pond construction and influence fish yields.
2. Fishpond design, layout and specifications are made largely in accordance with the land topography.
3. Adequate supply of good quality water must be available year round in the site for fish culture.

Operation Sheet -1

1.1. Selecting aquaculture farm establishments based on criteria

a/ Materials tools and equipment's

- All necessary PPE
- Note books

b/ Steps/factors considered based on selection criteria

- Soil: A good understanding of soil and its characteristics
- Evaluation of soil suitability: testing water holding capacity of soil
- Water: availability in terms of quality and quantity
- Topography: refers to the “lay of the land” or the changes in the surface elevations of the ground whether flat, rolling or sloping, undulating, and hilly
- Site preparation: clearing, excavating and designing
- Construction of dyke
- Digging the pond and construction of dyke
- Introducing water/filling water to the pond
- Stocking fish

1.2. Techniques of Soil Quality Testing by pit method

a. Materials, Tools and equipment's

- | | | |
|-------------|-------------|--------------------|
| • Shovel | • boots | • sun hat |
| • spade | • compactor | • sunscreen lotion |
| • water can | • roller | • ear protector |
| • over all | • gloves | • water |

b. Procedures in soil checking for pond by pit methods

- Dig a hole as deep as your wrist early in the morning fills it with water to the top.
- By evening some of the water will have sunk into the soil
- Then fill the holes with water to the top again. Cover the hole with boards or leafy branches
- The next morning if most of water is still in the hole at least 60%, the soil hold enough water, therefore the soil is suitable to build fish pond. If there is some or no water remaining reject the site.

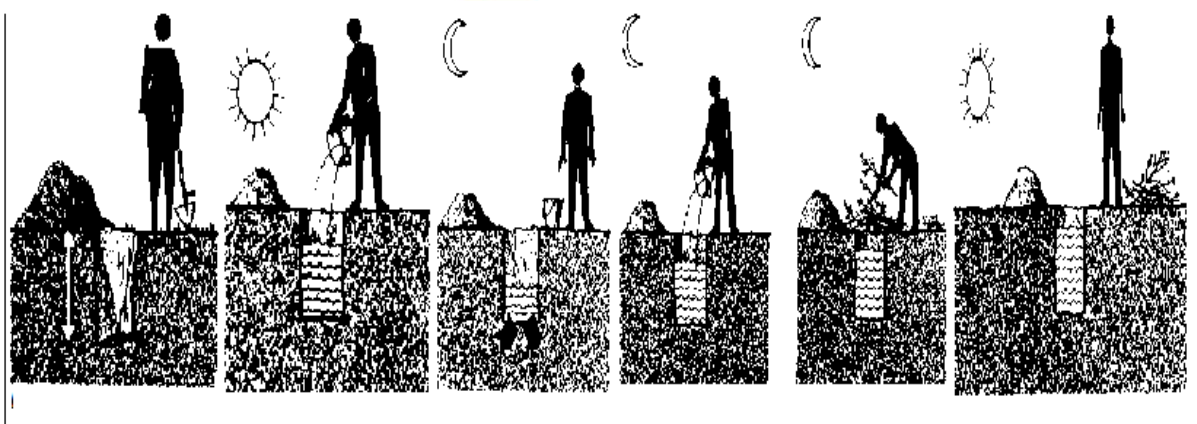


Figure 1.2: Procedures in soil checking for pond by pit methods

LAP Test-1	Performance Test
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Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2 hour**. The project is expected from each student to do it.

Task 1: selecting fish farm site based on selection criteria.

Task 1: Perform suitability of soil for pond construction by pit methods

LG #7

LO #2- Prepare for construction work

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Preparing and undertaking construction work plan
- Identifying types of pond
- Set bill of quantity for construction
- Identifying and using equipment, tools, materials and PPE
- Preparing and undertaking brief layout of fish farm

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Prepare construction work plan
- Identify types of pond
- Set bill of quantity
- Identify equipment, tools, materials and PPE

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet -2

2.1. Preparing and undertaking construction work plan

2.1.1. Preparing construction work plan

A construction plan is a set of documents that defines the requirements for a construction project, such as the activities, resources, schedule and budget. The layout of the site is governed by the combined requirements of operation and the particular site conditions. Prior to designing work, all information should be collected regarding technological requirements and the data particular to the site.

The construction work plan includes

- Construction activities
- Order of activities
- Construction or installation directions or design
- Expected time required to complete activities
- Standard of completed construction activities
- Materials, tools and equipment required/arranged
- Safety procedures.

Steps to develop a construction plan

- Identify key resources.
- Draft an initial plan.
- Meet with key stakeholders.
- Assign responsibilities.
- Track your performance.
- Evaluate the project.
- Close out the plan

Preparatory work

- Technological Requirements
- General Technical Data
- Geodetical Data
- Hydrological and Meteorological Data
- Geotechnical Data
- Water Quality Data

a/ **Technological Requirements**

- Species of fish to be produced.
- Sequence of operations envisaged: production from hatching to market fish, or production of market fish alone.
- Method of fry production.
- Production quantities envisaged.
- Methods and possibilities of nutrient supply to the ponds, such as organic manure, duck farming, fertilizer application.
- Feed distribution (fish feed, grain feed, etc.).
- Transport management - method and means of in-farm and external transportation.
- Buildings required (operation, social-cultural amenities, grain store, equipment shed, repair shop, housing, etc.).

b/ **General Technical Data**

- Data on existing water uses affected.
- Data affecting water supply and drainage.
- Future development plans for the area.
- Data on other facilities (roads, railways, etc.)
- Property conditions and data.

c/ **Geodetical Data**

Topographic surveys to the scale 1:500 to 1:5000 and with contour lines of 20-25 cm (perhaps 1 ft) vertical spacing are needed for the entire fish farm area, in order to permit designing complete pond drainage and earthwork volume estimates of the required accuracy.

On any existing earth structures (embankments, canals, etc.) cross sections should be taken at 50-100 m spacing, with points spaced sufficiently close to each other to plot the actual terrain with ± 20 cm accuracy on the cross sections of 1:100 scale.

Cross sections should be plotted at the sites of major structures (intakes, road crossings, etc.)

Cross sections at not more than 500 m intervals and continuous profiles are needed on the connecting stream or canal extending for the distance affected by the fish farm (e.g. to the backwater limit).

The topographic survey should be connected, especially as regards elevations, to the national survey network.

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d/ Hydrological and Meteorological Data

Where water is obtained from a natural stream, data must be acquired on the stages and flow rates to be anticipated at the diversion point in the periods of pond filling and for compensation of water losses. Water supply should be designed for a flow rate of 80 percent probability.

In the case of ponds through which floods must be conveyed, or the dikes which are required to retain floods on the stream, the designer will require also data on design flood levels and discharges. The probability of occurrence of the design flood is normally specified by the competent water agency. In the absence of such specification, the flood of 1 percent probability of occurrence (once in a hundred years) should be adopted as the design flood. In the case of minor ponds, where a dam failure would cause no other losses, a flood of say 3 percent probability might be adopted as the design flood. The retention capacity of upstream ponds is taken into account in estimating the design flood.

Data on the peak values of monthly evaporation and rainfall are needed for estimating the water demand. Data on the monthly average and extreme temperatures are needed for selecting the species of fish for farming, for planning the necessary feed supply rates and for designing the holding and storage facilities of live fish.

The annual volume of sediment entering the ponds should be estimated. Data are needed on the direction and highest speed of wind prevailing in the area in order to design wave protection.

e/ Geotechnical Data

The geotechnical explorations should be extended to the entire area of the fish farm, to provide data on the soil stratification in the pond area, under the dikes, along the canal traces and at the sites of structures.

The data obtained by soil explorations should be suited to estimate:

- seepage losses
- under seepage conditions and the hazard of piping failure
- stability of the dikes
- the required degree of compaction
- the allowable flow velocity in the supply canals, and
- the foundation of the structures.

The methods of exploration and laboratory testing, as well as the interpretation of the results are described in more detail in Chapter 5 on soil characteristics for aquaculture farms.

f/ Water Quality Data

The water supplied to the fish ponds must not contain pollutants and toxic substances detrimental to fish life.

The composition of the feed water should be subject to quality analysis, including the following:

- Oxygen content
- pH value
- total salts content
- ammonia content
- free CO₂ content
- Phenols, oil and tar content.

The water quality analyses should be such as to enable prediction of the interactions between the soil and the feed water.

2.1.2. Undertaking construction work plan

An intelligent design and layout is a prerequisite for an efficient pond construction. The excavated earth should be used to construct the dyke and with a plodding slope towards the outlet for the proper draining facility. Preferably construction of pond has to be completed during summer so that the pond can be used for stocking.

Survey

- Before constructing the pond, land is surveyed to find out determine its topography.
- Marking the area of proposed pond is the first step in the construction of a fish pond.
- The natural slope where the main wall is to be built should be ascertained.
- The main wall should be marked off at the lower end of the pond, where the slope is the greatest.

Designing

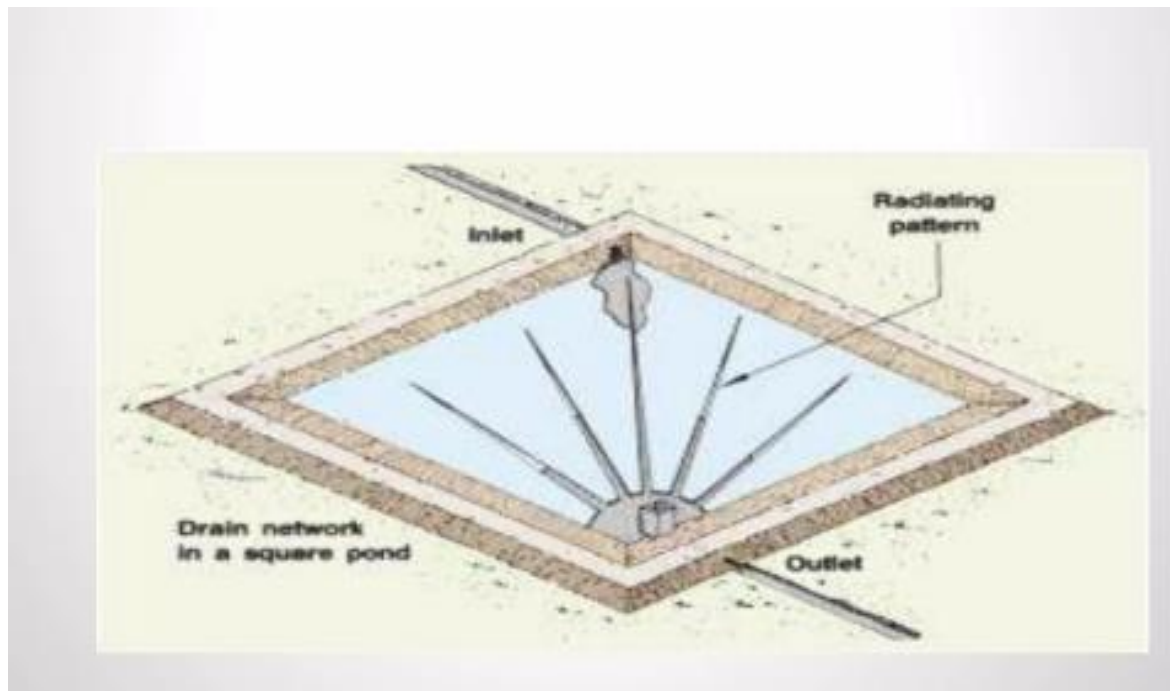
Pond Design

During the process of designing ponds, decisions on the following should be made:

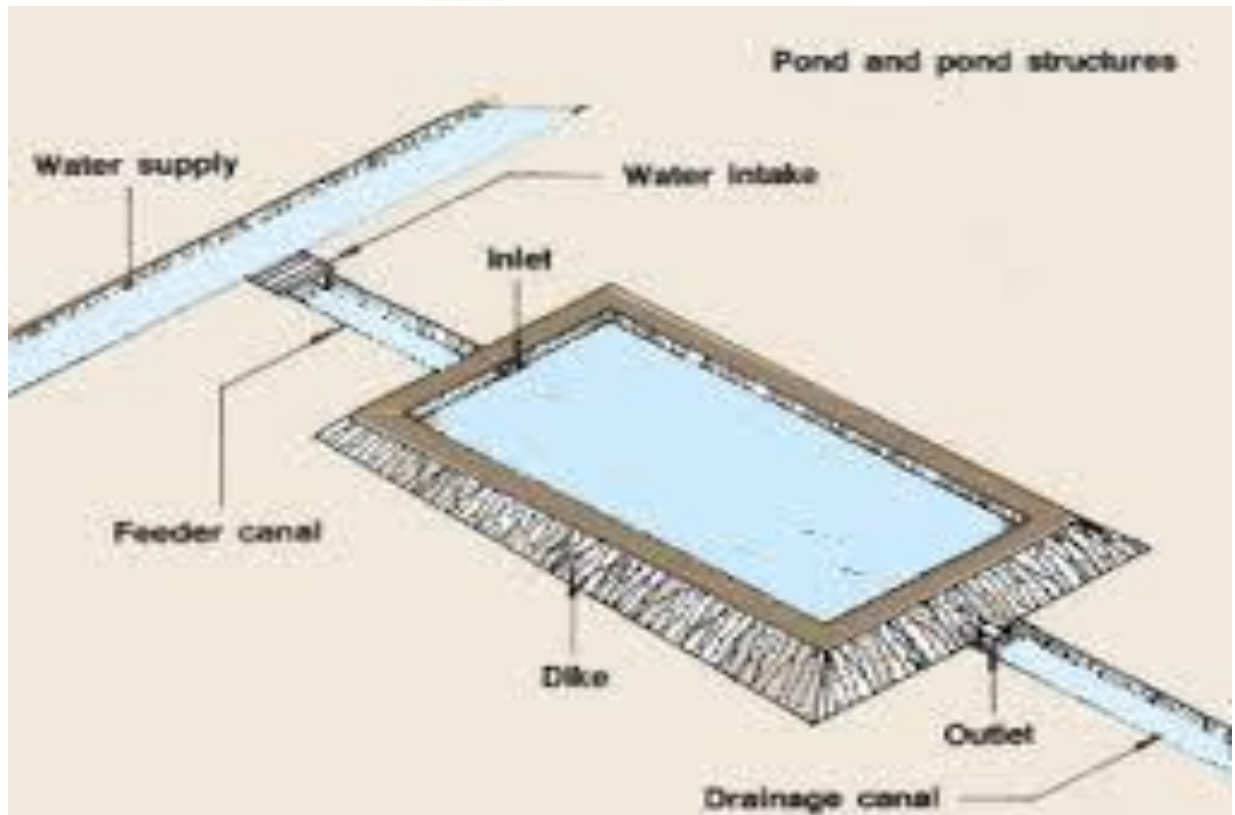
- Total Area of the pond water surface (this is the actual pond size)
- The Length and the width of the pond water surface
- The water depth and the total pond depth at the deep end
- The slope of the dykes and the pond bottom
- The size of the free board (height of dyke above water level)
- The width of dykes

The first step while designing fish ponds should be to study the soil type, topography and water supply.

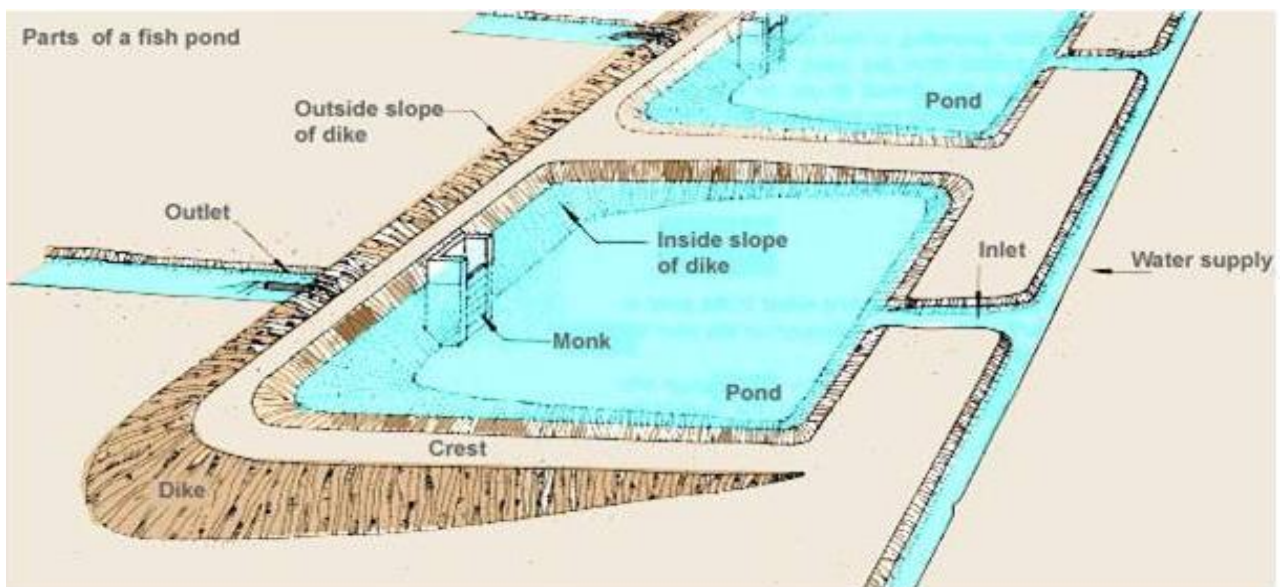
- In designing the fish farm, it should be decided as to where and how many nursery, rearing and stocking ponds are to be constructed.
- In case of a fish farm constructed solely for the purpose of seed production, only nursery and rearing ponds may be constructed, with a nominal area for the brood stock ponds.
- In case of grow-out farm, more stocking ponds will be constructed to produce table size fish after stocking fingerlings.
- For a composite fish farm all three types of ponds are required and their number should be based on the intended stocking density.
- Fish ponds should be at least one surface acre in size. Ponds smaller than one acre seldom support a satisfactory fish population over many years. They usually require much more intensive fish management and may not justify the costs.
- It is important to know the exact size, maximum depth, average depth, and water volume of the pond. This information becomes useful in calculating the amount of herbicide needed for weed control and the number of fish fingerlings needed for stocking.



Info graphics. 2.1. Drain network in square design pond.



Info graphics 2.2. different pond parts in rectangular pond



Info graphics 2.3: parts of fish pond

Site preparation

The place is cleared of ropes, cables and other items. Trees and bushes and other obstacles that hinder movement of heavy equipment around the site are to be removed - manually / animal power /using

machinery. All vegetation including wood is to be cleared in the area (inclusive of 2 to 3 m beyond the dyke for workspace). Trees within 10 meters surrounding, tree slumps, large stones, are also to be removed. The surface soil which has the highest concentration of roots and organic material is not suitable for pond construction. Hence, about 30 cm of surface soil has to be removed.

Steps in pond construction

Normally, the pond construction includes the following steps:-

Step 1: Prepare the site by removing unwanted things such as the trees, bushes, and rock

Step 2 : Construction of seepage-free and secure dyke by using the clay core

Step 3 : Digging the pond and construction of dyke over the clay core

Step 4 : Inlet and outlet construction

Step 5 : Pond dyke covered with soil and plant grass species (avoid long rooted plants such as Rhodes grass and star grass)

Step 6 : Pond should be fenced to avoid theft and entry of predatory animals

Construction of dyke

Dykes should be compact, solid and leak free. A desirable dyke is constructed using 15 - 30 percent of silt, 45 - 55 percent of sand and 30 - 35 percent of clay. A sufficient width of the berm (not less than 1 m) is required to stabilize slope. The embankment slope in horizontal to vertical should be 2:1 in good quality clay soil and 3:1 for loamy silt or sandy soils. To raise the dyke, the clay buddle (1:2 sand and clay) is deposited as 10 - 15 cm thick layer and it can be formed at centre or inside the waterside of the pond. The crest of the dyke should be sufficient to help allied farm activities and the top of embankment should be above 1 m. Extra outlet is essential on the embankment as a safety measure to avoid damage due to excess raise in the water level.

Digging the pond and construction of dyke

Types of pond

Specific kinds of ponds are required for specific life stage development of fishes - such as nursery, rearing, stocking, treatment and brood stock pond. The rectangular pond is preferred than round shaped corners as it prevents the fish escape during harvest. An ideal length and breadth ratio of the pond is 3:1 is ideal, with breadth not more than 30 - 50 m. The total farm area can be divided as - nursery - 5 % of total farm area, rearing pond - 20 %, stocking pond - 70 %, and bio pond or treatment pond - 5 % of the total farm area.

- **Nursery pond** - The size of the nursery pond is about 0.01 to 0.05 ha with a depth of 1.0 – 1.5 m. The spawn (3 days old) are stocked in nursery pond, reared for a maximum of 30 days (to attain 2 – 3 cm length).
- **Rearing tank** - a tank where the fry are reared into fingerlings (to attain a size of 10 – 15 cm) and the culture duration is 2 – 3 months. The size of pond varies from 0.05 – 0.1 ha with water depth of 1.5 – 2.0 m.
- **Stocking pond** - In stocking pond, the fingerlings (TL 10 – 15 cm) are reared into marketable size. The culture duration varies from 8 – 10 months. The stocking density varies according to the target fish production. The stocking pond is used as brood stock pond and breeding pond as per the requirement. However, the pond area ranges from 1 – 2 ha with a greater water depth of 2.5 – 3.0 m. There are no hard rules regarding the size of the ponds.
- **Bio pond or treatment ponds** - these are large settling tanks, where the water used for fishponds is purified biologically. They may also be used as stocking pond. However, an even flat bottom is recommended for easy netting operation.

A productive farm should use its higher altitude area for construction of nursery pond followed by the rearing pond. The lowest area of the farm should be used to build the stocking pond, which will help in reducing the cost of construction and increase ease of farm management.

Pond construction types

The ponds are constructed by two types namely, **dug out and embankment pond**.

The dug out pond is constructed by digging the soil and is most suitable to construct ponds in plain areas. It is to be scientifically constructed maintaining shape, size, depth and other factors.

Embankment pond is more appropriate for hilly areas. Dykes may be erected on 1 or 2 sides based on need. This pond is economically viable but not ideal for fish culture because the size, shape and depth of pond cannot be fixed as per scientific fish culture specifications.

Inlet and outlet construction

Feeder canals are constructed to provide sufficient amount of quality water to the ponds except in ponds which are filled by rainwater. Inlets are provided at top of the pond and screens are used to filter the pumped water to avoid entry of unwanted particles to the culture system. The inlet pipe size has to be designed in such a way that it should not take more than 1 or 2 days to fill the pond.

The **outlet pipe** is set up at bottom of the pond. It is used to dewater the pond during harvest and partial draining for pond water exchange to maintain the water quality of the pond during the culture period. The outlet is constructed prior to pond dyke construction.

Soil and vegetation coverage of Dyke

To reduce the soil erosion, creeping grass can be grown on the top and sides of dyke. The banana and coconut trees can be planted in the embankment. The slope of the embankment can be planted with grasses such as Hybrid Napier, gunny grass and elephant grass to supply feed to the grass carps reared in the ponds.

Pond fencing

The ponds are fenced to protect from theft. Live fences also serve as windbreak, increase farm diversity, provide privacy to farm and improve the appearance of the fish farm. There are several ways to make fences. These include live fence, piled fence, woven fence, post and rail fence, wire fence, wire netting fence and stone wall. Each type of fence has its own advantages and disadvantages. Wired net fence is primarily used in fish farms to stop intruders and protect the fish stock.

2.2. Identifying types of pond

The final size of a fish farm is determined by:

- Amount of water available for fish culture
- The technology to be employed; Intensive systems require less land compared to semi-intensive systems, to produce the same quantity of fish.
- The target production.
- Capital available for investment

The number, size and the shape of ponds will be determined by:

- Land size
- Topography of the land
- Intended use of the Pond
- The Species to be produced
- Frequency of Harvest
- Target quantity per harvest
- Whether juvenile production is intended etc.

The percentage of area covered by these different pond types are given below:

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- I. Nursery pond: 3%
- II. Rearing pond: 11%
- III. Production pond: 60%
- IV. Segregation pond: 1%
- V. Breeding pond: 25%

Nature of different ponds in aquaculture

- a) Nursery ponds: Shallow
- b) Rearing ponds: Moderately deep
- c) Production ponds: Moderately deep
- d) Segregation pond: Moderately deep
- e) Breeding ponds: Moderately deep
- f) Water level (for larger production ponds): 2-3 meters

2.2.1. Different kinds of pond

Freshwater fish ponds differ according to their source of water, the way in which water can be drained from the pond, the material and method used for construction and the method of use for fish farming. Their characteristics are usually defined by the features of the landscape in which they are built. Ponds can be described as follows.

A. According to the water source

1. Ponds can be fed by groundwater:

- (a) Spring-water ponds are supplied from a spring either in the pond or very close to it. The water supply may vary throughout the year but the quality of the water is usually constant.
- (b) Seepage ponds are supplied from the water-table by seepage into the pond. The water level in the pond will vary with the level of the water-table.

2. Rain-fed ponds:

Rain-fed ponds are supplied from rainfall and surface runoff. No water is supplied during the dry season. These ponds are often small depressions in impermeable soil, with a dike built at the lower side to retain more water.

3. **Ponds can be fed from a water body such as a stream, a lake, a reservoir or an irrigation canal.**

These may be fed directly (e.g. barrage ponds), by water running straight out from the water body to the ponds, or indirectly (e.g. diversion ponds), by water entering a channel from which controlled amounts can be fed to the ponds.

4. **Pump-fed ponds** are normally higher than the water level and can be supplied from a well, spring, lake, reservoir or irrigation canal, by pumping.

B. According to the means of drainage

- Undrain able ponds cannot be drained by gravity.
- They are generally fed by **groundwater** and/or surface runoff, and their water level may vary seasonally.

Such ponds have two main origins.

1. **Drainable ponds** are set higher than the level to which the water is drained and can easily be drained by gravity*. They are generally fed by surface water such as runoff*, a spring or stream, or are pump-fed.
2. **Pump-drained ponds** may be drainable by gravity to a certain level, and then the water has to be pumped out. Other ponds, similar to undrain able ponds, must be pumped out completely. These ponds are only used where groundwater does not seep back in to any extent.

C. According to the construction materials

1. **Earthen ponds** are entirely constructed from soil materials. They are the most common, and you will learn primarily about these ponds in this manual.
2. **Concrete (Walled ponds)** are usually surrounded by blocks, brick or concrete walls. Sometimes wooden planking or corrugated metal is used.
3. **Lined ponds** are earthen ponds lined with an impervious material such as a plastic or rubber sheet.

Earthen Pond Construction

When you understand how to construct an earthen fish pond, There are the activities/procedures involved in earthen pond construction.

- There are some essential **tools** you will need to **build** an outdoor fish **pond**, such as

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- ✓ a spade and shovel,
- ✓ a level, measuring tape, and a rake,
- ✓ Skid-steers and backhoes,
- ✓ Pond Liner or Preformed rigid pond (
- ✓ Digging tools.
- ✓ Hosepipe.
- ✓ Pond Filter.
- ✓ Pond Pump.
- ✓ Pond Plants.

Procedures of constructing earthen fish pond

1. Clearing: clear the pond area of all debris, trees, grass, stones, and stumps
2. Pegging: This is done on all the construction sites. You first mark the area for excavation with stakes indicating the depth
3. Of cut from the ground surface to the pond bottom
4. Demarcation: This should be done by pegging within the first marked areas and then the outer area depending on the size of the site and the pond you want to construct
5. Determine the gradient and mark out the water inlet and outlet
6. Remove the topsoil and set them aside
7. Dig the outlet inside the inner marked stakes
8. Build walls using loam or silt clay soil
9. Installation of drains, core trench, spillway, inlet pipes, freeboard
10. Compact walls at every 15-20cm layer to strengthen the embankment to avoid collapse when impounded with water
11. The pond bottom should slope towards the outlet/drain
12. Both inlets and outlets should be properly screened
13. Plant grasses on the dam to protect the pond from erosion
14. Provide a diversion ditch to protect the pond from flood

Maintenance

Just like the concrete pond, the earthen pond should be under maintenance so as to reduce the fish mortality rate. Below are different maintenance methods to employ:

1. Always Flush the pond to reduce turbidity
2. Liming is a must so as to regulate water pH. This process control predators, reduce silt and clay particles
3. Fertilize with chicken manure to increase natural fish food
4. Repair of leakages to reduce water seepage

5. Cleaning pond debris to reduce siltation/enhance the easy movement of fish/ enhance harvesting of fish
6. Weeding should be done always to reduce predators



Figure 2.1. Earthen fish pond

<http://hdl.handle.net/1834/34300> access date 07/05/2023

❖ Concrete (Walled ponds)

There are some essential **tools** and materials are used for concrete pond construction such as:

- Underlayment.
- Pond liner.
- Bricks or heavy rocks.
- Pump.
- Filter.
- Tubing, pipes and fittings.
- Skimmer (optional)
- Aerator (optional)

Procedures of constructing concrete pond

• Excavating the Pond

1. **Clear the area where your pond will go.** Remove any rocks and debris with a wheelbarrow. Completely uproot any trees or bushes that are near where the sides of the pond will be so that the roots won't grow through the sides of the pond.
2. **Make an outline of the shape of the pond with marking paint or a rope.** Mark the outline with a spray can or squeeze bottle of marking paint. Use a rope or cord of some kind to outline the pond if you don't have marking paint.
3. **Dig the pond out with a shovel or a front-end loader to the desired depth.** You will be able to excavate small-scale ponds using a wheelbarrow and a shovel. Hire a tractor driver with a front-end loader to excavate the pond if it is too large for you to excavate by hand.
4. **Slope the sides at a 45-degree angle.** Use a shovel or front-end loader to dig out the sides until they are at approximately a 45-degree angle. This angle will make it easiest to cover the sides in concrete

5. Dig a spillway 4–6 in (10–15 cm) below the ponds lowest edge. Find which way the pond naturally slopes. Use a shovel to dig a channel 4–6 in (10–15 cm) deep, 6–8 in (15–20 cm) wide, and at least 2 ft (0.61 m) long leading away from the side of the pond.

- Pouring the Concrete
- **Line the pond with heavy-gauge polythene sheet.** Use a plastic liner that is 0.75 mm (0.029 in) to 1.00 mm (0.039 in) thick. Cover the entire sides and base of the pond with the liner
- **Mix concrete in an electric mixer following the concrete package’s instructions.** Turn on your electric mixer and pour in the correct ratio of concrete to water. Wait until it is thoroughly mixed and there are no dry spots to start pouring it.
- **Cover the sides and base with 4 in (10 cm) of concrete.** Start with one side of the pond and work your way around. Pour the mixed concrete onto the sides and base and even it out with a shovel until there is a 4 in (10 cm) layer covering all sides.
- **Press chicken wire mesh into the wet concrete.** Use 2 in (5.1 cm) chicken wire mesh. Push the wire mesh into the freshly poured concrete and overlap the wire anywhere that 2 pieces meet.
- **Cover the wire mesh with another layer of concrete and smooth it with a trowel.** Pour or shovel another 2 in (5.1 cm) of concrete over the chicken wire. Use a hand trowel to smooth it out evenly.
- **Cover the pond with plastic sheets and let it cure for 3 days.** Spread out the sheets to cover the entire pond and anchor them down with rocks or other heavy objects. Let the concrete dry for 3 days until it is completely cured, and then remove the sheets
- **Spray on a rubber liner to seal the pond if you are using it for fish.** Use a dark-colored rubber liner, hold the can 6 in (15 cm) from the concrete, and spray it on from top to bottom. The liner will seal out the lime in the concrete that is harmful to fish



Figure. 2.2. Concrete fish pond

<https://www.youtube.com/watch?v=mIM5GoOkDk8> access date 07/05/2023

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❖ Lined ponds

Lined ponds are earthen ponds lined with an impervious material such as a plastic or rubber sheet. Pond liner is plastic for covering ponds including ponds for raising animals such as shrimp ponds, fish ponds. It helps preventing water seeping into the soil. Also, it prevents pathogens from soil mixing up in the water.



Figure 2.3. Lined ponds (plastic pond)

D. According to the construction method

1. **Dug-out ponds** are constructed by excavating soil from an area to form a hole which is then filled with water. They are usually undrinkable and fed by rainfall, surface runoff or groundwater.
2. **Embankment ponds** are formed without excavation by building one or more dikes above ground level to impound water. They are usually drainable and fed by gravity flow of water or by pumping.
3. **Cut-and-fill ponds** are built by a mix of excavation and embankment on sloping ground. They are usually drainable, and water, which is impounded within the dikes, is fed by gravity or by pumping.

E. According to the use of the pond

- a) **Spawning ponds** for the production of eggs and small fry;
- b) **Nursery ponds** for the production of larger juveniles;
- c) **Brood ponds** for brood stock rearing;
- d) **Storage ponds** for holding fish temporarily, often prior to marketing;
- e) **Fattening ponds**, for the production of food fish;
- f) **Integrated ponds** which have crops, animals or other fish ponds around them to supply waste materials to the pond as feed or fertilizer;
- g) **Wintering ponds** for holding fish during the cold season.

2.2.2. Basic pond types

There are three Basic pond types

Ponds can be conveniently grouped into three basic types depending on the way the pond fits in With the features of the local landscape.

- **Sunken Pond:**

- ✓ The pond floor is generally below the level of the surrounding land.
- ✓ The pond is directly fed by groundwater, rainfall and/or surface runoff. It can be but is not normally supplemented by pumping.
- ✓ The sunken pond is undrainable or only partially drainable, having been built either as a dug-out pond or to make use of an existing hollow or depression in the ground, sometimes with additional embankments to increase depth.

Barrage Pond

They are created in the bottom of a valley by building a DAM across the lower end of the valley. They may be built in a series down the valley.

- ✓ The barrage pond is drainable through the old river bed.
- ✓ If large floods are present, the excess water is normally diverted around one side of the pond to keep the level in the pond constant. **A diversion canal** is built for this purpose; the pond water supply is then controlled through a structure called the **Water Intake**.
- ✓ Directly fed from a nearby spring, stream or reservoir, the water enters the pond at a point called the **Inlet** and it flows out at a point called the **Outlet**.
- ✓ To protect the dike from floods, a **Spillway** should be built.

- **Diversion Pond:**

The diversion pond is fed indirectly by gravity or by pumping through a diversion canal (which becomes the Main Feeder Canal), from a spring, stream, lake or reservoir. The water flow is controlled through a water intake. There is an inlet and an outlet for each pond.

- ✓ The diversion pond can be constructed: either on sloping ground as a cut-and-fill pond; or on flat ground as a four-dike embankment pond sometimes called a **Paddy Pond**.
- ✓ It is usually drainable through a drainage canal.

Construction

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After the designing, it is necessary to prepare detailed estimates of the items of work to be carried out as per the design. The approximate cost of construction is also to be estimated.

Construction time

- The construction time of the pond is an important factor for pond management.
- If the construction of the ponds is completed in summer, the pond can be used for farming immediately for next season (monsoon).

2.2.3. Preparation of the site

The site should be cleared before the construction.

- All the bushes and small plants, etc. should be cut and removed along with their roots. The roots should be totally removed; otherwise the leakage problem will arise later on.
- If there are any trees near the construction site, it is better to cut the branches overhanging the ponds, so that the sunlight is not blocked and the leaves do not fall in the water.
- It is better to have trees near the ponds, but only 5m away from the pond.

2.2.3.1. Mark out the ponds

When the pond area is cleaned, it is necessary to mark the outlines of ponds and dykes.

- Mark out the main wall or dyke and other walls with stakes. The walls should be wide.
- Plan the depth of the pond and height of walls.
- The walls should always be at least 30 cm higher than the water level for a small pond, and at least 50 cm higher for a larger pond.

2.2.3.2. Excavation of the pond

- It can be carried out either by manual labour or by dozers (JCBs).
- The sides and bottom of ponds should be properly finished and trimmed until a good slope for drainage is made.
- The pond bottom should usually have a slope of 2-5%.
- The most important feature is to have the pond bottom slope such that the pond can be drained.
- If the pond site has a natural slope, the dyke or main wall should be constructed at the low level side.
- When the pond walls are constructed, the excavated soil can be placed on the top and planted with grass.
- This fertile top soil will root grass easily and this will help keep the walls from eroding.

- The pond bottom must be cleared by removing small rocks, roots, and stumps to prevent the nets from getting caught and torn during harvesting.

If grass is found in the pond bottom, it need not be removed, because after filling up the pond with water the grass will die and add nutrients to the water.

- When the stakes have been established for construction of dykes, about 2' top soil should be removed as it consists of large amounts of roots and other organic material.
- The core trench is cut immediately after the removal of the top soil. If the soil is porous, the seepage problem may arise at a later stage. It would be essential to provide a clay core in order to prevent seepage.
- A soil which is a mixture of sand and clay is best.
- Pure clay soil will crack and leak.
- If pure clay is to be used, it must be mixed with other soil before it can be used.
- Turf, humus or peaty soils should not be used.
- All stones, wood pieces and other material which may rot or weaken the wall must be removed before building begins.

2.2.3.3. Construction of dyke

- Construction of earthen dyke is always economical.
- Soil obtained from digging can be used to prepare the earthen dyke.
- The filling of earth should be done in layers not exceeding 20 cm in height and consolidate each layer by watering and ramming.
- The earth work for the dykes should be thoroughly compacted so that even minor seepage can be checked.
- If the fish farmer is economically sound, he can go for stone pitched dykes.
- The dykes of a pond should be strong enough to withstand weather action.
- In big ponds erosion of dykes is a problem which requires regular attention.
- Brick or stone pitching may be provided to arrest erosion of dykes.
- Earthen dykes can be protected from erosions with bamboo piling.
- Holes should be closed immediately with stiff clay mixed with lime and cementing material and should be compacted properly.
- By using concrete blocks, stones or bricks the earthen dykes will be protected more permanently from crab or rat holes.

- Side slopes of embankments depend upon the nature of material used for construction. The slopes should be flatter than the angle.
- Soil with a lot of clay in it can have a greater slope on the outside wall than on the inside wall.
- A typical embankment is built with an outside slope of 1:1 and an inside slope of 1:2.
- A slope of 1:2 means that for every increase in 2m width there is a change of 1 m in height.
- Once the embankment is constructed, it is better to plant grass on it.
- The grass roots help to hold the wall together and prevent erosion of the soil.

2.2.3.4. Drainage system

- A drainage system is used to empty the pond.
- It consists of the outlet system for letting water out of the pond and the drainage ditches which carry the water away from the pond.

Drainage of the pond water

- The best and easiest way to have a good drainage system is to build the pond in a place which provides a good slope.
- The drainage system must be built before the pond embankment because some drainage devices go through the walls.
- One of the easiest ways to drain the pond is to place a bamboo or plastic pipe through the base of the wall into the middle of the pond.
- The end of the pipe, which is inside the pond, should have a screen over it to keep fish from entering the pipe. The other end of the pipe is plugged with wood or clay. To drain the pond during harvest time, the plug is pulled out.
- Other methods of draining the ponds are the siphon and the pump.

2.2.3.5. Drainage structure of the pond

• Sluice

The sluice can be a screened gate in a water channel going into the pond or drainage gate leading water out of the pond.

- ✓ The sluice can be made of wood, cement and brick. It can be made up of one or two wooden gates which are removed to empty or fill the pond.
- ✓ A sluice also has a screen gate to keep unwanted fish from entering at the inlet and pond fish from leaving at the outlet.

- **Water inlet**

- ✓ All the ponds, except for those filled directly by a spring or by rainwater, need water inlets.
 - ✓ During the construction of inlets, filters should be used in the channel so that the unwanted fish or other materials do not enter into the pond and the water is clean.
 - ✓ A water inlet can be as simple as a bamboo pipe of good diameter running from a water source through the wall into the pond.
 - ✓ The inlet pipe should be placed above the water level.
 - ✓ A wire screen makes a good filter.
 - ✓ The horizontal screen is very effective.
 - ✓ A nylon mesh bag makes a good filter and can be fixed to the inlet pipe.
 - ✓ A sand and gravel filter is also used, but it requires a small tank at the water inlet, it is more effective and economical.
- If the water is muddy, or has plenty of leaves or grass in it, the wire screen is better.
 - If the water source is free from organic material, the mesh bag will work.
 - If the water contains unwanted fish and more organic matter, sand and gravel filters are best.

2.2.3.6. Sealing the pond bottom

- **Leaking Ponds**

One of the most common farm pond problems is heavy water loss through leakage. The ability of the pond to retain water depends largely on the characteristics of the soil at the pond site. Most leaky pond problems can and should be prevented by cautious site selection.

Before building a pond, be sure to test the capacity of the soil to hold water. Soils with a high clay content will minimize seepage since clay particles tend to swell when wet and, thereby, provide a good bottom seal.

- ✓ If the soil has more clay in it, no special sealing is needed.
- ✓ If the bottom is sandy, it should be sealed to hold the water. To seal the bottom a clay core lining is built over the pond bottom.
- ✓ Another method of sealing the pond bottom is with cement blocks, but it is expensive.
- ✓ The most commonly used pond sealant is bentonite clay. Bentonite is most effective on sandy soils that contain insufficient amounts of clay.

- ✓ For best results, bentonite should be spread evenly over the dry pond bottom at a rate of 50 lbs/100 ft (20,000 lbs/acre) mixed with the existing soil, moistened, and then compacted with a roller.
- ✓ Sealing with flexible plastic sheeting of polyethylene, or plastic or vinyl, or butyl or rubber sheet liner at least 2 mm thick is another method of sealing.
- ✓ The pond liners should be covered by at least 6 inches of sand or fine soil.
- ✓ Technique developed in the USSR, is called gley or biological plastic. In this method, the pond bottom is covered with animal manure after cleaning the bottom.
- ✓ The animal manure layer is then covered with banana leaves, cut grasses or any vegetable matter, and a layer of soil is put on it. The layers are rammed down very well and 2-3 weeks are allowed to elapse before filling the pond.

2.2.4. Preparation of pond

2.2.4.1. Preliminary or preparation stage

- **Soil sampling**

Before starting other procedures, the soil should be tested. Samples are collected from the bottom of the pond and dike. Generally, pH and organic matter contents are analyzed. pH is important to determine the amount of lime to be treated later. Soil sampling is very important, especially for the new ponds.

- **Demudding**

One of the most important steps of pond preparation is to “de-mud” the pond, which we wish to prepare. “De-mud” basically is the process of removing mud from the pond which we wish to use. The main purpose of **demudding** is to make it more suitable for fish farming. **Demudding** can be done just by removing the mud from the pond, which is the easiest way. Instead of demudding directly, we can go for deepening of our pond which is the best option for larger fishes.

- **Pond drying**

The bottom of the pond is dried to remove the unwanted fish species. Drying is done until the soil cracks. Drying also ensures the oxidization of harmful substances and mineralization of organic matters.

- **Make the dike of the pond taller**

The most common problem of the rainy season for most of the ponds is that flood can carry away fishes of the pond. So, if the pond is located in an area which is closer to the river or stream, then taller

embankment or dike is a must. It should be at least 2 to 3 ft higher than the highest level of water in the pond. This can be done very easily and automatically during the time of **digging** or **demudding**. Sand removed during de-mudding/digging can be used to make dikes taller. Otherwise, sandbags can be used to make the dikes/embankments taller.

- **Efficient inlet and outlet system:**

Efficient inlet and outlet system is very much important for the proper working of the pond system. This mostly comes in the form of a pipe through which water can enter and exit from the system. The inlet system of the pond should be placed slightly higher than the outlet system to ensure maximum water flow.

Proper inlet and outlet system prevent overflow of the pond by taking care of heavy rainfall/slight flood. This is very much helpful for the proper maintenance of water quality.

2.2.5. Pond treatment stage

- **Controlling harmful aquatic plants and animals**

Aquatic weeds and insects both are very much harmful to fish farming ponds as weeds consume almost all nutrients and reduce the amount of oxygen. Their growth should be controlled efficiently so that they cannot create any problem in the pond.

- **Removing cannibalistic and unwanted fishes**

Removal of cannibalistic and unwanted fishes is very much important step in pond preparation. Shol, gozar, boal, taki, etc. are cannibalistic fish and mola, dhela, chanda, pumpti etc. are unwanted fish. They can be removed by drying the pond or by using poison in the pond. Rotenone powder is the best option for this purpose.

- **Conditioning the pond**

Conditioning is done by application of a layer of lime or calcium hydroxide which is spread over the bottom of the pond for two weeks. It is usually applied during or after the pond drying stage. This removes the acidity of the soil, facilitates biogeochemical cycles and prevents unwanted species.

Liming can be done in three different ways:

- By broadcast over a dried pond which includes the dike walls.

- By mixing with water and spraying over the pond and
- By liming the water flowing into the pond.

- **Manuring:**

After 15 days of liming, manuring or fertilization is done in order to facilitate the growth of fish food organisms. Manure can be of organic or chemical nature. The application rate of raw cow dung for stocking pond is 2-3 tonnes/ha. The application rate of poultry manure is 5000 kg/ha. Use of chemical fertilizer depends upon the concentration of phosphorus and nitrogen in the soil and varies accordingly. The standard combination of NPK is 18:10:4 for freshwater ponds.

2.3. Set bill of quantity for construction

Bill of quantity (BoQ) in fish pond and supporting facilities

- Refer all discrepancies to the relevant professional.
- All material not in conformity with design specification and description will not be accepted/approved.
- All critical work stages should not be carried out in the absence of the relevant professional..
- All construction work to be carried out by competent skilled workers
- All steel and concrete construction should be in accordance to BS 5950.

No	Item	Description	Unit	Quantity	Rate (br)	Amount (br)
1						
a	Mobilization/Demobilization	Initial Mobilization and final demobilization of equipment, labour and materials to and	sum	1		
b	Site preparation	Clear shrubs, grasses, debris and move to a safe dumping site	sum	1		
		Total section 1				
2						
a	Preliminaries	Clear and level 35x18m (630m ³) site for the installation of 40nos of 8000 litre portable tanpaulin ponds				
b	Setting-out of Drainage	Set out as shown in the drawings.	sum	1		

c	Excavation	Excavate foundation trench to a minimum depth of 0.3m (plus 0.25m sideways to allow working space)	m ³	15		
d	Blinding	Cast 75mm blinding under block work with concrete of ratio 1:3:6. slope towards south	m ³	2.15		
e	Block work	Laying of concrete block work (150x450x230mm) ; laid stretcher bond on cement and sand mortar (1:3) as shown in the drawing	m ²	16		
f	Block wall filling	Fill block walls with weak concrete of ratio 1:3:6	sum	4		
g	Back-filling	Back-fill and compact excavated material into the block work allowance space	m ³	6.66		
h	Rendering	Internal, external and floor rendering of the drainage block walls using 1:4 mortar and gauge of 12mm	m ²	35		
i	Soak-pit	Soak-pit to be constructed as shown in the drawings to absorbed waste water into the soil	sum	1		
Total section 2						
3						
a	150mm (6") PVC storm drain pipes	Installation of 150mm PVC storm drains (with all fittings and accessories) to collect waste water	m	8		
b	50mm (2") PVC water supply pipes	Installation of 50mm PVC water reticulation pipe (with all fittings and accessories) to supply water into	m	260		
c	50mm (") PVC water supply pipes	Installation of 50mm PVC water reticulation pipe (with all accessories) to drain waste water from ponds into the drainage system	m	260		
d	50mm (") PVC water supply	Installation of 50mm PVC water reticulation pipe (with all fittings and accessories) to drain	m	260		

	pipes	waste water from ponds into the drainage system				
e	PVC ponds	Supply and install 8000 Litres portable PVC ponds (Tarpaulin) as shown of the layout drawings. Installation includes reinforcement	Pcs	40		
4		Power house				
a	Setting-out of power house	Set out generator house as shown in the drawings	sum	1		
b	Excavation	Excavate foundation trench to a minimum depth of 0.3m (plus 0.25m sideways to allow working space)	m3	15		
c	Blinding Cast	50mm blinding under block work with weak concrete of ratio 1:3:6. slope towards south	m3	8		
d	Foundation Blockwork	Laying of concrete block work (230x450mm) ; laid stretcher bond	m2	2		
e	Back-filling	Back filling of trench with selected excavated soil, including spreading, watering and compaction around the block wall perimeter	m3	2.55		
f	Laterite filling /Hardcore filling	Filling of foundation wall perimeter with laterite, including supply of material, spreading, watering, compacting in layers to achieve specific compaction density and placement of Hardcore materials not exceeding 300mm as per specifications and drawings (provisional quantity)	m3	3.83		
g	Formwork/BR C mesh for Generator House	Sawn formwork to cover foundation wall perimeter and place 4mm thick BRC (A142) wire mesh to receive over site concrete slab	sum	1		
h	Oversite	Cast plain M15 grade concrete (1:2:4);	m3	1.3		

	Concrete slab for Generator House	developing minimum 15N/mm ² working strength after 28 days of curing - with thickness of 150mm				
i	Block walls for Generator House	Laying of sancrete blockwork (230x450mm) ; laid stretcher bond on cement and sand mortar (1:3)	m ²	25		
j	Lintel for Generator House	Prepare Sawn formwork to cover sides of the block wall and place Y12 high yield reinforcement bar appropriately; Cast plain M15 grade concrete (1:2:4) for lintel;	sum	1		
	Roof					
a	2x4" hard wood (obeche) for Rafter	Rafter Supply, cut and nail full gauge 2x4" wood	Pcs	10		
b	2x3" hard wood (obeche) for Purlin	Supply, cut and nail full gauge 2x4" wood	pcs	10		
c	1x12" hard wood for board	Supply, cut and nail full gauge 1x12" wood	pcs	5		
d	Roof covering - 0.55mm thickness	Approved long span corrugated aluminium otherwise approved roofing sheets fixed to purlins with appropriate accessories in accordance with manufacturers printed instructions and as directed by the engineer	m ²	7.5		
	Door					
	1,200x2,100mm Burglary proof Door	Supply and fix Burglary proof Door with accessories of superior quality - with approved frames, architraves and set of necessary iron as approved by the engineer	nos	1		
	Rendering					
a	Rendering	Internal and external rendering of the block walls and floor using 1:4 mortar and gauge of 25mm	sum	1		
b	Painting	Apply emulsion paint - 20 litre drum	dru m	2		

c	Visibility	Placement of 2metallic visibility: IOM and donor visibility. This should be printed on A3 sized metal sheet - Sample to be approved before placemen	sum	2		
5		Water Storage tank and platform				
	Water Storage tank and platform	Construction of platform and installation of 5000 litre tank as shown	sum			
6		Contingency				
	Contingency	Allow a provisional sum as contingency amount to cover for all unforeseeable costs	sum			

Some of the Bill of quantity for the work Construction of Sedimentation Pond and Catch drain are listed below:-

- Earth work in excavation by mechanical means (Hydraulic excavator)
- Dry stone pitching 22.5 cm thick including supply of stones and preparing the surface complete.
- Providing and laying non pressure NP2 class (light duty) R.C.C. pipes with collars joined with stiff mixture of cement mortar 1:2 (1cement : 2fine sand) including testing of joints, etc. complete: 450 mm dia RCC pipe
- Providing and laying cement concrete of specified grade excluding the cost of centering and shuttering in all works up to plinth level : 1:2:4 (1cement : 2coarse sand : 4graded stone aggregates 20 mm nominal size).
- Supplying at site: RCC standards post / struts / rails / pales of mix 1:1.5:3 (1cement : 1.5coarse sand : 3graded stone aggregate 12.5 mm nominal size) with wooden plugs or 6mm bar nibs wherever required as per direction of Engineer-in-charge (cost of earth work in excavation, concrete works in foundation to be paid separately)
- Fencing with RCC post placed at required distance, embedded in cement concrete blocks, every 15th post, last but one end post and corner post shall be strutted on both sides and end post one side only, provided with horizontal lines and two diagonals of barbed wire 9.38 kg per 100 metre (min) between the two posts fitted and fixed with G1 staples of wooden plugs or GI binding wire tied to 6mm bar nibs fixed while casting the post (cost of RCC posts, struts, earth work and

concrete to be paid for separately): Payment to be made per metre cost of total length of barbed wire used: With GI barbed wire.

- Providing and fixing M.S. grills of required pattern in frames of windows etc. with M.S. flats, square or round bars etc. all complete: Fixed to steel windows by welding.
- Earth work in excavation by mechanical means (Hydraulic excavator) / manual means foundation trenches, drain not exceeding 1.5 m in width as well as 10 sqm on plan including dressing of sides and ramming of bottom, lift up to 1.5 m including getting out the excavated soil and disposal of surplus excavated soil as directed within a lead of 50 m. (All kinds of soils).
- Providing and laying cement concrete of specified grade excluding the cost of centering and shuttering in all works up to plinth level : 1:4:8 (1cement : 4 fine sand : 8graded stone aggregates 40 mm nominal size).
- Brick work with FPS bricks of class designation 50 in foundation in plinth in cement mortar 1:6 (1cement : 6coarse sand).
- Cement concrete flooring 1:2:4 (1cement : 2coarse sand : 4graded stone aggregates) finished with a floating coat of neat cement including cement slurry but excluding the cost of nosing of steps etc. complete: 40 mm thick with 20 mm nominal size stone aggregates.
- 12mm cement plaster finished with a floating coat of neat cement of mix: 1:4 (1cement: 4fine sand).

2.4. Identifying equipment, tools, materials and PPE for construction work

2.4.1. Identifying equipment, tools and materials for construction work

a/ Taking Measurements and demarcation



Info graphics 2.4. Materials used for taking measurements and demarcation

b/ Tools and equipment's for taking level

Elevation (height), distance (length) and slope are critical measurements taken continuously during construction.



Info graphics 2.5. Material used for taking level

c/ Site clearing, excavation and earth movement tools and equipment's



Info graphics 2.6. Material used for site clearing, excavation and earth movement

d/ Earth moving machinery



Figure 2.7. Earth moving machineries

e/ Compaction equipment



Info graphics 2.8. Material used for soil compaction

f/ Tools for maintaining suitable moisture content of soil during compaction














Containers, small impoundments, jerry cans, hoses and/or sprinklers for holding and conveying water to moisten pond walls during compaction.

Info graphics 2.9. Tools for maintaining suitable moisture content of soil during compaction

2.4.2. Identifying personnel protective equipment for construction work

Personnel protective equipment for construction work and their functions are discussed below:-

No.	Item of PPE	Purpose	Image
1	Gloves	<ul style="list-style-type: none"> To protect from abrasion, disposable plastic to maintain bio-security. They will provide protection against dampness, fish fins and tails, and the cold. 	
2	Boots	<ul style="list-style-type: none"> Protection against: Falling objects, Stubbing your toes, Sharp objects such as hooks and Insulated safety boots protect the feet from cold. 	
3	Goggles	<ul style="list-style-type: none"> Goggles are especially effective because they provide an airtight seal around the eye. 	
4	Respirator	<ul style="list-style-type: none"> When you wear a respirator you should choose a filter that best suits the substance you are working with. Some cover the mouth and nose only, while others include a mask and cover the entire face 	
5	Overalls	<ul style="list-style-type: none"> Use overalls to protect the body from damage due to hazardous chemicals 	

6	Sun hat:	<ul style="list-style-type: none"> Help protect only your head from sun rays. 	
7	Ear protection	<ul style="list-style-type: none"> help protect only your ear from noise sound and other hazards 	
8	Earplugs:	<ul style="list-style-type: none"> Earplugs are used to protect the ears from too much noise in the workplace 	
9	Face Shield	<ul style="list-style-type: none"> Best for general protection of the face. Commonly worn under a welding helmet. 	
10	Helmet	<ul style="list-style-type: none"> Safety hats (head Protection) should be kept free of abrasions, scrapes and nicks and should not be deliberately dropped, thrown or otherwise abused because they will lose their protective qualities. 	
11	Vests	<ul style="list-style-type: none"> Are great when hiking, bicycling, running, setting up camp or fly fishing. This is because these types of activities are vigorous enough to keep your body temperature up. 	

2.5. Preparing brief layout of fish farm

Design layout is the organization of text and images on a web page, poster, book or two-dimensional page. Web designers and graphic designers apply graphic design principles and typography to organize, or lay out, the contents of a page. Composing a design layout also helps organize the text and images into a easily understood hierarchy of information.

2.5.1. Components and layout plan of pond system

Fish farm layouts that are properly engineered should strike a balance considering economy, functionality and aesthetics. Within a prescribed production management scheme, the layout must be economical. The basic principle is to minimize the number of gates, and the size and length of the main secondary and tertiary dikes and canals. But this should not sacrifice the biological requirements for suitable environment of the cultured species.

Fishponds should be planned in such a way that the length of the pond is positioned parallel to the prevailing wind direction. The wind direction in Southeast Asia is shown in figure 2.4. and the suggested orientation of the ponds, As such, the length of dike exposed to wave action is lessened, thus, the cost of repairs also less. The position also takes advantage of the wind energy in effecting good water aeration through mixing and circulation. However, in areas where very strong winds are prevalent, wind breakers are included in the design and layout of ponds.

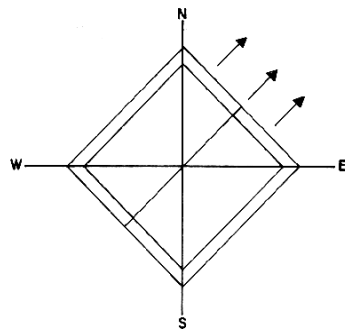


Fig. 2.4. Layout of pond compartments oriented to the prevailing wind direction

2.5.2. Components of a fish farm

In general, the fish farm is an establishment which is composed of pond system and support facilities. The pond system usually consists of various compartments with specific uses such as nursery or fry pond, transition or holding stunting pond, production or rearing ponds and other features (catching, desilting food-growing ponds, etc.). Also a part of the system are the water control structure or gates, pipes or culverts and water supply or drainage canals. Each of these units should be properly located and fitted in the system in order to have ease in water management and manipulation of cultured stock.

On the other hand, support facilities consists of farm buildings, farm roads and road dikes, bridges, fish tanks, storage shed (for feed and equipment), chilling tanks, and other ancillary structures. Efficient

organization of support facilities in relation to the pond system is of paramount significance in the overall developmental planning and operation of the farm.

Fish farms are located at convenient distance from the sea or river. In the Philippines, a sanctioned buffer zone of at least 100 m from the sea to the main perimeter dike and 20 m along river banks is spared for ecological consideration as well as physical protection against flooding and wave action. The required buffer zone along the shoreline in Indonesia is 400 m.

2.5.3. Types of pond compartments

Existing fishpond layouts, especially for a milkfish farm may have all or just a number of the following compartments depending on the layout requirements as dictated by the management scheme and cultured species.

1. Fry acclimatization pond

Sometimes called fry box this is the smallest unit in a pond system usually 4 to 8 m². Fry are first stocked in this pond for 1 to 4 days and then allowed passage to the nursery pond proper by just cutting open the small dike partition.

2. Nursery pond

The nursery pond is small in size, about 1 to 4 percent of total production area and usually square or rectangular in shape. It may be a single pond unit or made up of two, four, six, etc. sub-compartments which form the whole nursery unit. A manageable area ranges from 500 to 10 000 m² per compartment, although 1 000 to 5 000 m² is preferred.

The nursery is used for rearing the fry for at least 30 days (in the case of milkfish) before transferring into another larger pond. Rearing the fish in small area is more convenient and safer as it can be watched more closely and taken cared of more adequately.

Nursery pond should be located in elevated portion of the farm in the central or near the corner of a rearing pond compartment. The most suitable place is where it can be easily supplied with new unpolluted water at all times when necessary and at elevation where it can readily be drained even during ordinary low tides.

Avoid locating nursery ponds directly adjacent to perimeter dikes. Crab holes and leaks that might occur during the rearing period will serve as exits of fry from the nursery pond to the river. These can also

serve as entrance for predators and unwanted species into the nursery pond, causing further loss of stock. From the nursery pond the fry is moved into the transition pond or directly into the rearing or production ponds.

3. Transition pond

The transition, holding or stunting pond is located adjacent to the nursery pond in order to have efficient and quick transfer of fingerlings. Depending on the management scheme, close to 10 percent of the total production area is usually allocated for this purpose. The fingerlings or post-fingerlings are reared here for varying periods before finally stocking them in the production or rearing ponds. The fish can be retained in the transition pond longer or up to a few months especially when the number of fry stock is sufficient for several cropping within the year. A manageable area for transition ponds ranges from 1 000–20 000 m² per compartment but 5 000–15 000 m² is preferred.

4. Production or rearing pond

This is also called grow out pond. It is the largest compartment in the pond system occupying about 80 percent of the total farm area.

The bottom elevation of the rearing pond should be about 0.2 m lower than that of the transition pond but slightly higher than the Mean Lower Low Water (MLLW) or zero tidal datum. The pond bottom slopes toward the catching pond or water supply canal to facilitate harvesting of marketable-sized fish. A manageable size ranges from 1.0 to 10 ha per compartment although 2.0 to 5.0 ha is preferred. Production ponds for milkfish of 15 to 20 ha per compartment is common in the Philippines.

5. Catching pond

This pond serves as a concentration area or basin for the fish during harvest. It is constructed adjacent to the gate inside a bigger pond compartment. Catching ponds may be provided also for nursery ponds, transition ponds, and rearing ponds. The catching pond for the nursery and transition ponds is usually about 2 percent of the respective compartments' water surface area; for rearing pond, it is usually 1–1.5 percent.

6. Food growing pond

This pond is optional and may be built, if deemed necessary. Named “kitchen pond”, it is a compartment set aside for growing live food organisms at high density. this is a recent innovation and is intended to

augment the availability of food in fishpond areas where natural food organisms does not grow well or in farm set-up where high density stocking of cultured fish is used.

2.4. Layout of pond system

The simplest form of pond layout is that of a single compartment. More recently, improved layouts consisting of multiple combinations of compartments have come to general use. Through the years of experience in pond fish production the pond operators have evolved and developed the arrangement and relative proportion of the various pond compartments that would fit into the system together with the appropriate production management scheme.

a. Suitability of layout for cultured species

Pond layouts may be grouped into:

- (i) Conventional;
- (ii) Radiating;
- (iii) Modular or progression; and
- (iv) Multiple stock/harvest pond system

Examples of these layouts are shown in Figs. 2.14 to 2.15 and 2.16 and 2.17. All of these, however, are intended for milkfish production and in general maintain shallow water that is required by fish food called “lab-lab” (a complex community of micro-benthic biota closely associated with pond bottom). However, combination of deep-water for plankton production and shallow water for lab-lab production is also being practiced. The basic characteristics or differences of these layouts are shown in Table 2.1.

Table 2.1. Comparison of various layouts of fish ponds

S no.	Layout scheme (production: kg/year)	Nursery pond	Transition pond	Rearing pond
1.	Conventional (1 000–2 000)	1 percent of total production area	9 percent of total production area	80 percent ¹ of total production area
2.	Radiating	1 percent of total production area	9 percent of total production area	80 percent ¹ of total production area
3.	Modular (1 800–3 000)	4 percent	6 percent	80 percent ¹ ; there are three production process stage; each stage follows a ratio 1:2:4 or 1:3:9 (Figs. 4.6, 4.17 and 4.18)
4.	Multiple	6 percent	No transition pond; instead	

	stock/harvest (1 000–2 000)		holding canal for fingerlings is allocated for each rearing pond; 19 percent of every rearing pond	
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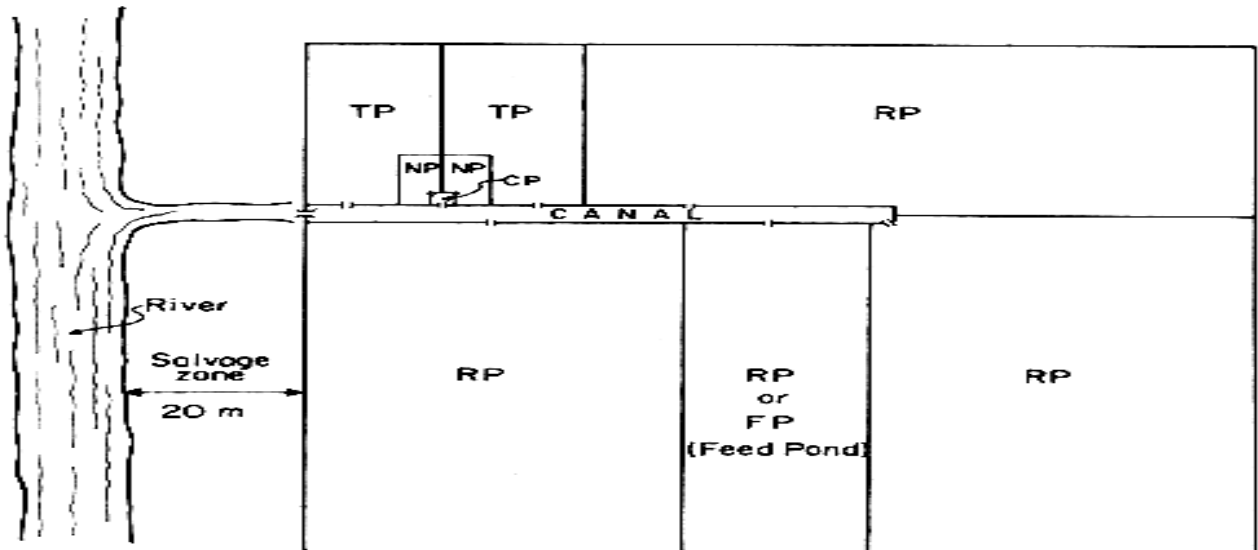


Figure 2.5: A conventional pond system with catching pond (CP), nursery pond (NP), transition pond (TP), feed pond (FP) and rearing pond (RP)

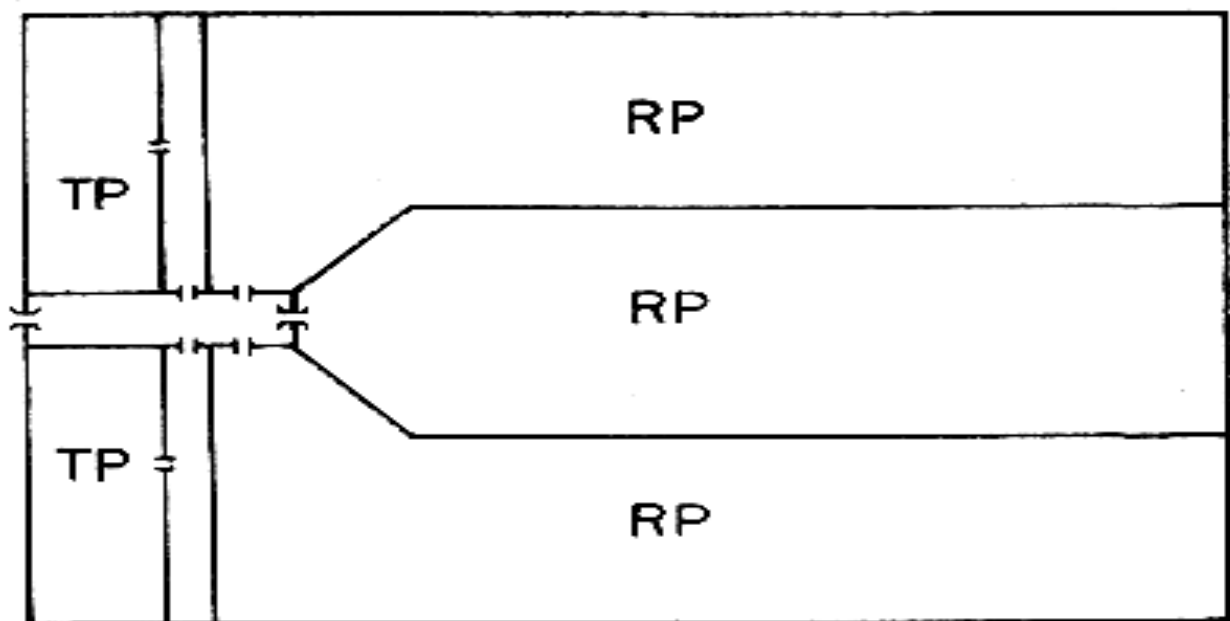


Figure. 2.6: Radiating type layout showing transition pond (TP) and rearing pond (RP)

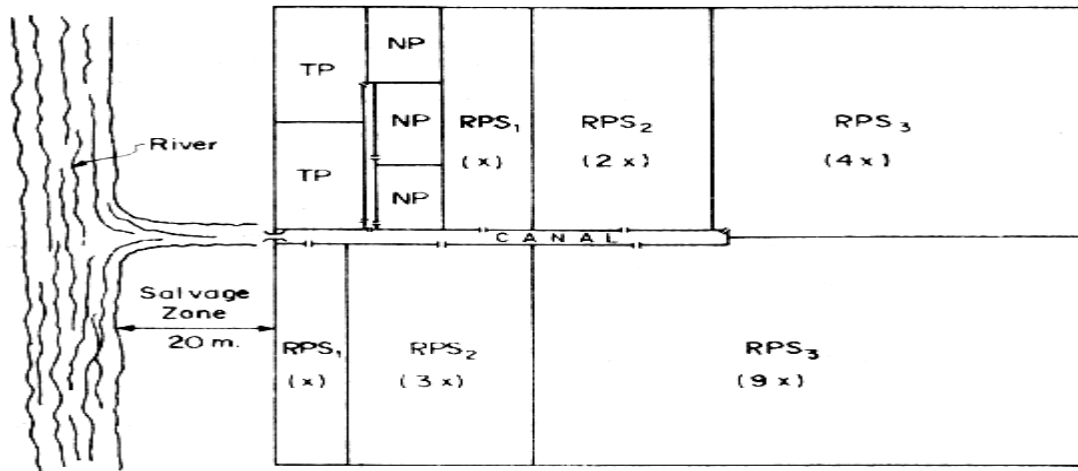


Figure. 2.7: A modular pond system in the Philippines showing rearing pond stages (RPS) with ratio of 1:2:4 and 1:3:9

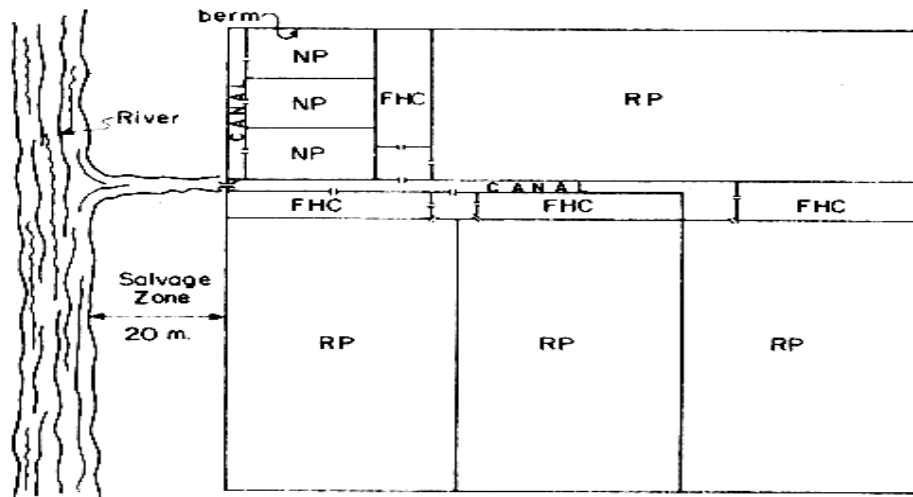


Figure. 2.8: Layout of a farm by multiple stock/harvest system showing fish holding canal (FHC) as added feature

b. Layout appropriate for prescribed management method

The requirements of the cultured species is always the basis for planning the layout and formulation of management scheme. Within limits, however, management techniques can be manipulated to enhance production without affecting the normal growth of species.

The modular or progression system is a typical example of a layout wherein the management scheme involving fish movement in the various compartments are prescribed. In this system, specified number of milkfish fingerlings from the transition pond are stocked in the smallest production pond, then moved to the next bigger then to the largest pond. Movement of fish in each production pond stage can vary but is

usually done in about 30 to 45 days. When inputs and conditions for normal growth exist, by this time the weight of fish stock has at least double, hence, movement to an area twice as large than where the fishes are, is logical. This enables the fish farmer to make four to six harvests per year with food growing period of 2 to 4 weeks between crops.

The multiple stock harvest system involves stocking of two to four different size groups of fish at different times in the pond. After 20 to 45 days, the large ones are harvested by gillnet or by netting selectively the fish swimming against the current during water inflow known as “pasubang” method in the Philippines. Another batch of small fish replaces the harvested ones. Repeated harvests, thereafter, is done every 30 to 50 days.

Because of this prescribed management method, fish holding canal (FHC) for each rearing pond is added in the layout, instead of transition pond. This is to insure availability of designated size(s) of fish for the rearing of ponds .

Another example is a flow through system of shrimp culture. The rate of water exchange is regulated depending on the density of stocking. Water must be available any time irrespective of the tide cycle; hence, a combination of pump and reservoir system (using a head pond) or just a pump system should be provided. Gates and canals are also strategically located to effect good movement and circulation of water.

c. Location of gates and water supply/drainage canals

When necessary such as in intensive shrimp monoculture farms, each pond compartment should have individual water supply and drainage outlets to make them independent from each other (Fig. 4.13). The location of water control gates depends primarily on the water management scheme. In general, main gates and secondary gates are positioned where entrance and circulation of water could be most efficient. Ordinarily, a single gate per pond connected to a canal provides passage for tidal inflow and outflow. In a flow through system, two gates located in opposite ends of the ponds are required.

Although slightly expensive, narrow rectangular slope is desirable from the viewpoint of effective water exchange. Likewise, separate canals that accommodate inflow and outflow of water from the gates are provided. Canals should be located where it could connect or serve the most number of pond compartments. The lengths of canals should be minimized without sacrificing the functionality of the

pond and intended management scheme. Water control gates and canals that are properly located provides ease in water management and reduces operational costs.

d. Other facilities/features in pond system

- **Peripheral, central or diagonal ditch**

The desirable temperature for milkfish and shrimp ranges from 27 to 32°C and 28 to 30°C, respectively. During the dry season, the water temperature may increase, especially in the shallower part of the pond. Providing canals inside pond compartments deeper than the general pond bottom remedies the situation and serves as a hiding place for shrimp during critical pond condition. These canals are also suitable in milkfish ponds with generally shallow water, where polyculture with shrimp is desired. The ditches can vary from 0.5 to 1.0 m in depth.

- **Division pond**

The use of division pond is popular in Indonesia. this compartment distributes the tidal inflow to the various ponds and provides independence in the operation of individual pond compartment. It is a common feature for rearing ponds (Fig. 4.5) and even in nursery farm systems.

- **Reservoir pond**

This is appropriate for the flow through system in shrimp culture. The pump raises the level of water in the reservoir even during low tide so that gravity flow through in the rearing pond of shrimp can be effected.

- **Sedimentation basin**

This may be located near the water source before incoming tide enters the ponds. It is intended to settle suspended solids carried by the inflowing water.

- **Chilling tank**

Wooden or concrete tanks with capacity of 1 to 5 tons are usually constructed near the catching pond. Newly harvested milkfish are dumped and immediately covered with crushed ice to chill them to preserve their quality and freshness. This serves also to wash the fish and reduce bacterial growth.

- **Road system**

It is advisable to have road system which should reach at least the main gate and catching ponds for easy and cheap transportation. This can reduce marketing cost.

- **Housing site**

Some space is to be set aside for houses of persons employed and as storehouses for feeds, equipment and other fish farm materials.

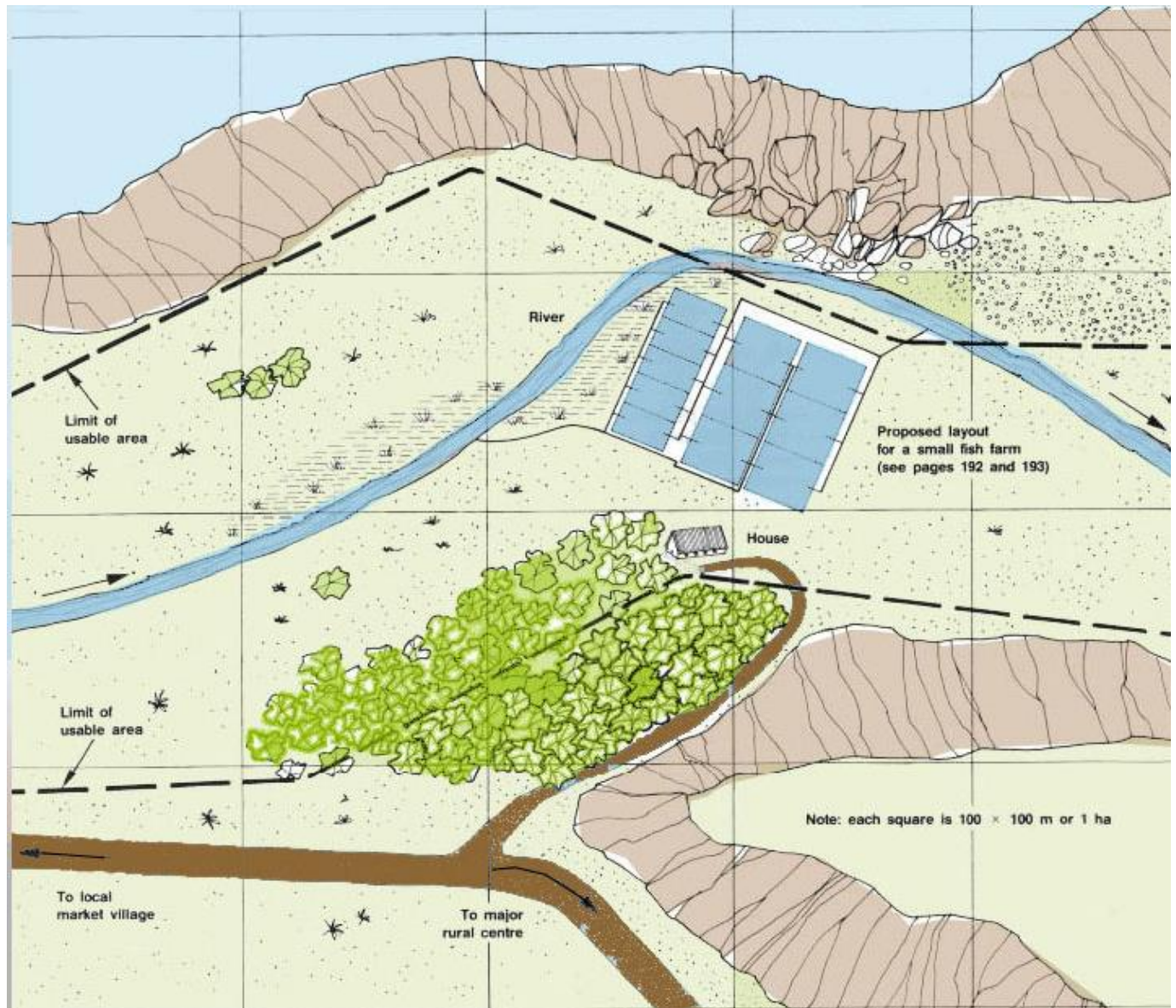


Figure 2.9. Layout of pond system

Self-check – 2

Written test

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Multiple choices

- is governed by the combined requirements of operation and the particular site conditions.
 - The layout of the site
 - Construction of bottom
 - Excavation
 - All
- Which one is Preparatory work in construction work plan
 - General Technical Data
 - Hydrological and Meteorological Data
 - Water Quality Data
 - All
- The data obtained by soil explorations should be suited to estimate:
 - Seepage Losses
 - Stability Of The Dikes
 - The Required Degree Of Compaction
 - The Foundation Of The Structures.
 - All

Test II: Short Answer Questions

- Write composition of the feed water should be subject to quality analysis.
- List factors that determine the final size of a fish farm.

Test III: Matching

	A			B
1.	Fattening ponds,	Answer	A.	For holding fish during the cold season
2.	Wintering ponds.		B.	For holding fish temporarily, often prior to
3.	Nursery ponds		C.	The production of eggs and small fry
4.	Storage ponds		D.	For the production of food fish;
5.	Spawning ponds		E.	The production of larger juveniles

Operation Sheet -2

2.1. Steps to develop a construction work plan

a/ Materials tools and equipment's in construction work plan

- Note book
- Pen
- Pencil
- Calculator

b/ Steps/procedures

- Identify key resources.
- Draft an initial plan.
- Meet with key stakeholders.
- Assign responsibilities.
- Track your performance.
- Evaluate the project.
- Close out the plan

2.2. Techniques of constructing earthen fish pond

a/ Materials, tools and equipment's used in earthen pond construction:-

- a spade and shovel,
- a level, measuring tape, and a rake,
- Skid-steers and backhoes,
- Pond Liner or Preformed rigid pond (
- Digging tools.
- Hosepipe.
- Pond Filter.
- Pond Pump.
- Pond Plants
- All necessary PPE

b/ Procedures/steps

1. Clearing: clear the pond area of all debris, trees, grass, stones, and stumps
2. Pegging: This is done on all the construction sites. You first mark the area for excavation with stakes indicating the depth
3. Of cut from the ground surface to the pond bottom
4. Demarcation: This should be done by pegging within the first marked areas and then the outer area depending on the size of the site and the pond you want to construct
5. Determine the gradient and mark out the water inlet and outlet

6. Remove the topsoil and set them aside
7. Dig the outlet inside the inner marked stakes
8. Build walls using loam or silt clay soil
9. Installation of drains, core trench, spillway, inlet pipes, freeboard
10. Compact walls at every 15-20cm layer to strengthen the embankment to avoid collapse when impounded with water
11. The pond bottom should slope towards the outlet/drain
12. Both inlets and outlets should be properly screened
13. Plant grasses on the dam to protect the pond from erosion
14. Provide a diversion ditch to protect the pond from flood

2.3. Techniques of constructing concrete fish pond

a/ Materials, tools and equipment's used in concrete fish pond construction

- Underlayment.
- Pond liner.
- Bricks or heavy rocks.
- Pump.
- Filter.
- Shovel
- Tubing, pipes and fittings.
- Skimmer (optional)
- Aerator (optional)
- All necessary PPE
- bull dozer
- excavator
- spade

b/ Procedures of constructing concrete pond

- **Excavating the Pond**
- ✓ **Clear the area where your pond will go.** Remove any rocks and debris with a wheelbarrow. Completely uproot any trees or bushes that are near where the sides of the pond will be so that the roots won't grow through the sides of the pond.
- ✓ **Make an outline of the shape of the pond with marking paint or a rope.** Mark the outline with a spray can or squeeze bottle of marking paint. Use a rope or cord of some kind to outline the pond if you don't have marking paint.
- ✓ **Dig the pond out with** a shovel or a front-end loader to the desired depth. You will be able to excavate small-scale ponds using a wheelbarrow and a shovel. Hire a tractor driver with a front-end loader to excavate the pond if it is too large for you to excavate by hand.

- ✓ **Slope the sides at a 45-degree angle.** Use a shovel or front-end loader to dig out the sides until they are at approximately a 45-degree angle. This angle will make it easiest to cover the sides in concrete
- ✓ **Dig a spillway 4–6 in (10–15 cm) below the ponds lowest edge.** Find which way the pond naturally slopes. Use a shovel to dig a channel 4–6 in (10–15 cm) deep, 6–8 in (15–20 cm) wide, and at least 2 ft (0.61 m) long leading away from the side of the pond.
- **Pouring the Concrete**
 - ✓ Line the pond with heavy-gauge polythene sheet. Use a plastic liner that is 0.75 mm (0.029 in) to 1.00 mm (0.039 in) thick. Cover the entire sides and base of the pond with the liner
 - ✓ Mix concrete in an electric mixer following the concrete package’s instructions. Turn on your electric mixer and pour in the correct ratio of concrete to water. Wait until it is thoroughly mixed and there are no dry spots to start pouring it.
 - ✓ Cover the sides and base with 4 in (10 cm) of concrete. Start with one side of the pond and work your way around. Pour the mixed concrete onto the sides and base and even it out with a shovel until there is a 4 in (10 cm) layer covering all sides.
 - ✓ Press chicken wire mesh into the wet concrete. Use 2 in (5.1 cm) chicken wire mesh. Push the wire mesh into the freshly poured concrete and overlap the wire anywhere that 2 pieces meet.
 - ✓ Cover the wire mesh with another layer of concrete and smooth it with a trowel. Pour or shovel another 2 in (5.1 cm) of concrete over the chicken wire. Use a hand trowel to smooth it out evenly.
 - ✓ Cover the pond with plastic sheets and let it cure for 3 days. Spread out the sheets to cover the entire pond and anchor them down with rocks or other heavy objects. Let the concrete dry for 3 days until it is completely cured, and then remove the sheets
 - ✓ Spray on a rubber liner to seal the pond if you are using it for fish. Use a dark-colored rubber liner, hold the can 6 in (15 cm) from the concrete, and spray it on from top to bottom. The liner will seal out the lime in the concrete that is harmful to fish

LAP Test-1	Performance Test
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Name..... ID.....

Date.....

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **6 hour**. The project is expected from each student to do it.

Task 1: Perform construction of earthen pond for fish farming

Task 2: Perform construction of concrete pond for fish farming

Task 3: prepare a construction work plan for establishing fish farm.

LG #8

LO # 3- Construct fish farm

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Occupational health and safety regulation
- Measuring, Cleaning and excavating site
- Position and construct farm structures
- Fish farm infrastructure
- Water supply and disposal systems
- Assembling and fixing fixtures and fittings
- Stock culture structure

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Occupational health and safety regulation
- Measure, Clean and excavate site
- Position and construct farm structures
- Fish farm infrastructure
- Water supply and disposal systems
- Assemble and fix fixtures and fittings
- Stock culture structure

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet-3

3.1. Occupational health and safety regulation

3.1.1. Common hazards in aquaculture

The occupational health and safety includes

- Operating power tools and equipment
- Using load shifting equipment
- Manual handling
- Using chemicals and/or toxic substances
- Excavations
- Exposure to sun

The rapid growth of the aquaculture sector has meant that policy and regulation is often lagging. While many studies have focused on the environmental impacts of aquaculture farms, far fewer have focused on the OH&S risks to aquaculture workers, particularly for low- and middle-income countries (LMICs). This is a significant oversight, with more than 20 million workers in the aquaculture industry globally, with a large proportion in LMICs. OH&S hazards in aquaculture have been categorized as falling into six categories covering safety, physical, chemical, biological, ergonomic, and psychosocial aspects (Table 1).

Table 1: Common aquaculture hazards in aquaculture activities

Hazard category	Causative agents / processes
Safety	Slips and trips, falls, needle-sticks, unprotected machinery, electricity, diving,
Physical	Heat and cold, vibration, solar radiation, noise
Chemical	Sensitizers, irritants, antibiotics, toxic gases
Biological	Sharp teeth, spines, poisonous insects, snakes, allergens, microbes, fish feed,
Ergonomic	Heavy lifting, prolonged standing, awkward postures, repetitive motion,
Psychosocial	High demand-low control situations, shiftwork, remote locations and lone work,

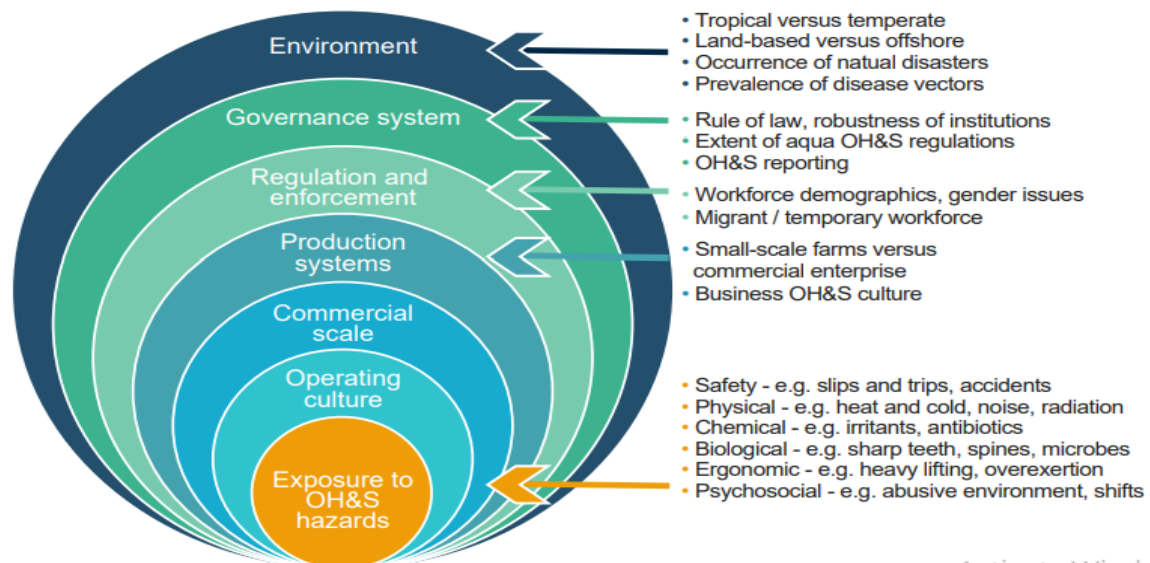


Figure 3.1. Occupational health and safety in the aquaculture industry – a global review

3.1.2. Leading indicators of aquaculture health and safety risks

Indicators of aquaculture OH&S risk can be categorized in a number of ways, particularly where attempts are made to identify the root causes of particular types of OH&S accidents or incidents such as falls, cuts, drowning's, etc. This review aimed to identify the higher-level indicators that influence the risk landscape of health and safety in aquaculture settings.

However, currently there is only very limited evidence that supports any of these indicators and further investigation is needed to explore how these factors interact with one another to drive OH&S risks in aquaculture and the risk outcomes (see Figure 6 for suggested framework).



Info graphics 3.1: Conceptual framework for how different indicators combine to form the degree of exposure to OH&S hazards (i.e. the risk).

From the country profiles, it is hypothesized that the seven following factors will have the greatest influence on aquaculture OH&S outcomes (in no particular order):

- **Country governance** – robustness of institutions, rule of law, and extent of corruption will influence to what level development of the aquaculture sector is socially (and environmentally) responsible.
- **Country regulations and implementation** – a robust inspection system could be an important aspect i.e. a sense of enforcement and consequences for poor practice. Lack of any regulation or consequences likely driving risks of non-compliance.
- **Production system type and pace of aquaculture development** – particularly where this includes the adoption of new technology and exploitation of new environments.
- **Commercial large scale versus small scale** – For commercial / large scale, in countries with poor regulation/enforcement, indigenous investors may be less concerned about compliance, external investors with CSR22 already defined and brand value / reputation will be more interested in compliance and using their own models for this, where it does not exist.
- **Environment** – extremes and how dynamic it is. Climate change will drive unpredictability of local weather events and probably escalate/amplify known events such as typhoon seasons. Some areas will be more vulnerable to natural disasters such as earthquakes and associated tsunamis, also tropical storms and hurricanes.
- **Social-cultural factors** – modern, stable regimes more likely to be lower risk and then developing, politically unstable regimes. Attitude to migrant/displaced people/attitude to rural, marginalized, lower educated makes them more vulnerable to the risk of exploitation.
- **Extent of safety systems and third-party certification** – formal safety management systems (e.g. ISO 45001) provide organizations with a framework through which they can pro-actively improve health and safety performance as verified via third-party certification. Additionally, employee OH&S criteria (and worker welfare) is becoming a key part of the various international aquaculture third-party certification schemes. The use of certification standards is skewed towards the larger, better resourced organizations although there are improvement models that aim to support small farm holdings. It is plausible to assume that countries where these schemes have greater penetration will have improved OH&S outcomes.

3.1.3. Country regulations and implementation

From this review, most countries have developed a legal framework for OH&S at some scale. Countries that have defined clear policies and established implementation measures, such as inspectorates and

enforcement tools, may see greater success in developing and improving OH&S across all sectors, including aquaculture; but where policy or political will is undefined, there are examples of inadequate resource allocation and /or corruption which results in ineffective implementation.

3.1.4. Pond Safety

Ponds, like any body of water, attract people so that there is always a chance of injury or drowning. You may be planning to build a pond for watering livestock, irrigation, or any of the other purposes discussed in this handbook, but your family and friends may want to picnic beside the pond or use it for fishing, swimming, boating, or ice skating, and you can never tell what a small child passing by may do. Your pond can become a source of pleasure as well as profit but only if it is safe. To prevent injuries or drowning's and to protect yourself financially you can take some of the following steps.

Before Construction

Almost all states have laws on impounding water and on the design, construction, and operation of ponds. In many states small farm ponds are exempt from any such laws. You should become familiar with those that apply in your state and be sure that you or your engineer complies with them. Find out what your community or state laws are regarding your liability in case of injury or death resulting from use of your pond, whether you authorize such use or not. This is particularly important if you intend to open your pond to the public and charge a fee for its use. You may find that you will need to protect yourself with insurance. You should decide how the water is going to be used so that you or your engineer can plan the needed safety measures before construction starts. For example, if the water is to be used for swimming, guards over conduits are required. You may wish to provide for beaches and diving facilities; the latter require a minimum depth of about 10 feet of water.

During Construction

There are other safety measures that your contractor should take during pond construction. Remove all undesirable trees, stumps, and brush. Remove all rubbish, wire, junk machinery, and fences that might be hazardous to boating and swimming. Eliminate sudden drop offs and deep holes.

After Completion

Mark safe swimming areas and place warning signs at all danger points. Place lifesaving devices such as ring buoys, ropes, planks, or long poles at swimming areas to facilitate rescue operations should the need arise. Place long at ice skating areas for the same planks or ladders reason.

3.2. Measuring, Cleaning and excavating site

3.2.1. Construction Site Clearing and Excavation

After the layout of the structure is set accurately, the excavation work begins and the soil is removed to a required depth in which the foundation of the structure is placed. There are various types of machinery used to excavate and transport soil at project site.

After selecting the site for the fish pond, it must be cleared of all trees, roots, stumps, grass, bushes, rocks, ant hills and all such matter. Selecting the right site and constructing your pond correctly determine to a large extent the success of your fish farm.

Tree roots, stumps or grass roots if left in the site. Will rot as time goes on when the pond is full. The rotting, stumps and roots then causes weak points through ,i which water will leak from your ponds.



Figure 3.2. Clearing in preparation/or the pond

- **Marking Out Your Pond with Pegs**

A pond can be of any shape. However, a rectangular' pond is recommended because:

1. In terms of maintenance it is more cost effective.
2. It is easier to 'harvest a rectangular pond with a seine net.
3. It is easier to build.

- To mark out your pond you need pegs and string

Measure and mark out the area you have chosen. Place the pegs at the corners and run the string between the pegs to show where the outside of the banks will be.

Remove about 20 cm of top soil from the area within the demarcation. Pile this soil outside the string. The top soil is fertile. It should later be used to cover the top and outer dykes of the pond before planting grass.

Now mark a smaller rectangle within the bigger using pegs as before. The edges of the smaller rectangle should be one meter from the outer one. The inner rectangle forms the actual pond base line. The one meter distance makes the slope of the pond wall.

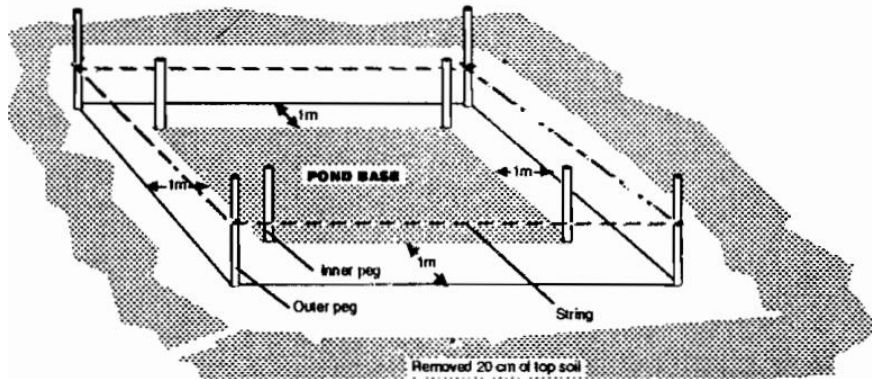


Figure 3.3. Rectangles of the pond

2.2.1. Excavation of the Pond

4. The Pond Floor 1, an excavated earthen pond should gradually deepen toward the outlet from the inlet. The gradient of this slope should be 2% to 4%. This facilitates the drainage of the pond.
 - The inlet of the pond should be nearest to your water source, and the outlet. Opposite the inlet.
5. Start excavating (digging out the earth) from the smaller rectangle at the deeper end, that is the outlet. Dig out about 1 meter to 1 1/2 meters (approximately waist level) at this end. Gradually reduce the depth to about 1/2 to 3/4 meters as you progress towards the inlet (approximately knee level). As you dig out the earth, pile up this soil outside the outer (bigger) rectangle.
 - The required pond depth varies according to the '~" M species being farmed. However. An average W depth of 3/4 meters to 1 1/2 meters is generally, recommended or all species.

Steps of Fish Pond Construction in general

- Reconnaissance survey: Visit to the site of the project to get first-hand information.
- Land clearing: The removal of the vegetation on the site.
- Land mapping: It is marking of the specific area for specific structure
- Excavation: It is the earth removal for specified structure e.g. pond, channel etc.
- Construction of associated structures e.g. monk, slice gate etc.
- Pond dressing: It the smoothening of the dykes to look good.
- Grassing: It is the planting of grasses on the dykes to prevent soil erosion.
- Pond impoundment: It is the introduction of water into the pond.

2.2.2. Design calculation: -

- Dyke slope: 50% (0.5)
- Bottom slope: 1% (0.01)

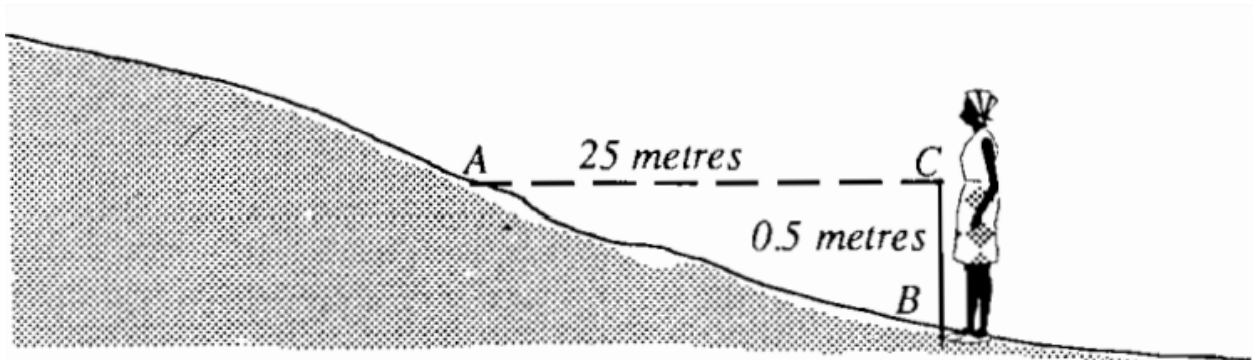


Figure 3.4. Determining slope of landscape.

Slope = $0.5 \div 25 = 0.02$ $0.02 \times 100 = 2\%$ B to C - is 0.5 meters A to C- 25 meters (tape measurement or pacing out) The slope between B and A is 0.5 meters divided by 25 meters ,which is 0.02 or 2%. Therefore the slope is 2%

The above exercise is repeated throughout the area to be surveyed in order to give a complete picture of the potential site's landscape.

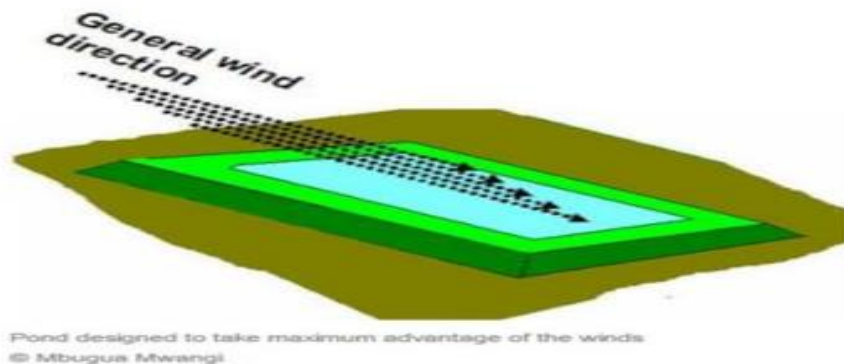


Figure 3.5. Pond Design to take maximum merit of the winds

3.3. Positioning fish farm structures

Land elevation and flood level are important factors in determining the suitability of the area for the construction of a fish farm or hatchery. The land should be free from deep flooding; the maximum flood level for the past 10 years should not be higher than the top of the dikes. Fishponds should be planned in such a way that the length of the pond is positioned parallel to the prevailing wind direction.

A location that receives all the morning sun, but shaded from the hot afternoon sun is ideal. You will want to sit and watch your pond, so one that you can be viewed from your favorite sitting position either from within the garden, or from a window inside your house will increase your enjoyment.

The pump should be positioned at the bottom of the pond yet within easy reach for maintenance. A top tip is to attach cord or rope to the pump so it can be easily lifted out of the pond - never lift a pump by its electrical cable as this is dangerous.

3.4. Fish farm infrastructure

Fish-farming structures means water reservoirs as well as the structures and facilities intended for servicing them and for the rearing and growing of fish. Aquaculture containment structures may include intake reservoirs, supply channels, production ponds, discharge channels and water treatment ponds. The most common type of aquaculture is farming in net pens or cages anchored to the sea floor in the ocean near the coast.

Fish farm infrastructure may include

- Pond
- Storage
- Buildings
- Fence and security system
- Communication and electricity facilities
- Aquaculture lab
- Jetties
- Tank
- Pump
- Tap water

3.5. Constructing water supply and disposal systems

Major constraints to aquaculture development are shortages of suitable land and water space and pollution problems. Rapid urban development in the new territories has increased land values leading to the conversion of freshwater fish ponds for residential development or their use as open storage sites for containers.

Water supply and disposal system (for closed or semi-closed structures only) may include the following :

- Intake structure support screens
- Channels, canals, or trenches (can be earthen, concrete or plastic lined)
- Road banks
- Spill ways
- Siphon, including reducing diameter pipes
- Hose
- Pipes (can be metal, PVC, rubber, concrete or polyethylene/ polypropylene) pressure or sewage rating

- Sumps
- Pumps, bores, windmills
- Storage dams or reservoirs
- Sediment dams
- Sprays
- Flow meters, pressure gauges
- Float switches, solenoids
- Header tank
- Settlement tank
- Non-return mechanisms
- Depth gauges
- Sieves, filters or other mechanical, chemical or
- Biological treatment structures
- Flow control devices (taps, valves, float valves, monks, dykes, weirs, gates).

3.5.1. The outlets

- The outlet is to let water out of your pond. It should be placed at the lower end of the deepest part of the pond.
- Dig a center ditch to the outside of the pond of about 50 cm wide.
- There are several kinds of outlets. Select one according to your need and ability.

a/ Simple outlets can be made from:

1. A plastic (PVC) or metal pipe
 2. A heavy piece of bamboo
- The outlet pipes should be long enough reach through the bottom of the dyke from the inside to the outside.
 - If need be, pieces can be joined together to form leak proof- joints. The joints should be straight in order to ensure the smooth flow of water.
 - Dig up the bank where the outlet is to be. Lay down the pipe. Cover it up with soil. Compact the ground above the pipe.

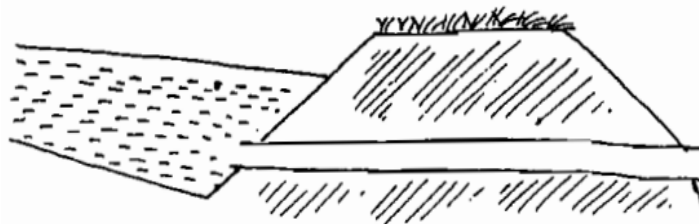


Figure 3.6. Simple outlets.

b. A sluice is a special kind of outlet made of brick and or concrete. It is more expensive than the former:

1. Using brick and concrete, make the framework shown in the diagram.

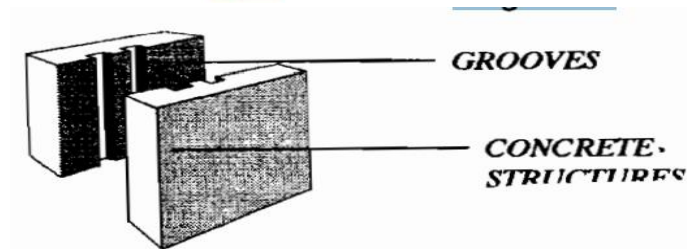


Figure 3.7. A sluice .

2. In the grooves. Place planks of timber above each other.

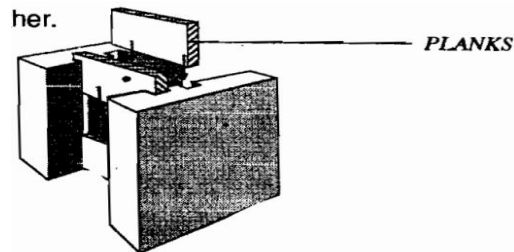


Figure 3.8. Simple outlets with planks .

- Compact the space between the timber planks with clay in order to make it leak proof.
- c. **A MONK:** In addition to brick and concrete, piping is required to make a monk. There are two versions to the monk as is illustrated below. A monk also serves as an overflow. It is most suitable for draining large ponds

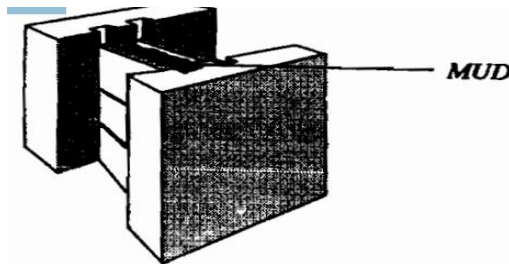


Figure 3.9. Simple outlets with a monk made by mud .

- A tall box, similar to a sluice made out of brick, concrete or timber can be used. At the bottom of the box, a pipe is placed to let out water.

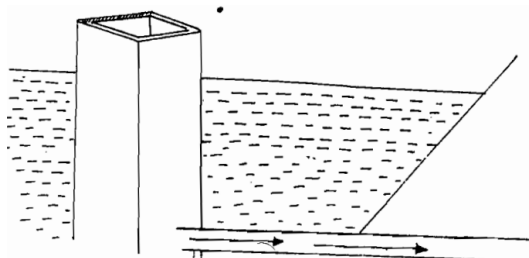


Figure 3.10. Sluice made out of brick

This structure can be taken advantage of when cropping ponds.

Instead of the box or **sluice a pipe** is used. This pipe is connected with an elbow joint to the pipe lying horizontally on the floor.

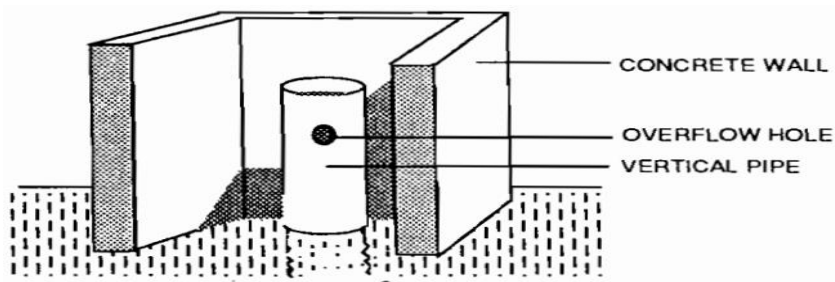
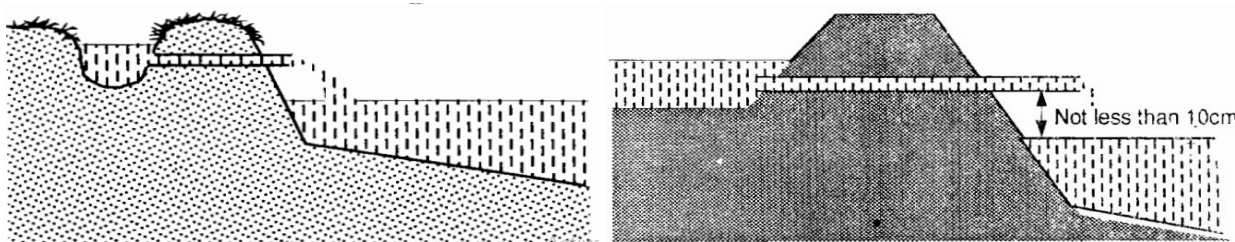


Figure 3.11. Sluice a pipe

3.5.2. The Inlet

The inlet lets water into the fish pond. The outlet and inlet should always be at opposite ends of the fish pond.

The bottom or floor of the inlet should be at least 10 cm above the highest expected level of water within the pond. This is to allow water fall into the pond. When water falls into the pond, more oxygen is incorporated into the water entering the fish pond.



An Inlet must be at least 10 cm above the water level.

Figure 3.12. Inlet position in pond structure

An inlet can be made of:

1. Bamboo, PVC piping,
2. Bricks and concrete.

a. A Simple Inlet Using Piping

- The principle of connecting the pipes is the same as for the outlets
 - Dig a gap in the dyke and place the pipe. Cover the gap and compact the earth

b. **An Inlet Sluice** An inlet sluice is made of brick and concrete or from sluice.

3.5.3. Screening the inlet and outlet

All outlets and inlets must be screened in order to prevent predators entering your fish ponds or fish : swimming out of the fish pond.

Anything that can allow water through and not small fish can be used as screen. Screening can be done using:

1. **Weld mesh** covered with coffee wire mesh.
2. **Bamboo or reeds** that are finely woven.

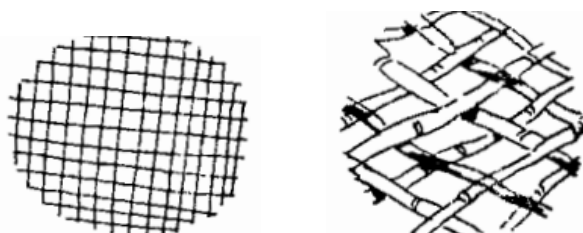


Figure 3.13. A/ Weld mesh

Figure 3.13. B/ Bamboo or reeds

3. **Netting material** - This is more applicable when pipes are used.
4. **A loosely woven grass mat.**

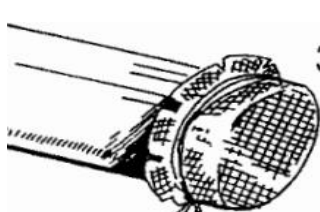


Figure 3.14. A/ Netting material

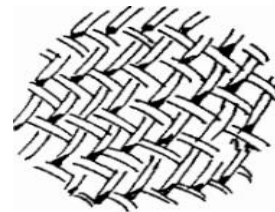


Figure 3.14. A/ A loosely woven grass mat.

So inlets and outlets have to be screened to keep impurities from entering the pond and to avoid the possible loss of fish.

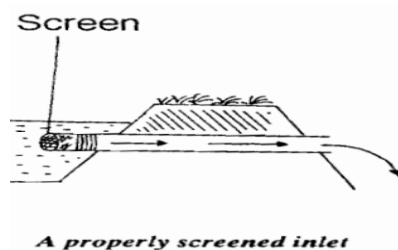


Figure 3.15. A/ A properly screened inlet

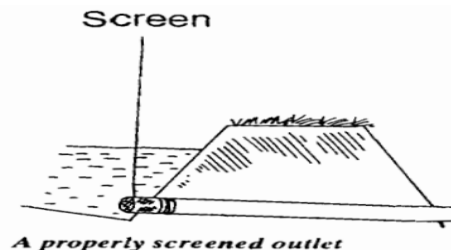


Figure 3.15. A/ A properly screened outlet

3.5.4. Supplying water to your pond

- a. The Inlet Channel As mentioned before, the pond should be at least 3 to 4 meters away from the water source. Dig a channel from the water source to the inlet.

The channel supplying water to the pond must be:

1. Large enough to carry all the water required.
2. Constructed well enough so that there is a minimum amount of seepage.

The inlet channel should be at level of at least 10 cm higher than the intended water level within the pond as indicated earlier.

In order to bring water into your ponds at this level, it might be necessary to raise the level of water from your source. An example of such a situation is when the stream supplying your water is not much higher than your pond.

This can be done using:

- A barrage of tree branches logs or stones
- Making a Concrete structure similar to a sluice across the inlet channel.

A sluice across the inlet channel can also help you control the amount of water to your pond.

A bypass should be made around the pond to take off excess water from the supply channel. This is very useful especially after heavy rains. It helps prevent flooding into the pond. The bypass channel drains into the drainage channel.

The Drainage Channel

The drainage channel carries used up water from the ponds. It should be large and deep enough to ensure that all water drained from the ponds plus any excess from the bypass channel can be carried away without flooding tile site. The floor of the drainage channel must be lower than the floor at the deep end of your pond.

Note:- Water from the inlet channel and drainage channel must never mix. Therefore, the water supply and drainage system must have a parallel arrangement. The floor of the Drainage Channel must be lower than the pond.

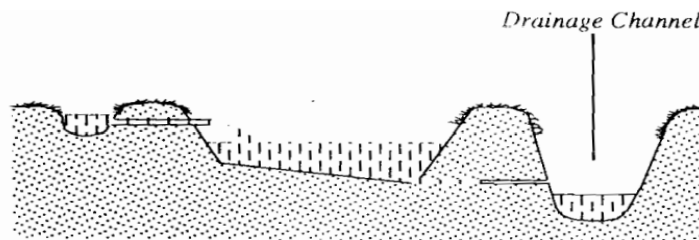


Figure 3.16. The drainage canal

3.6. Assembling and fixing fixtures and fittings

Fixtures and Fittings means references to any of the fixtures, fittings, furniture, furnishings, or effects, floor, ceiling or wall coverings. Fixtures and Fittings means all fixtures, fittings, plant, machinery and equipment in or on the Property from time to time including by way of example bar server, back fittings, counters, boilers, Pipes, and equipment relating to heating, ventilation and air conditioning and the provision of hot and cold water, cellar cooling system, pumps, septic tanks, sprinkler systems, sanitary ware, electrical installation (except interior light fittings), tiles and similar fixed surface coverings, external lighting and signage, lifts and hoists, and any other fixtures, fittings or equipment in or on the

Property which do not form part of the Trade Inventory. Fixtures and Fittings means built in furniture, refrigerator, stove, air conditioning unit, floor coverings, fixed awnings and solar panels.

Fixtures and Fittings means **all fixtures and fittings (other than tenant's fixtures and fittings)** in or upon the Premises including plant and machinery, lifts, boilers, central heating, air conditioning, lighting, plumbing, sanitary and sprinkler systems and any other apparatus from time to time in or upon the Premises. Fixtures and Fittings means all items contained in the Inventory and signed on behalf of the parties at the commencement of the Agreement or any items replacing them, including reference to any of the fixtures, fittings, furnishings or effects, floor, ceiling and wall coverings.

Fixtures and fittings are types of assets that come with a building. Fixtures are assets that are attached to the building or land, while fittings are assets that are not permanently attached to the building or land.

Difference between fixtures and fittings

The difference between fixtures and fittings is whether or not they are physically attached to the property or the land it occupies.

Fixtures are things that are physically 'fixed' to the property and can't be easily moved or lifted.

Fittings are either free-standing (like most household furniture) or loosely attached with nails or screws (like pictures, hooks, etc.).

All buildings include fixtures and fittings Employer's requirements, drawings and specifications, contracts and health and safety manuals refer to them. However, the term FF & E (furniture, fixtures and equipment) is frequently used as an alternative.

- A fixture is any item that is intended to be reasonably permanent and is affixed to the property through the application of plaster, cement, bolts, screws, nuts, or nails
- A fitting/ furnishing are any item that is free standing or hung by screws, nails or hooks.
- Below is a list of items that typically fall within each category.

Again, fixtures are classified as something that's bolted directly onto the property but isn't structural.

Common examples of fixtures include:

- Boilers and heating systems
- Built-in wardrobes and storage features
- Bathroom suite items including baths, showers, sinks and built-in storage
- Carpets and flooring
- Fixed partitions and doors
- Light fittings
- Security alarm systems
- Plumbing installations

- Bathroom suites and other sanitary ware installations
- Sinks
- Built-in furniture, including proprietary reception desks, worktops
- Built in wardrobes/ cupboards/ shelf units (e.g. if they use a wall to form one of their sides and would thus be incomplete if they were removed)
- Plants and shrubs [rooted] in land belonging to the property

After the fixtures, fittings make up the rest of the items you would typically see in a property.

Examples of fittings include:

- All free-standing furniture, regardless of size
- Free-standing white goods – fridges, washing machines, etc.
- Decorative items – lampshades, pictures, mirrors, ornaments and artworks shelving, curtains and curtain rails (as they are easily removable)
- Garden furniture
- Edge-fitted and loose-laid carpets
- Notice boards
- Plumbed-in/ connected but free-standing equipment (e.g. commercial catering equipment, laboratory equipment)
- Free-standing ovens, refrigerators, washing machines and other white goods
- Lockers, changing room furniture, etc.

3.7. Stock culture structure

A fish stock can be defined as a subset of species which encompass an intraspecific group of randomly mating individuals at a specific time and space.

A stock's share structure is a description of how a company's shares are split up. That is, it reflects how many shares exist and how much ownership of a company each share represents. At the end of the day, the ownership in a company represented by a single share matters more than the price of that share.

Fish stock management refers to aiming to catch the maximum quantity of fish that can safely be removed from a stock, while also maintaining its capacity to produce sustainable yields in the long term. Primary stock cultures stored at room temperature are maintained in sterile soil or in agar or broth that is provided with an overlay of sterile mineral oil.

Agar and broth cultures without mineral oil also are refrigerated and cultures in milk or agar are maintained frozen at low temperatures.

A culture of a microorganism maintained solely for the purpose of keeping the microorganism in a viable condition by subculture, as necessary, into fresh medium.

Stock culture structures in aquaculture activities includes

- Enclosures and nets-holding, predator protection, handling and harvesting (dip, brails, traps, seines)
 - Fish on growing-long lines, rafts, racks, fences-socks, trays, baskets, tags, barrels, cages, panels, self-feeding cages
 - Floating structures cages /pens, long lines, rafts, moorings
 - Ponds, tanks, dams, race ways
 - Harvest stock holding structures—tanks, bins, cages
- pest, predator and disease control structures

Self-check – 3	Written test
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Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Multiple choices

- Which one common hazards in aquaculture activities
 - Physical
 - Chemical
 - Biological
 - Ergonomic
 - All
- Which one is initial step of fish pond construction
 - Reconnaissance survey
 - Land clearing:
 - Land mapping:
 - Excavation:
 - Construction
- which one of the following fish farm infrastructure
 - Storage
 - Fence and security system
 - Communication and electricity facilities
 - Aquaculture lab
 - All

Test II: Say True or False Based on the Given Statements

- A sluice is a special kind of outlet made of brick and or concrete.\
- A fish stock can be defined as a subset of species which encompass an intraspecific group of randomly mating individuals at a specific time and space.
- The drainage channel carries used up water from the ponds.
- Fittings are things that are physically ‘fixed’ to the property and can’t be easily moved or lifted.

LG #9 LO # 4 - Complete construction work

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Undertake checking and commissioning
- Cleaning, checking and returning equipment and materials
- Disposing waste materials
- Organizing, documenting and reporting works

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Undertake checking and commissioning
- Clean, check and return equipment and materials
- Dispose waste materials
- Organize, document and report works

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet-4

4.1. Undertake checking and commissioning

Checking

Before you store your farm equipment, give it a good cleaning. In addition to washing the exterior of each piece, take the time to do a deep cleaning. With the equipment turned off, get into exposed gears and belts to clear debris and ensure overall cleanliness and functionality. To help protect the finish, you may even want to consider waxing the vehicles paint, which can help the paint last longer and serve as a rust inhibitor.

Your farm equipment is one of the largest investments on your farm. Keeping your farm tools regularly maintained and properly stored are the best ways to ensure that they last you for a good, long time. Read on to learn how to store your equipment during the off-season.

- **Stay Up-to-Date With Maintenance**

After you give your equipment a thorough cleaning, make sure each piece is up-to-date on its regular maintenance. This includes checking fluid levels and tire pressure as well as making any necessary repairs. Don't put off until next season what you can do now. When you put your equipment away in good working order, you'll have a smooth time pulling it out and putting it to work next season.

- **Ensure Storage Facility Security**

Once your equipment is stored in the shed, barn or other facility, make sure that your storage unit is secure to keep your equipment safe from intruders and the elements. Your facility should be reasonably weatherproof to keep snow and ice from accumulating around the equipment. You should also keep your facility locked and accessible only to family or farm staff who need to access or maintain the equipment.

Commissioning is a documented process that ensures facilities, systems and equipment are designed and installed as specified and function as expected.

The commissioning process is the integrated application of a set of engineering techniques and procedures to check, inspect, and test every operational component of the project from individual functions such as instruments and equipment, up to more complex entities such as subsystems and systems.

Before a plant or facility is handed over for normal operation, it should be inspected, checked, cleaned, flushed, verified and tested. This process is called commissioning and involves both the contractor and operator of a facility.

The transition from construction to operation is the commissioning and startup. Processing plant commissioning embraces activities such as cleaning, flushing, verifications, leak tests, performance evaluation and functional tests essential for bringing a newly installed plant or facility into routine operation.

Correct commissioning is vital to the satisfactory operation of any plant or facility. A schedule must be established with benchmarks and monitoring activities in order to keep track of progress.

Commissioning can be divided into three main activities:

- Commissioning preparation
- Commissioning execution
- Commissioning documentation and handover to operation

- **Commissioning Preparation**

Commissioning preparation required to maintain two types of records

- ✓ Commissioning Preparation Check Record
 - Valves and equipment flow direction correct.
- ✓ **Instrument Installation and Inspection Installation check**
 - Check the instrument against the datasheet.
 - Check CE marking.
 - Check calibration certificates.
 - Installation check.
 - Leakage test.
 - Flushing carried out.

- **Commissioning Execution**

- Calibration and testing of instruments prior to installation.
- Visual inspection for complete and correct installation.
- Insulation and continuity testing of cables.
- Cleaning, flushing, pressure and leak testing of pneumatic and hydraulic tubing.
- Adjustment of control, alarm and shutdown settings.
- Loop testing.

- Function testing of control systems.
- Function testing of field instruments.
- Punch point list for field instruments
- Area completion.
- **Commissioning Documentation Preparation & Handover**

Following are the documentation is prepared before the startup or at the end of commissioning and to be handed over once the commissioning process has been completed.

4.2. Cleaning, checking and returning equipment and materials

4.2.1. Cleaning of materials, tools and equipment's

Cleaning is the process of removing unwanted substances, such as dirt, infectious agents, and other impurities, from an object or environment. Cleaning occurs in many different contexts, and uses many different methods. Several occupations are devoted to cleaning.

Types of cleaning materials

- Cleaning clothes
- Sponges
- Water
- Water hose/pipe

Use/Purpose of cleaning

- Make material easy to use
- Protect material from dust, rust or rot
- Clean for future use
- Clean for long life use

Methods of cleaning materials, tools and equipment's

Cleaning is broadly achieved through mechanical action and/or solvent action; many methods rely on both processes.

1. **Washing**, usually done with water and often some kind of soap or detergent
 - Pressure washing, using a high-pressure stream of water
2. **Abrasive blasting**, typically used to remove bulk material from a surface, may be used to remove contaminants as well
3. **Acoustic cleaning**, the use of sound waves to shake particulates loose from surfaces
 - Ultrasonic cleaning, using ultrasound, usually from 20–400 kHz.
 - Megasonic cleaning, a gentler mechanism than ultrasonic cleaning, used in wafer, medical implant, and industrial part cleaning.

4. **Carbon dioxide cleaning**, a family of methods for parts cleaning and sterilization using carbon dioxide in its various phases.
5. **Dry cleaning** of clothing and textiles, using a chemical solvent other than water
6. **Flame cleaning** of structural steel with an oxyacetylene flame
7. **Green cleaning**, using environmentally friendly methods and products
8. **Plasma cleaning**, using energetic plasma or dielectric barrier discharge plasma created from various gases
9. **Sputter cleaning**, performed in a vacuum by using physical sputtering of the surface
10. **Steam cleaning**, in both domestic and industrial contexts
11. **Thermal cleaning**, in industrial settings, involving pyrolysis and oxidation
12. **Wet cleaning**, methods of professional laundering that avoid the use of chemical solvents



Figure 4.1. Methods of cleaning materials, tools and equipment's

Cleaning agents are substances (usually liquids, powders, sprays, or granules) used to remove dirt, including dust, stains, bad smells, and clutter on surfaces. Purposes of cleaning agents include health, beauty, removing offensive odor, and avoiding the spread of dirt and contaminants to oneself and others. Some cleaning agents can kill bacteria (e.g. door handle bacteria, as well as bacteria on worktops and other metallic surfaces) and clean at the same time. Others, called degreasers, contain organic solvents to help dissolve oils and fats.

Different cleaning agents are used depending on the item to be cleaned, the cleaning method and the type of soiling found on the item.

There are four main types of cleaning agents used in commercial kitchens:

a. Detergents

Detergents are the most common type of cleaning agent and are used in home and commercial kitchens. They work by breaking up dirt or soil, making it easy to wash it away. The detergents used in commercial kitchens are usually synthetic detergents made from petroleum products and may be in the form of powder, liquid, gel or crystals.

b. Degreasers

Degreasers are sometimes known as solvent cleaners and are used to remove grease from surfaces such as oven tops, counters and grill backsplashes. Methylated spirits or white spirit were commonly used as degreasers in the past. Most food businesses now try to use non-toxic, non-fuming degreasers in their operations to prevent chemical contamination.

c. Abrasives

Abrasives are substances or chemicals that depend on rubbing or scrubbing action to clean dirt from hard surfaces. In commercial kitchens, abrasives are usually used to clean floors, pots and pans. Abrasives should be used with care as they may scratch certain types of materials used for kitchen equipment such as plastic or stainless steel.

d. Acids

Acid cleaners are the most powerful type of cleaning agent and should be used with care. If they are not diluted correctly acid cleaners can be very poisonous and corrosive.

Acid cleaners are generally used to remove mineral deposits and are useful for descaling dishwashers or removing rust from restroom facilities. Always follow cleaning with sanitizing: Cleaning is only the first step to a germ-free kitchen. Cleaning is done using detergent, but it doesn't kill bacteria or other microorganisms that can cause food poisoning. To kill bacteria and ensure a clean workplace, you must follow cleaning with sanitizing.

Effective cleaning and sanitizing also helps to:

- prevent pests from entering your business
- prevent cross-contamination
- prevent allergic reactions caused by cross-contamination

4.2.2. Checking and maintaining tools and equipment

The technical meaning of maintenance involves functional checks, servicing, repairing or replacing of necessary devices, equipment, machinery, building infrastructure, and supporting utilities in industrial,

business, governmental, and residential installations. Over time, this has come to include multiple wordings that describe various cost-effective practices to keep equipment operational; these activities take place either before or after a failure.

- Any activity—such as tests, measurements, replacements, adjustments, and repairs—intended to retain or restore a functional unit in or to a specified state in which the unit can perform its required functions.
- All action taken to retain material in a serviceable condition or to restore it to serviceability. It includes inspections, testing, servicing, classification as to serviceability, repair, rebuilding and reclamation.
- All supply and repair action taken to keep a force in condition to carry out its mission.
- The routine recurring work required to keep a facility (plant, building, structure, ground facility, utility system, or other real property) in such condition that it may be continuously used, at its original or designed capacity and efficiency for its intended purpose.

Maintenance is strictly connected to the utilization stage of the product or technical system, in which the concept of maintainability must be included. In this scenario, maintainability is considered as the ability of an item, under stated conditions of use, to be retained in or restored to a state in which it can perform its required functions, using prescribed procedures and resources.

Types of maintenance

4. Preventive maintenance

Preventive maintenance (PM) is "a routine for periodically inspecting" with the goal of "noticing small problems and fixing them before major ones develop." Ideally, "nothing breaks down."

The main goal behind PM is for the equipment to make it from one planned service to the next planned service without any failures caused by fatigue, neglect, or normal wear (preventable items), which Planned Maintenance and Condition Based Maintenance help to achieve by replacing worn components before they actually fail. Maintenance activities include partial or complete overhauls at specified periods, oil changes, lubrication, minor adjustments, and so on. In addition, workers can record equipment deterioration so they know to replace or repair worn parts before they cause system failure.

Main objective of PM are:

1. Enhance capital equipment productive life.
2. Reduce critical equipment breakdown.

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3. Minimize production loss due to equipment failures.

Other terms and abbreviations related to PM are:

- scheduled maintenance
- planned maintenance, which may include scheduled downtime for equipment replacement
- planned preventive maintenance (PPM) is another name for PM
- Breakdown maintenance: fixing things only when they break. This is also known as "a reactive maintenance strategy "and may involve "consequential damage."

5. Planned maintenance

Planned preventive maintenance (PPM), more commonly referred to as simply **planned maintenance (PM)** or **scheduled maintenance**, is any variety of scheduled maintenance to an object or item of equipment. Specifically, planned maintenance is a scheduled service visit carried out by a competent and suitable agent, to ensure that an item of equipment is operating correctly and to therefore avoid any unscheduled breakdown and downtime.

The key factor as to when and why this work is being done is timing, and involve a service, resource or facility being unavailable. Planned maintenance is preplanned, and can be date-based, based on equipment running hours, or on distance travelled.

6. Predictive replacement

Predictive replacement is the replacement of an item that is still functioning properly. Usually it's a tax-benefit based replacement policy whereby expensive equipment or batches of individually inexpensive supply items are removed and donated on a predicted/fixed shelf life schedule. These items are given to tax-exempt institutions.

7. Condition-based maintenance

Condition-based maintenance (CBM), shortly described, is maintenance when need arises. CBM maintenance is performed after one or more indicators show that equipment is going to fail or that equipment performance is deteriorating.

Advantages and disadvantages of CBM

CBM has some advantages over planned maintenance:

- Improved system reliability
- Decreased maintenance costs

- Decreased number of maintenance operations causes a reduction of human error influences

Its disadvantages are:

- High installation costs, for minor equipment items often more than the value of the equipment
- Unpredictable maintenance periods cause costs to be divided unequally
- Increased number of parts (the CBM installation itself) that need maintenance and checking

8. Corrective maintenance

Corrective maintenance is a type of maintenance used for equipment after equipment break down or malfunction is often most expensive – not only can worn equipment damage other parts and cause multiple damage, but consequential repair and replacement costs and loss of revenues due to down time during overhaul can be significant. Rebuilding and resurfacing of equipment and infrastructure damaged by erosion and corrosion as part of corrective or preventive maintenance program involves conventional processes such as welding and metal flame spraying.

9. Predictive maintenance

This maintenance strategy uses sensors to monitor key parameters within a machine or system, and uses this data in conjunction with analyzed historical trends to continuously evaluate the system health and predict a breakdown before it happens. This strategy allows maintenance to be performed more efficiently, since more up-to-date data is obtained about how close the product is to failure.

4.2.3. Returning and storing materials tools and equipment

Safe storage of materials and equipment is essential for many businesses, such as construction job sites, laboratories, and other locations that handle chemicals, flammable gases and other hazardous materials. Storage methods and procedures are regulated for many such items; when in doubt it is always best to be cautious to prevent accidents. Locking storage cabinets and restricting access to storage areas will prevent unauthorized handling of stored items and minimize the possibility of theft.

General Plan

Create a plan for storing all equipment and materials at your site. Assign a specific location to each item or type of item and label the space accordingly. Make certain that work areas and walkways are kept clear of all stored items. Use tape or paint to identify such areas on the floor of a large area, such as a manufacturing facility. In an office, laboratory or similar smaller setting, use cabinets with doors

that close securely. Always leave at least 1.5 feet between the top of stored items and fire sprinklers, if present. Make sure that all stacks are solid and secure them whenever possible.

Flammable Materials

Materials that are highly flammable require special handling. Gases such as propane and butane must be kept in pressure-safe containers with appropriate labels. Flammable gases are to be kept in a separate, well-ventilated area. According to the Occupational Safety and Health Association, flammable liquids such as gasoline and kerosene must be stored in approved containers located away from other flammable materials. These can be stored only in a specially constructed room that is able to contain a fire for one to two hours. Keep flammable materials 50 feet away from sources of heat or flame.

Chemicals and Other Hazardous Materials

All chemicals, including cleaning materials, should be kept in their original containers or in properly labeled containers of an appropriate type. Every workplace that uses chemicals of any type should have a book containing all material data safety sheets, and the book must be kept where it is easily accessible. Chemicals must be stored where there is no public access and where tipping or breaking can't happen, such as secure shelves inside a locked cupboard. The cupboard must be labeled with the type of materials it contains.

Machinery and Equipment

Machinery such as forklifts must be kept in a safe location where it is protected from unauthorized access, weather and accidental damage. It must be kept away from driveways, walkways and other areas where access is required. All equipment should be turned off when not in use. If there is a chance of oil, hydraulic fluid or other liquids leaking from the vehicle while it is stored, use a drip pan underneath it to catch any spills. Check the area frequently for such leaks and clean them up immediately if any are found, as these represent significant fall hazards for employees.

Remember: always after work was accomplish clean, maintain and store on their original place of materials tools and equipment.

4.3. Disposing waste materials

Materials should be returned to store or disposed according to the condition. After the accomplishment of task all necessary materials, tools and equipment must be stored properly or if there is need to be disposed should be done accordingly.

Remove waste from living area and dispose of according to facility policy and procedures (Note: Toxic gases such as carbon dioxide, hydrogen sulfide and ammonia may build up to lethal levels. Never enter storage tank unless absolutely necessary and then with professional assistance on site.) Utilize PPE. Select equipment appropriate for size and type of area to be cleaned.

Review safety procedures with supervisor and follow all safety guidelines. Provide maximum ventilation when store perishable materials.

Types of wastes and disposal methods

The correct management of waste material such as waste water (also called effluent), stock feed and chemicals is an important part of successful Education for sustainable development (ESD) in aquaculture. Waste management should focus on: Managing and controlling waste water, Minimizing waste, Disposing of construction waste and Disposing of dead stock.

A. Managing and controlling waste water

Waste water from aquaculture can come from ponds that have been drained, or from tanks and containers used to hold or keep stock. This water is usually rich in nutrients and chemicals that can have a negative effect on the environment, especially when it manages to drain into creeks and rivers. This can pollute natural waterways and wetlands, and may lead to the growth of poisonous blue-green algae.

B. Minimizing waste

A good strategy for managing waste products is to minimize the amount of waste produced by stock. Use a high-quality diet and avoid overfeeding stock. Maintain correct stocking densities in all your ponds. Finally, if fertilizing ponds, avoid adding too much fertilizer as this can cause high nutrient levels in the effluent from ponds.

C. Disposing Dead stock

The recommended method of disposing of dead stock is to bury the stock. Cover the dead stock with lime before you fill in the hole. Lime helps decompose the stock and prevent diseases from spreading. Make sure that any tools such as shovels, rakes, gloves, buckets, bins and nets that come in contact with the dead stock are washed and disinfected thoroughly.

Dead stock must be disposed of by either

- bagging it up and sending it to an authorized rubbish site
- burying it on site

- Incinerating it.

We have an area at the east of the farm for burying dead stock. All dead stock must be buried in this area.

When burying stock:

- dig a hole deep enough to allow a good covering of soil over the dead stock
- place the dead stock in the hole
- Spread lime over the dead stock before the dead stock is covered over with soil.

D. Diseased stock

Diseased stock that has died should be disposed of in a way that prevents the disease from spreading to other ponds and to the environment.

Remove diseased stock from ponds and place it in a suitable disinfectant such as chlorine, bag it and then bury it in the same area for burying dead stock. If the resources are available, incinerate the dead diseased stock on site.

Diseased stock may be buried in a suitable area that is away from the ponds, and the addition of lime to the stock will help prevent the spread of disease.

E. Solid waste

Solid waste from fish ponds will accumulate unless it is removed from time to time. Store the waste for use as fertilizer. When fertilizing crops, care must be taken to prevent excessive nutrients from leaching into the environment.

F. Disposing of construction waste

Any waste materials from construction work need to be disposed of properly or they can become both environmental and health hazards. A good strategy to control and dispose of construction waste is to collect all waste materials in one area, put them in a skip bin and have them removed.

G. Disposing of poor quality (Spoiled) feed

Never feed poor-quality food to stock. Where possible, poor-quality food should be bagged and removed from the site by a waste company. Alternatively, large quantities of poor-quality food can be buried. Never place large quantities of food in household bins.

Fish food that has gone off should not be fed to stock, as this may increase the chances of disease, due to nutritional problems or from toxins that may have accumulated. Waste feed should be bagged for disposal off-site or buried in a suitable area away from ponds.

Methods of disposing waste;

- recycling
- burning
- fermentation (used as bio fuel)

Plan the placement or disposal of the material excavated from the pond in advance of construction operations. Adequate placement prolongs the useful life of the pond, improves its appearance, and facilitates maintenance and establishment of vegetation. The waste material can be stacked, spread, or removed from the site as conditions, nature of the material, and other circumstances warrant.

If do not remove the waste material from the site, place it so that its weight does not endanger the stability of the side slopes and rainfall does not wash the material back into the pond. If you stack the material, place it with side slopes no steeper than the natural angle of repose of the soil. Do not stack waste material in a geometric mound, but shape and spread it to blend with natural landforms in the area. Because many excavated ponds are in flat terrain, the waste material may be the most conspicuous feature in the landscape. Avoid interrupting the existing horizon line with the top of the waste mound.

4.4. Organizing, documenting and reporting works

Reporting of work outcome started from recording. As a fish farmer, your main objective is to earn money by selling fish at a profit. To understand why you are getting good or poor results, you will need to keep complete and accurate records of everything that goes on at your farm.

As a commercial fish farmer, your main objective is to earn money by selling fish at a profit. To understand why you are getting good or poor results, and more importantly whether or not you are making a profit, you will need to keep complete and accurate records of everything that goes on at your farm.

i. Record

Keeping and analyzing to make production and business decision make it possible to execute production objectives with in the cost structures of the enterprises. Through the records the evidence of what is at a stake (your stock), changes that have occurred during production and marketing. Impending challenges and opportunities become available.

The basic aquaculture records are

- **Production record** (feeding, management, stock, growth, disease and survival)

As opposed to terrestrial animals, fish are always under water during the production cycle. The only time a farmer sees them is at feeding, if they feed by response, or at sampling . keeping records of inputs, water, quality, management action, average weights, at sampling and mortalities up to date provides a lot of insight on the status of operation.

- **Marketing records** (market requirement and prices) :- records of purchase and sales from the various markets, turnover, promotion and communication costs and results and market profiles are important.
- **Financial records** (costs of expense, sale revenues and expenses)

Records are sets of information that have been systematically and carefully collected and appropriately stored for a specific purpose. To be able to run any economic enterprise successfully, carefully thought out and properly collected records are a must. Comprehensive record keeping will assist both in tracking farm activities and expenses and in assessing the level of investment, the motivation of the investor, and the management skills of the farmer.

ii. Importance of record keeping

Maintaining good records helps you with the following:

- Tracking the activities of your enterprise
- Tracking the expenses of the enterprise
- Monitoring the performance of the enterprise
- Evaluating the performance and operations of the enterprise
- Making decisions about improving operations
- Keeping institutional memory of the enterprise
- afford evaluation of the profitability and general economic of fish farm investment
- provide vital management information for future planning, improvement and development of the farm
- provide necessary grounds to obtain credit or funding support from financial institutions

Good records will, for example:

- Be useful in projection of expected production
- Help in determining the amount of inputs required for specific ponds at various stages of fish production

- Help determine the expected harvesting time
- Determine the economic health of the enterprise

Important aquaculture parameters for record keeping

- Pond identity
- Total area under culture
- Fish species stocked
- Sources of seed and feeding rate
- Stocking densities and time
- Kinds, quantities, and costs of inputs
- Daily events
- Fish production in amounts and values
- Production of other farm crops and their values

Table 1. Format for Pond management Records

S/N	Pond	Date	Type Of Input	Quantity Of Input	Unit Cost	Total Cost	Remarks
1.							
2.							

Table 2. Stocking records in established fish farm

Species stocked	Quantity stocked	Average Size at stocking Cm and/or weight (gr)	Date stocked
1.			
2.			

Self-Check – 4	Written test
-----------------------	---------------------

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Choose the correct answers from the given alternatives

- Which one is a method of waste disposing?
 - Recycling
 - Burning
 - Fermentation
 - All.
- refers to removal of matter from a surface on which it is not acceptable.
 - Cleaning
 - Sanitizing
 - Washing
 - All

Test II: Matching

	A			B
1.	Financial records		A.	Burying
2.	Methods of disposing wastes		B.	Detergents
3.	Cleaning agents		C.	Used for equipment after equipment break down or malfunction
4.	Corrective maintenance		D.	Provide vital management information
5.	Good records		E.	Costs of expense, sale revenues and expenses

Test III: Short Answer Questions

- Write waste handling techniques?
- Write two steps of cleaning?
- Write the purposes of recording?

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