



## **PRINCIPLES OF FISH FARM ESTABLISHMENT: SITE SELECTION, POND/CAGE DESIGN AND DEVELOPMENT**

*Arkorn Choomthi  
Department of Fisheries, Thailand*

### **INTRODUCTION**

Fish farming is the principal form of aquaculture. It involves raising fish efficiently in ponds tanks, cages or enclosures, usually for food. A facility that releases juvenile fish into the wild for recreational fishing or to supplement for culture is generally referred to as a fish hatchery. Fish are excellent animals to rear. They can convert feed into body tissue more than most farm animals, transforming about 70 percent of their feed into flesh. Fish also have excellent dress-out qualities, providing an average of 60 percent body weight as marketable product and a greater proportion of edible, lean tissue than most livestock. Fish can be intensively cultured in relatively small amounts of water. They can be farmed at densities with careful management. Increasing demands on wild fisheries by commercial fishing operations have caused widespread overfishing. Fish farming offers an alternative solution to the increasing market demand for fish and fish protein.

Fish farming is, like most other types of farming that requires special knowledge, skills, and careful considerations. Individuals with little or no experience in fish farming and few resources available can become successful fish farmers, but they should start small and expand slowly, and be willing to invest lots of time and effort. Besides knowledge and skills, one of the most important factors to consider in determining whether you should begin a fish farming in location for fish farm establishment.

To be profitable, fish farm must be sited properly and designed for efficiency. An inaccessible location, leaks in the pond, lack of good quality water will doom an fish farm to failure. Ideally, fish farm built on flat land and used ground water or surface water are more suitable for fish production.

#### **Water availability**

Water for fish farm; ponds, hatcheries or tanks can come from a variety of sources; ground water (wells), surface water (springs, streams and reservoirs) which are available in the areas. The primary criterion is that adequate water of desirable quality be available.

#### **Water quality**

Selection of the water source has many considerations, including initial cost, permit restrictions and dependable quality. Water quality is one of the most factors to succeed fish farm especially, hatchery and cage culture. The water used should be good for fish growth and avoided contamination of wild fish, parasites and diseases that could result in fish loss and other costs.

#### **Soil type**

For fish production pond (earthen pond), good quality soil containing at least 20 percent clay is necessary for building dike and spillways. This includes clay, silty clay, clay loam and sandy clay. They must be held water and prevent water seepage. Pond construction, mainly concrete tanks in lime stone areas can be especially risky because underlying cracks and sinks. Soils should be checked for their texture.

#### **Soil texture**

Texture indicates the relative content of particles of various sizes, such as sand, silt and clay in the soil. Texture influences the ease with which soil can be worked, the amount of water and air it holds, and the rate at which water can enter and move through soil.

To find the texture of soil sample, first separate the fine earth, all particles less than 2 mm, from larger particles such as gravel and stones. Fine earth is a mixture of sand, silt and clay. You must be sure to use only fine earth to perform the following field tests.

*Grain size:*

Sand 0.05 – 2.0 mm, Silt 0.002 – 0.05 mm, Clay < 0.002 mm

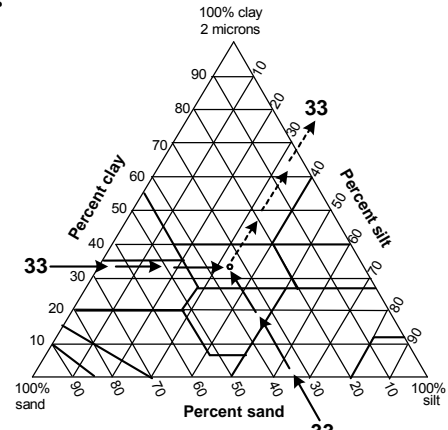
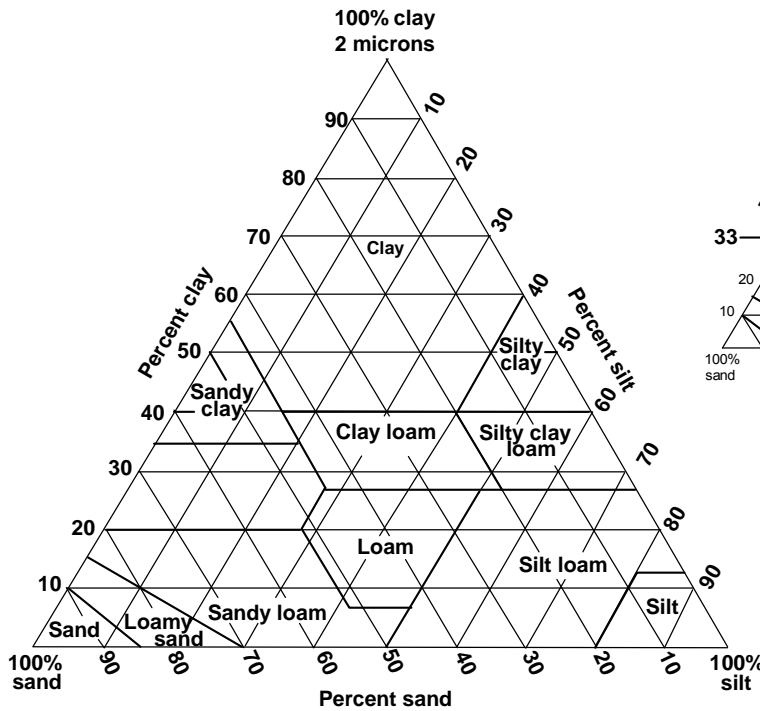
Opening Sizes for USA Standard Wire Cloth Sieves Conforming to American Standard Testing Materials (ASTM) Specifications E 11.

USA Standard Series, ASTM No.	Opening Size (mm)	USA Standard Series, ASTM No.	Opening Size (mm)
5	4.75	80	0.18
10	2.00	100	0.15
20	0.85	140	0.106
30	0.60	200	0.075
40	0.42	270	0.053
50	0.30	400	0.038
60	0.25		



Separation of soil particles.

Triangular diagram of the basic soil textural classes according to USDA partical sizes



**PARTICAL SIZES (USDA)**

clay	<0.002mm
silt	0.002-0.05mm
sand	0.05 -2 mm

NOTE: The soil textural classes shown in the white portion of the large triangle are best for fish-pond construction.

Triangular diagram of the basic soil textural classes according to USDA particle size

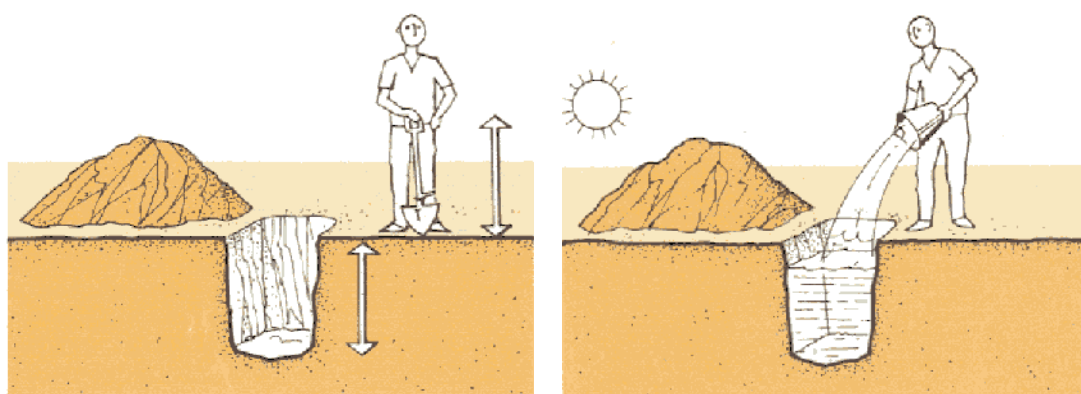
USDA textural classes of soils: Soil texture (percentages, dry weight)

Common names of soils (General texture)	Sand	Silt	Clay	Textural class
Sandy soils (Coarse texture)	86-100	0- 14	0- 10	Sand
Loamy soils (Moderately coarse texture)	70- 86	0- 30	0- 15	Loamy sand
Loamy soils (Moderately coarse texture)	50- 70	0- 50	0- 20	Sandy loam
Loamy soils (Medium texture)	23- 52	28- 50	70- 27	Loam
	20- 50	74- 88	0- 27	Silty loam
	0- 20	88-100	0- 12	Silt
Loamy soils (Moderately fine texture)	20- 45	15- 52	27- 40	Clay loam
	45- 80	0- 28	20- 35	Sandy clay loam
	0- 20	40- 73	27- 40	Silty clay loam
Clayey soils (Fine texture)	45- 65	0- 20	35- 55	Sandy clay
	0- 20	40- 60	40- 60	Silty clay
	0- 45	0- 40	40-100	Clay

The relative suitability as dike material of various types of soil.

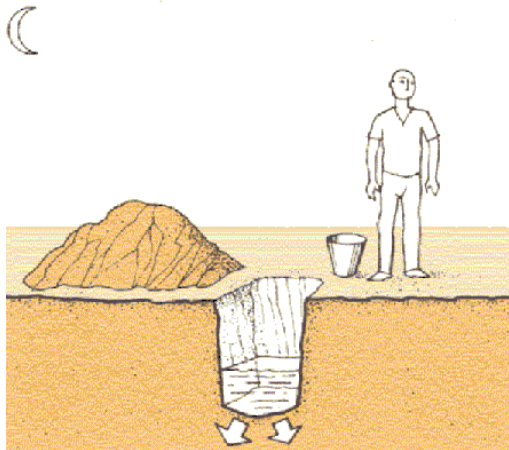
Texture	Permeability	Compressibility	Compaction characteristics	Suitable as dike material
Clay	Impermeable	Medium	Fair to good	Excellent
Sandy clay	Impermeable	Low	Good	Good
Loam	Semi- impermeable to impermeable	High	Fair to very poor	Fair
Sandy loam	Semi- impermeable to impermeable	Medium to high	Good to very poor	Poor
Sand	Permeable	Negligible	Good	Poor
Peat				Very poor

A simple field test for estimating soil permeability

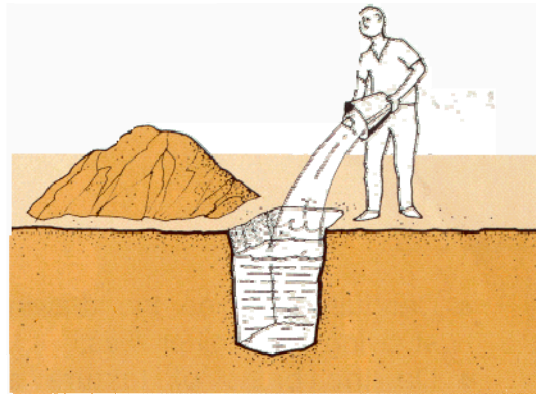


(1). Dig a hole as deep as your waist;

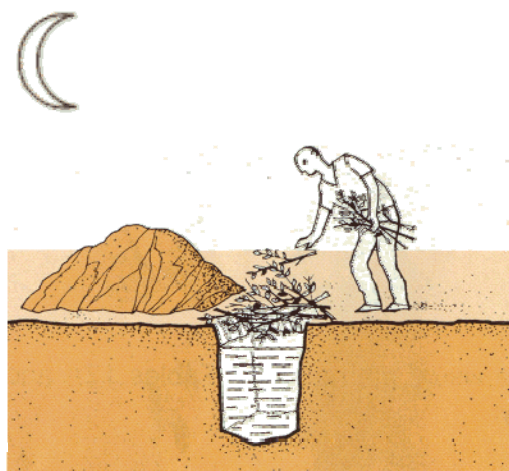
(2). Early in the morning, fill it with water to the top;



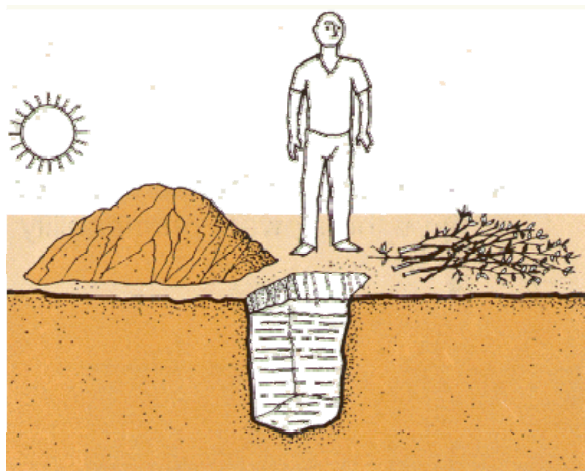
(3). By the evening, some of the water will have sunk into the soil;



(4). Fill the hole with water to the top again, and cover it with boards or leafy branches;



(5). If most of the water is still in the hole the next morning, the soil permeability is suitable to build a fish-pond here;

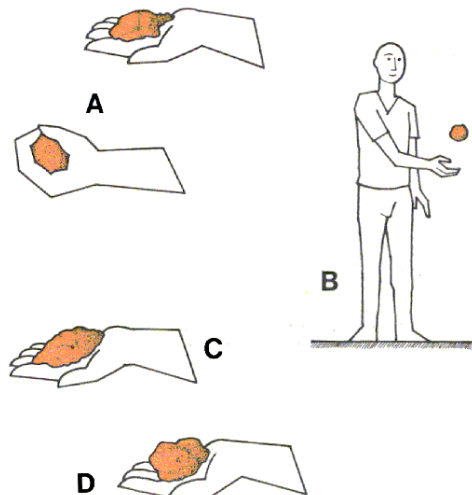


(6). Repeat this test in several other locations as many times as necessary, according to the soil quality.

### Quick field tests to determine soil texture

For fish-pond construction, it is better to have a soil with a high proportion of silt and/or clay which will hold water well. To check quickly on the texture of the soil at different depths, here are two very simple tests you can perform.

#### Throw-the-ball test

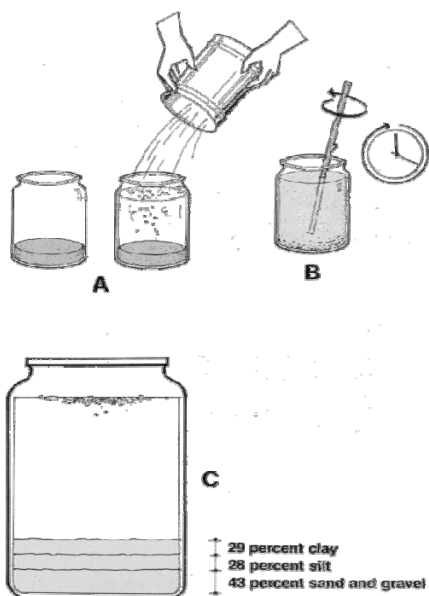


- Take a handful of moist soil and squeeze it into a ball (A)
- Throw the ball into the air (B) about 50 cm and then catch it...
- If the ball falls apart (C), it is poor soil with too much sand;
- If the ball sticks together (D), it is probably good soil with enough clay in it.

### How to find the approximate proportions of sand, silt and clay

This is a simply test which give you a general idea of the proportions of sand, silt and clay present in the soil.

#### The bottle test



- Put 5 cm of soil in a bottle and fill it with water (A);
- Stir the water and soil well, put the bottle down, and do not touch it for an hour. At the end of an hour, the water will have cleared and you will see that the larger particles have settled (B);
- At the bottom is a layer of sand;
- In the middle is layer of silt;
- On the top is a layer of clay. If the water is still not clear, it is because some of the finest clay is still mixed with the water;
- On the surface of the water there may be bits of organic matter floating;
- Measure the depth of the sand, silt and clay and estimate the approximate proportion of each (C).

### Topography

Topography will determine the size and shape of fish farm components; hatchery or production ponds. Gently, flat land is better than sloping. However, some slope or drainage pattern is desirable for draining water from the ponds. Sites should be selected so that water outlet channels can be installed to drain the ponds completely. Floods from nearby water sources should not overflow the ponds.

### CRITICAL FACTORS FOR CAGE-SITE SELECTION

One of the most important factors to consider for cage-site selection is water quality. While many different sites are adapted to cage culture such as lakes, reservoirs, rivers and streams. To maximize good water quality, critical factors that should be considered are:

**Wind and water current.** It is important that the cage be in an area where it will receive maximum natural circulation of water through the cages. Usually, this is in an area that swept by the prevailing wind. However, the cages must be located apart from an area where risk to appear strong wind or storm.

**Water depth.** A minimum of 2 feet of water is needed under the cages to keep cages wastes away from the fish.

**Coves and weed beds.** Coves and weed beds and overhanging trees can reduce wind circulation and potentially cause problems.

**Disturbances.** Disturbances from people frequently walking on the dock, fishing or swimming near the cage, and/or from animals which frequent that area will excite the fish and can cause stress, injury, reduces feeding and secondary diseases.

## **OTHER SITE SPECIFIC CRITERIA**

After requirements for an area have been evaluated, more factors should be considered before final selection of a particular site. First consideration should be availability and second, the comparative cost for capital outlay and operations.

**Utilities.** The availability and cost of power are important factors in selection the site. Utility lines or pipelines rights of way across a potential site should be investigated.

**Accessibility.** This aspect must also be considered. Roads must accommodate vehicles that deliver feed and transport fish. If such roads are not present they must be built.

**Supplies and equipments.** Feed should be available at an economic cost. Ice may be necessary for used while harvesting and hauling fish. Equipments for pond construction and associated structures should be available.

**Labor.** Both skilled and unskilled labor are needed for all aquaculture installations. If not available locally, labor must be imported which may be a considerable cost.

**Market.** Market should be available and not so far from fish farm for transportation cost reason.

**Licenses and permits.** These vary between states and regions. Before making final site selection, contact state or government agencies for information on licenses, permits and regulations.

## **POND DESIGN AND LAYOUT**

This is important for efficient operation of any pond system. A good site survey and layout design will contain the following information:

1. Distances from water supply and access roads.
2. Location, top width, slopes, earth fill requirement, and elevation of dam
3. Emergency spillway location and size
4. Shoreline dimensions
5. Soils investigation report
6. Dimensions of the cutoff trench and core.
7. Location, dimensions and elevations of riser and barrel pipes
8. Estimate of the total cut and fill
9. Watershed area and characteristics
10. Materials needed

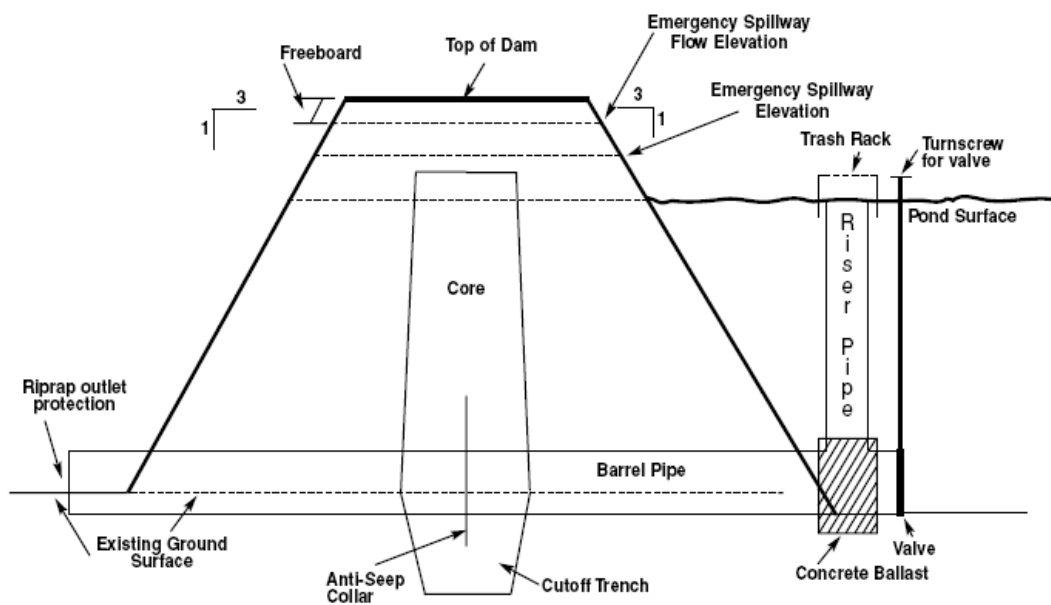
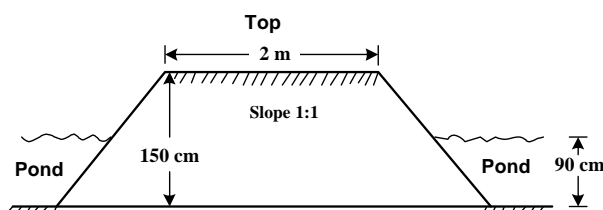
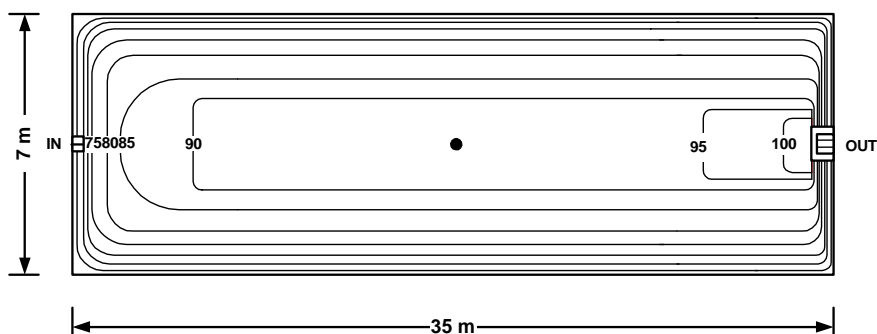
### **Pond size, depth and shape**

Size of production pond should be based on water supply. Water should be deep enough to compensate evaporation and seepage. Marketing strategy also influences pond size. Even during summer drought the water should be at least 1-1.2 meters. Generally, an average water depth in the production pond should be 1.2-1.5 meters. Pond shape should be based on areas, and compensated harvesting. Generally, the production pond is built in square or rectangular shapes of 800-1,600 squaremeters.

### **Pond morphometry**

- Size
- Length
- Width
- Surface area
- Depth

- Dike slope
- Volume



### Hydrology (water budget) of fish pond

Gains	Losses
scheduled filling (f)	scheduled discharge (d)
rainfall (r)	evaporation (e)
seepage (s)	seepage (s)
surface runoff (o)	

$$\text{Water storage} = (f + r + s + o) - (d + e + s)$$

### Equipments needed for monitoring water gains and losses

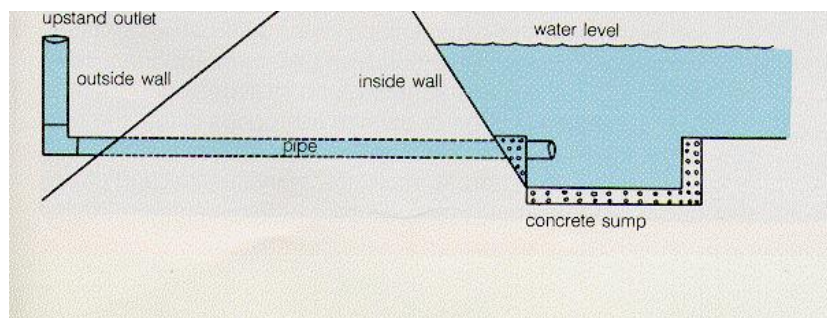
- Depth gauge
- Rain gauge
- Evaporation pan

### **Pump and water supply system**

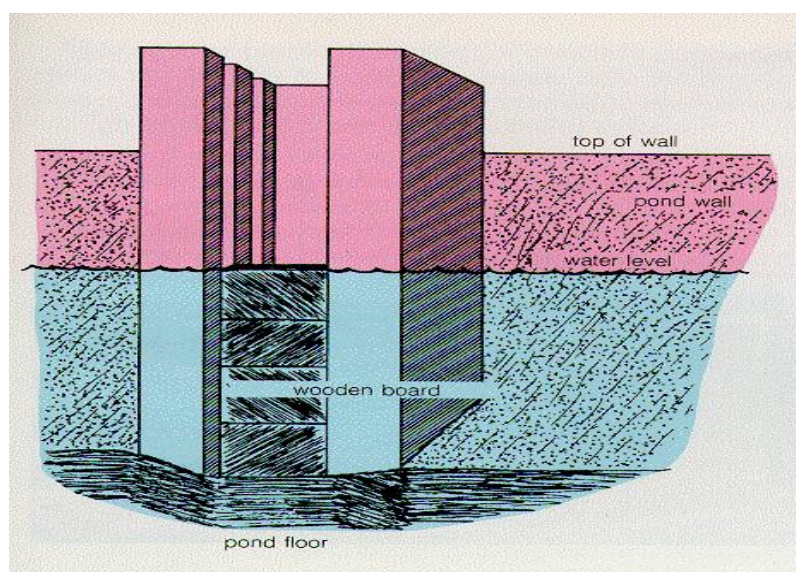
This system must be designed based on the water supply available. Where water is plentiful low lift pumps are preferred. The pipe from the pump should be installed in the dike. Valves should open and close easily and permit water flow control to each pond.

### **Drain pipe requirements**

Design of the drain system should be adequate to handle a 20 percent pond flush and can be drained within a few day. A 1,600 squaremeters pond will require a 4 inch outlet pipe. Drain pipe should be installed at the lowest point in the pond. A barrier should be built at the opening to the drain to prevent fish from escaping.



*Outlet (drain) pipe*



*Water gate*

### **Spillway**

Emergency spillway is required to remove large water quantity of water during heavy rainfall so that water does not flow over the top of the dike. Emergency spillway is variable in width depending on intensity and amount of rainfall, land slope and soil type. A barrier should be stood on spillway to prevent fish from escaping.

## **HATCHERY DESIGN AND COMPONENTS**

Hatchery should be located close water sources so that the distance required to pump water is kept to minimum. Sufficient area need to be available at the site of accommodate the hatchery and ancillary buildings and also to allow for any future expansion.



### Water system (Water treatment area)

High water quality is needed for hatchery. It is important to ensure that the water is treated. So, filtration system and water treatment area are required.

### Broodstock holding and spawning area

Space is required to hold and condition broodstock. The amount of space needed depends in part on the number of species being held. Space is required for spawning pond.

### Larval and juvenile culture area

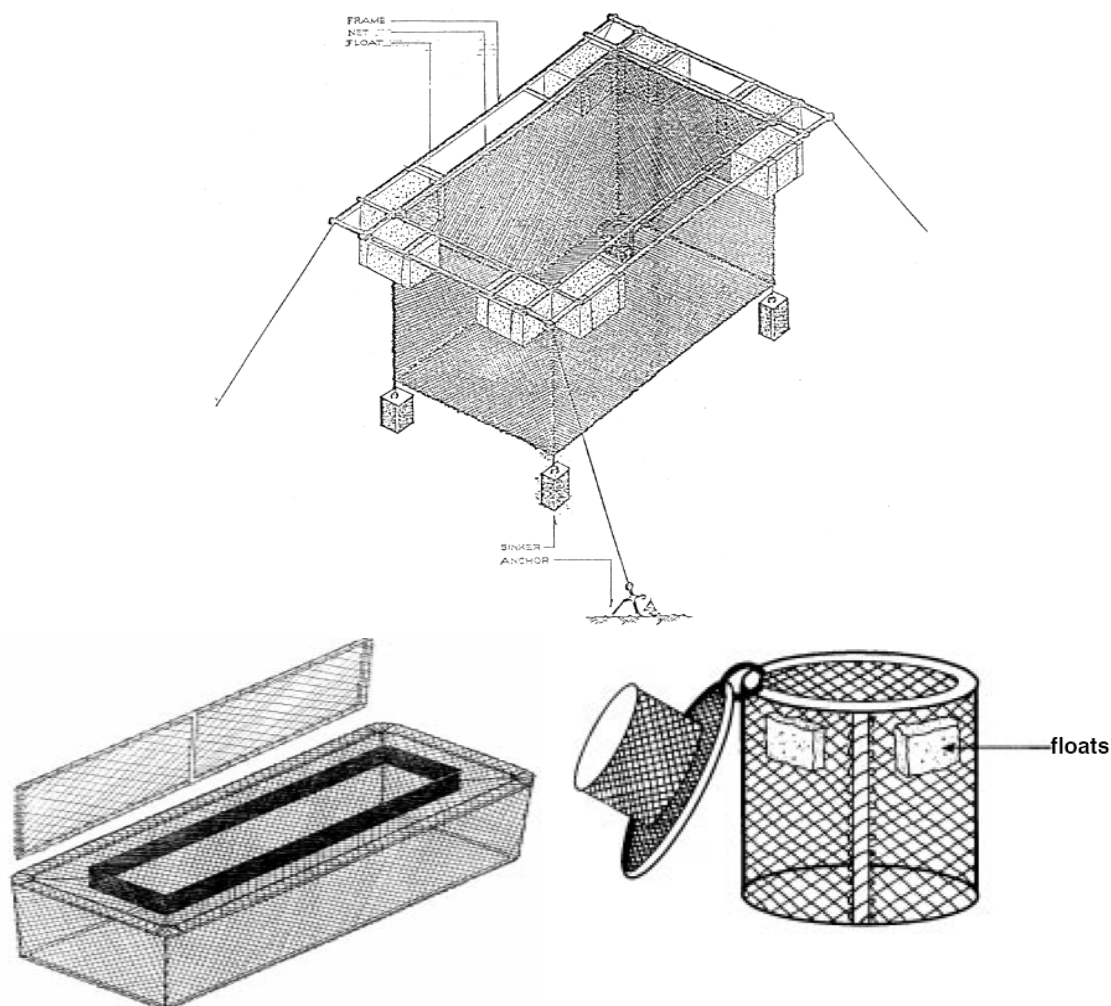
Another major part of the hatchery is occupied by larval and juvenile rearing facility and dimensions of this area depend on the scale of production. The space is occupied with tanks or concrete ponds, the number needed depending on production levels and techniques used to rear larvae and juveniles.

### Other space requirement

Hatcheries dealing with broodstock from outside the immediate region or with exotic species may be required to quarantine stock and rear progeny in isolation. Other rooms including office, laboratory and storage room are also required.

### Cage design, materials and construction

Cages shape and size depend on the size of water body, the availability of aeration and method of harvest. Cages shape may be round, square or rectangular. Shape does not appear to affect production.



Cages for fish culture have been constructed from a variety of materials. Basic cage construction requires that cage materials be strong, durable, and non-toxic. Cage components consist of frame, mesh or netting, lid and floatation. The frame of the cage can be constructed from wood, iron, steel, aluminum, fiberglass or PVC. Frames of wood, iron, steel should be coated with a water-resistant substance like epoxy or swimming pool paint. Bolts or fasteners used to construct the cage should be of rust-resistant materials. Mesh or netting that can be used include plastic coated weld wire, solid plastic mesh and nylon netting (knotted or knot-less). Mesh size should be suitable for fish size and good water circulation through the cage. All cages should have lids to assure that fish do not escape and that predators do not have access to the cages. All cages also need feeding rings to keep floating feed inside the cages.