

# Farming methods

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- Pond culture
- Cages
- Pens enclosure
- Raceway
- Rope
- Raft
- Monoculture
- Polyculture
- Sewage fed culture
- Organic aquaculture

# Cage culture

- Rearing of fish from juvenile stage to commercial size in a volume of water enclosed on all sides.
- Cage culture is suitable to water areas which cannot be drained.
- Cages of metal, bamboo, mesh or nylon mesh are left in flowing water
- Used for salmon, Trouts, Yellow tail, Sea bass, Murrels.
- Cage culture originated in Kampuchia 200 years ago



# Types and layouts of cage farms

1. Floating type of cages
2. Submersible type of cages

# Floating type cage

Consist of:

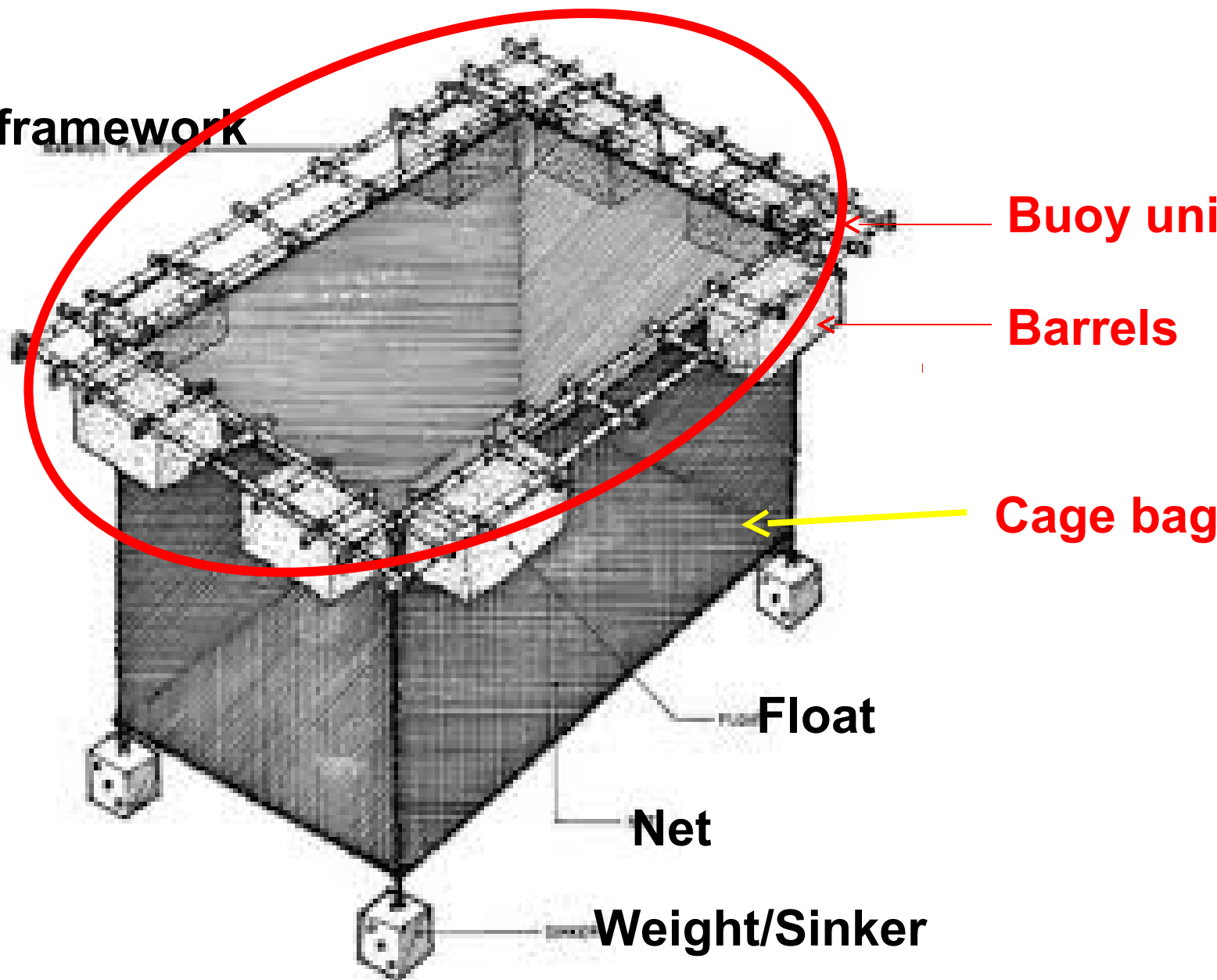
## 1. **Floating unit** in the form of a framework and

- Floating unit contains empty barrels, styrofoam polythene pipes or pontoons of plastic.
- Floating units are built into framework impregnated with wood, bamboo spars, Al bars.

## 2. **Flexible mesh net cage bag** suspended under it.

- Net is commonly made up of Nylon.
- Cages of under water net volume of 200 and 500 m<sup>3</sup> are preferred.
- It is common practice to have **double netting: outer for predators and inner for fish stock**

**Bamboo framework**



**Buoy unit**

**Barrels**

**Cage bag**

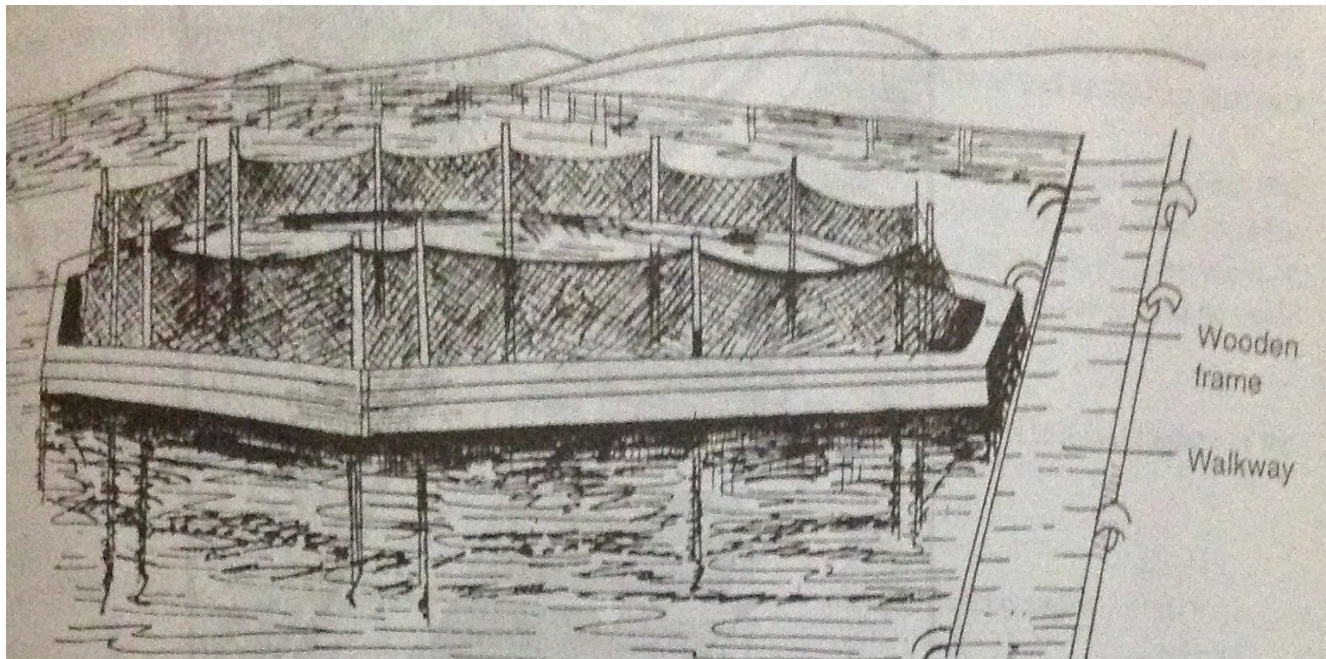
**Float**

**Net**

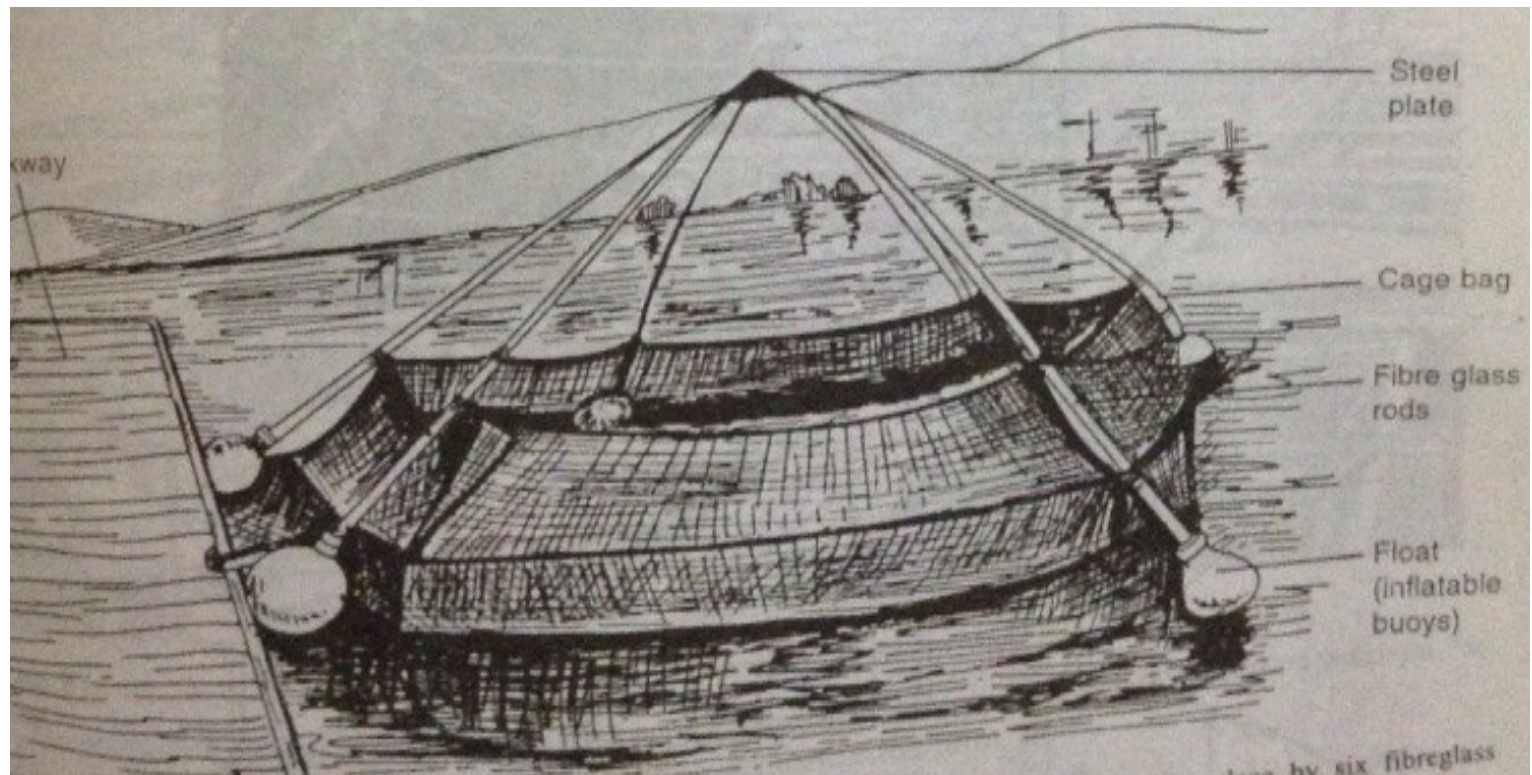
**Weight/Sinker**

**Floating cage structure**

- When timber is used as framework, 6 or 8 sided structures are made.
- Such cages are linked together by flexible joints.



Hexagonal Floating cage with wooden framework

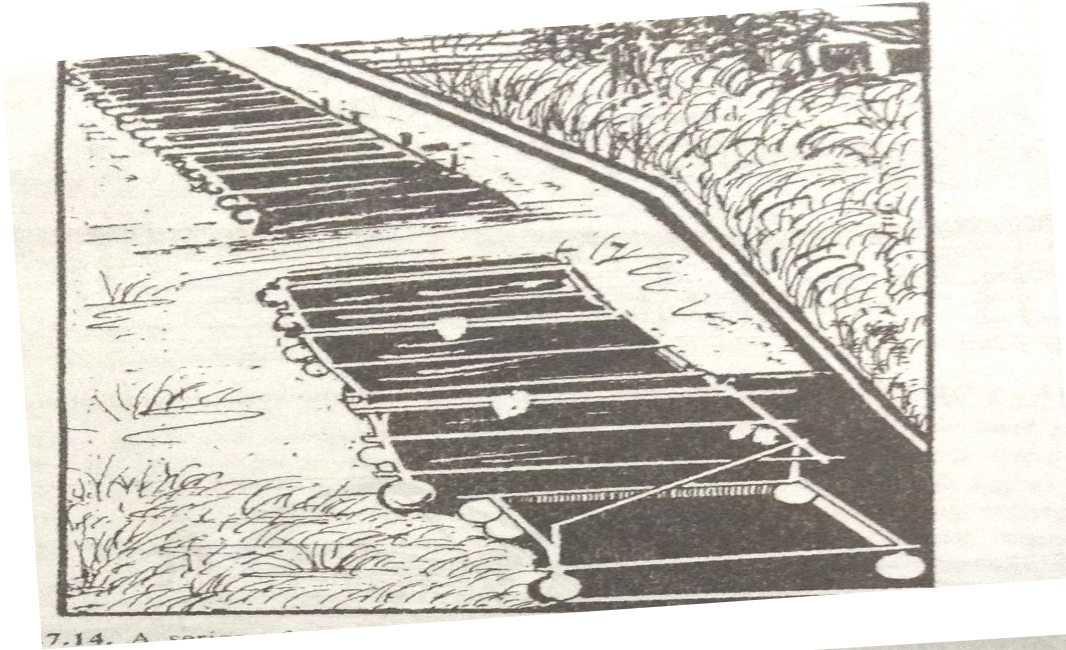


Six sided floating cage (six inflatable rubber buoys are used and kept in place by six fiberglass poles radiating from a steel plate above the cage, looking like inverted umbrella)

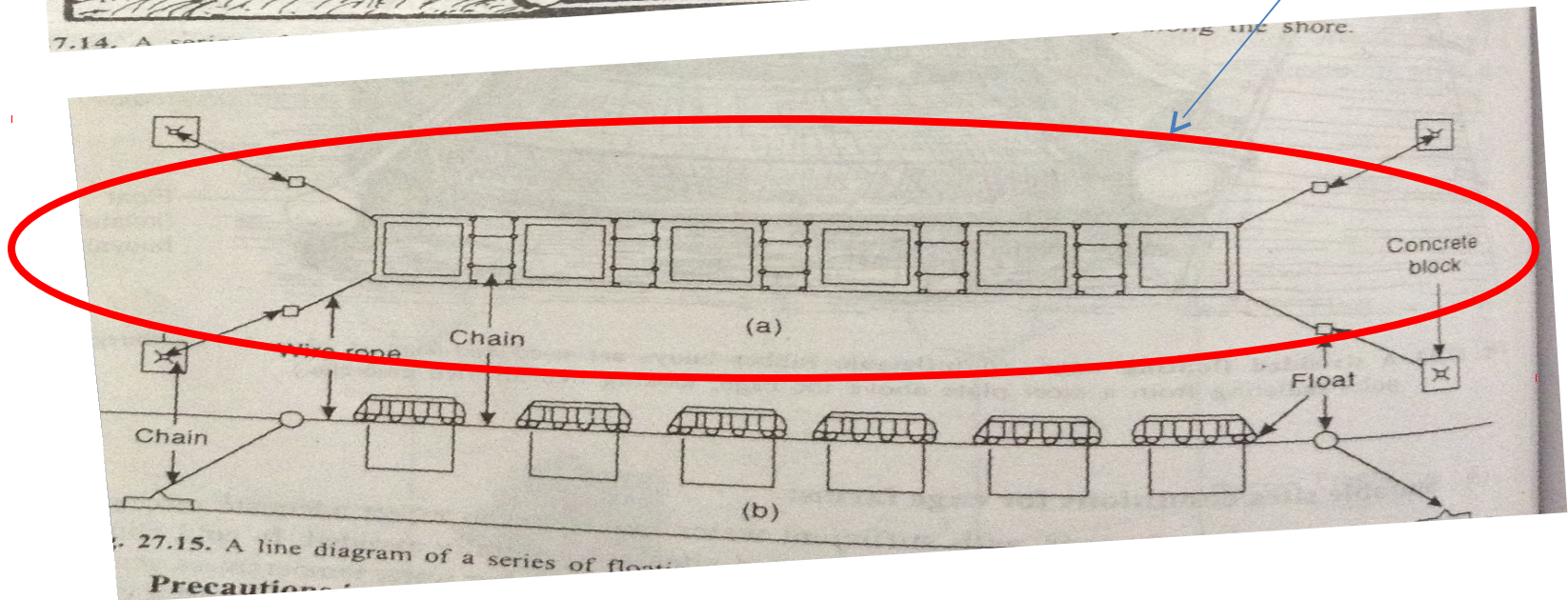
A nylon net is stretched between the laths to prevent leaping fish from escaping.



# Arrangements of floating cages



Top View

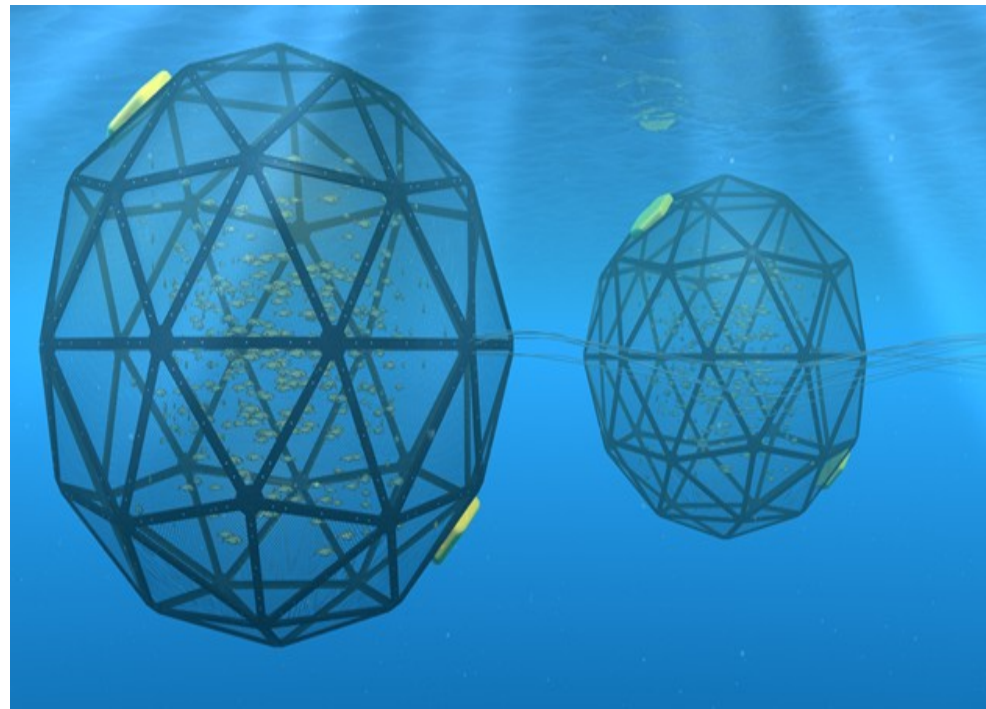


# Submersible type of cage

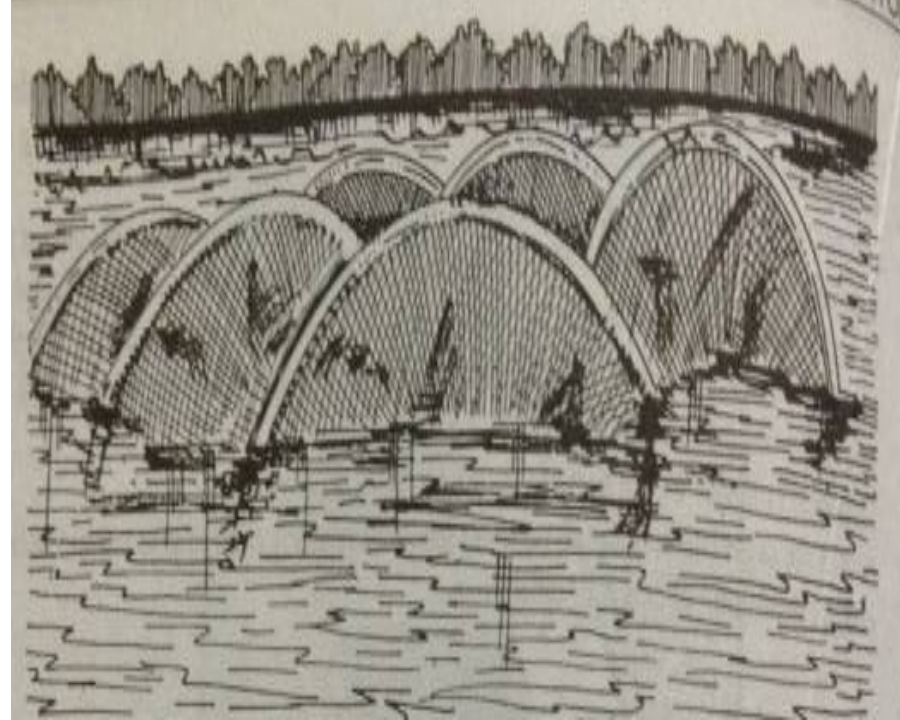
- Generally used in areas subjected to typhoons and cyclons.
- Used in Japan for **yellow tail rearing**.
- Can withstand the wind and waves.
- The shape of cage is maintained by attaching weights of upto 10 kgs at each corner of cage bottom.
- Cage can be lowered or raised in water using ropes.



Submerged cage







Spindle shaped submersible cage

In hurricane affected areas, **Spindle-shaped** collapsible net cages are used. These cages are held in position by circular PVC rings of different diameters.

Under normal conditions, the cages float on the surface but when cyclones or tycoons occur, they **can be sunk to the bottom** by increasing the weights or removing floats

# Suitable sites/ conditions for cage farms

- Areas with sufficient movement of water for adequate mixing and aeration.
- Polluted sites are avoided.
- Cages should be installed in the sides of central walkway to facilitate day to day work on the farm.

# Precautions in using and designing cage farms

- Designing should be based on conditions prevailing at selected sites.
- Cages should be **easy to handle**.
- **Mooring** blocks should be **heavy**.
- Provision should be made for regular, manual and mechanical removal of the wastes.
- Nets should be changed regularly due to fouling of nets.

# Advantages of cage farming

1. Fishes can be stocked at **high density rate**.
2. Enclosed fishes are **protected from predators**
3. Water flowing through the cage brings food supply and carries away water.
4. Management and capital investment is less.
5. Effective use of existing water bodies
6. Technically simple
7. Easier stock management and monitoring

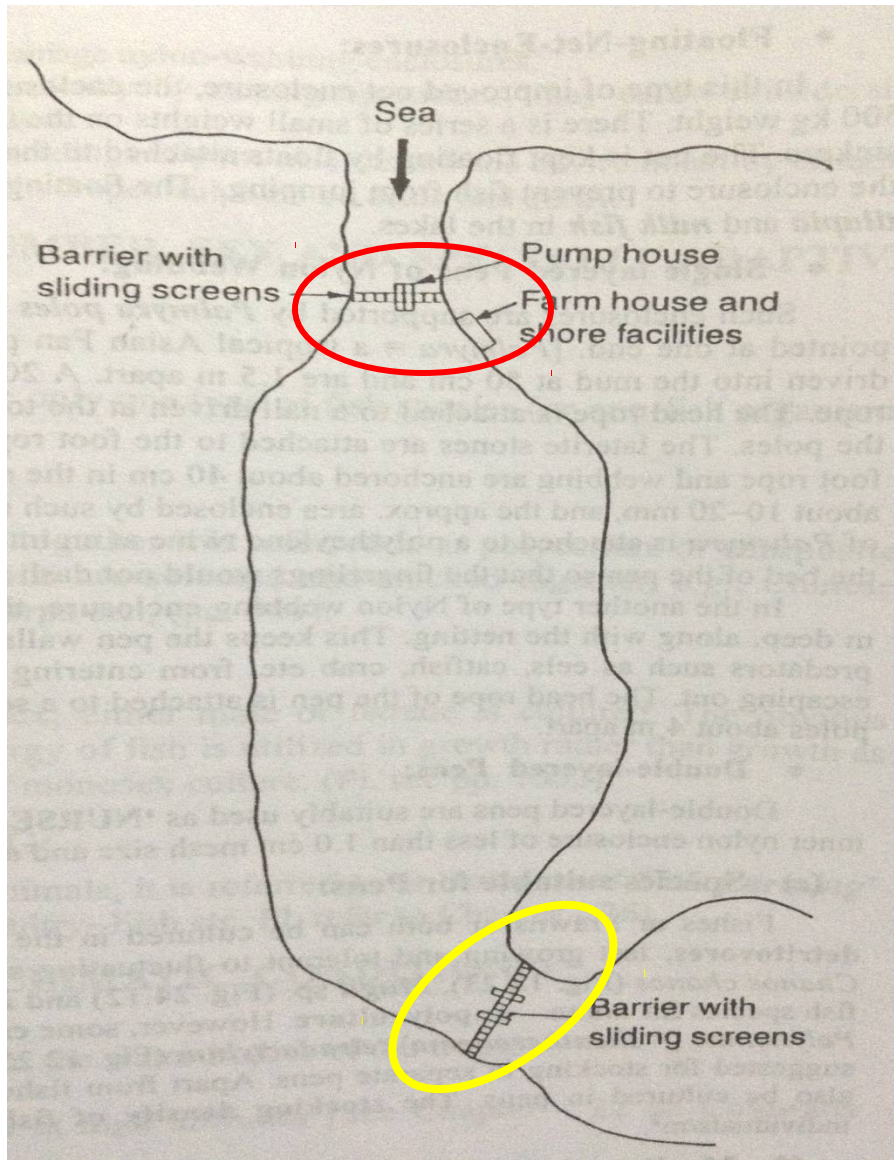
# Disadvantages

- Cages occupy a space (can disrupt access to navigation), reduce land value.
- Increase sedimentation rate.
- Can introduce diseases
- Uneaten food affect water quality



## II) Culture in Pens

- Pens (enclosure): a small enclosure used for confinement or safekeeping of animals.
  - Pen culture is defined as raising of fish in a volume of water enclosed on all sides except bottom
- Transitional structure between ponds and cages.
- Formed by **damming a bay, fjord (an arm of sea), estuary, river, lake or reservoir.**



- **Site:** Pens are those where barriers can be constructed, in order to reduce the costs and inc the ease of operation.
- Sites must be sheltered against high winds.
- Depth > 1 m.

**Area:** enclosure area = 2-7 ha.

**Barriers:** for blind end- one or one series of enclosure.

For continuous flow- two or two series, one upstream and other downstream

# Types of barriers



- **Site material dependent barrier**

Barrier (Dam) made up of stones, sand, soil or concrete.

such barriers are provided with **Screens**, which are made of vertical Al or galvanized metal bars with 1 cm spacing. These prevent the escape of fish.

# Nylon net barrier

- Some enclosures are used to partition off areas of open water body, intertidal area of sea.
- Enclosure is formed on one side by shore and other 3 sides by a wall of **nylon netting** .

# Wire-mesh barrier

- Galvanized wire mesh or chain links are used.
- The net is embedded in the sand or silt at bottom, sealing it properly, to prevent entry of predators.

# Types of enclosures

- Bamboo scaffolding enclosure
- Floating net enclosure
- Single layered pens of nylon webbing
- Double layered pens

# Bamboo scaffolding

- In shallow eutrophic bays and in lakes of China, Bamboo scaffolding of various sizes (2.5 m high, 5-10 m wide) are built.
- Inter space of 1 cm between 2 bamboo splits is essential for exchange of water.





# Floating net enclosure

- the enclosure is held in place by concrete block sinkers of 500 kg wt.
- The net is kept floating by floats attached to headrope.
- Horizontal net is stretched at the top of enclosure to prevent fish from jumping

# Single layered pens of nylon netting

- Such enclosures are supported by Palm poles (3 m length, 15 cm wide and 5 cm thick) which are pointed at one end.
- These poles are driven into mud at 50 cm and are 1.5 m apart.
- A 20 mm rope serves as head rope and foot rope.
- Mesh size of nylon net is about 10-20 mm

# Double Layered pens

- Suitably used for nurseries for fish or prawn seeds.
- These pens have inner- nylon enclosure  
Outer- bamboo mats.

## **Advantages**

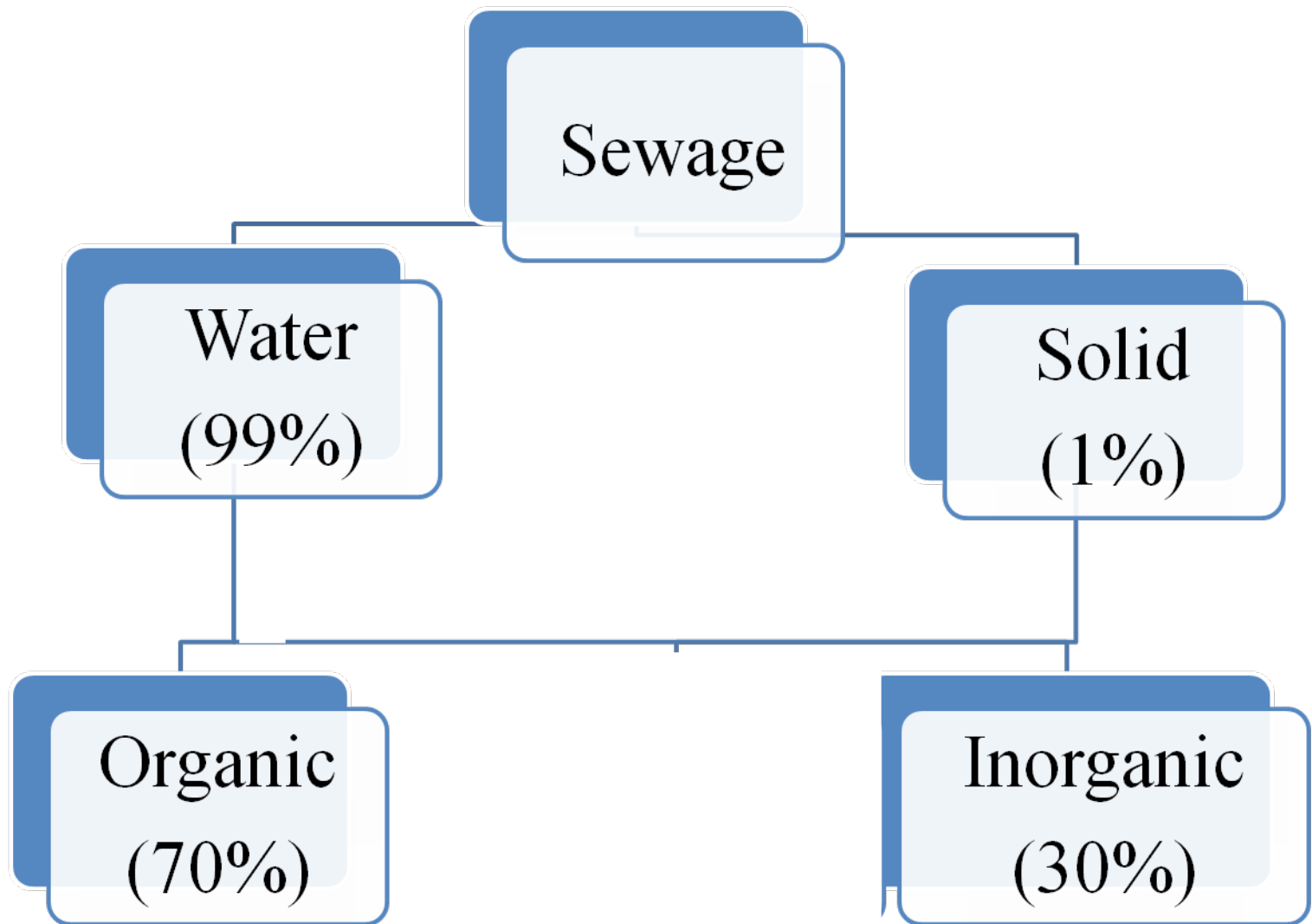
1. Pen culture is a continuous process due to continuous supply of water.
2. Greater production is assured in a limited space with rich food and oxygen supply.
3. Greater growth is possible as energy is saved towards locomotion and feeding etc.
4. Ease of harvest
5. Availability of natural food and exchange of materials with the bottom

# Disadvantages

- Unfavorable weather- damage the pen-culture sites.
- During summer or southwest monsoon, pen culture site may be polluted with dinoflagellates.
- Organisms like Balanus and algae adhere to bamboo poles and cause biofouling.
- Certain sps of crabs may cut and damage nylon webbing enclosure.
- Predator fishes may damage the seed and growing fishes.
- the abundance of sea weeds disturb by lowering oxygen level through release of hydrogen sulphide on death and decay.

# Sewage fed farming

- Fertilizer value of sewage in fish farming has been widely recognized in several countries.
- Sewage is: a **cloudy fluid** arising out of waste, containing **mineral, organic** and **inorganic matter** either in solution or having particles of solid matter floating or in suspension or in colloidal and pseudo-colloidal form of dispersed state.



Component of sewage

- Raw sewage    ↑ BOD, organic carbon,  
Ammonia, Carbon dioxide,  
hydrogen sulphide, bacteria  
                  ↓ DO

It is inimical to fish life.

**Only diluted and pre-treated sewage can be used as fertilizer**

**Sewage is rich in nutrients: Phosphorous and nitrogen.**

**It promotes primary productivity .**

**It develops algal bloom-causes first trophic level consumers (zooplanktons) to flourish**



## System adopted for sewage-fed fisheries



- In India WB, TN are states where sewage-fed fisheries is practicing.
- IN WB- **irrigating fishponds with sewage** or the **sewage is let** into ‘**Bheries**’ - allowed to settle for 15-20 d so that water become clear and loses its foul smell.

# Treatment of sewage for Pisciculture

- Raw sewage – detrimental to fish.

The **strength of sewage** is determined by the **amount of oxygen required to oxidized** the whole **organic matter** and **ammonia** present in it.

## Treatment processes

1. Mechanical treatment  Primary treatment
2. Chemical treatment  Secondary treatment
3. Biological treatment
4. Dilution of sewage

# WASTE WATER TREATMENT

## Primary treatment

Removal of solid particles by

### i) Screening

(for larger coarse particles)

ii) skimming (floating solids)

### iii) sedimentation

(for suspended particles whose density is greater than that of liquid).

**Secondary treatment**-Removal of organic and inorganic soluble matter. Involves:

**Activated sludge**

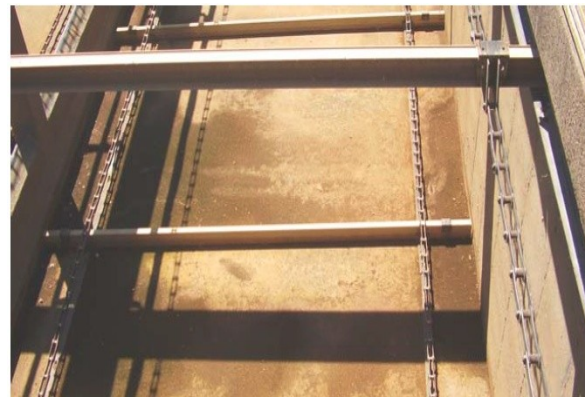
**Filtration**

**Oxidation pond**



Coarse screener for large floating garbage and twigs.

Fine screener



Mechanical Skimming device.

# Mechanical treatment

Use of screening and filtering devices.

Involves :

- **SKIMMING** - to remove suspended matter having a relative density lower than that of liquid part of waste.
- **SEDIMENTATION** - to remove the suspended matter having a relative density greater than that of liquidity.

- Non-settleable solids are coagulated and removed
- Initially **Primary clarification** is done by bringing waste waters to **primary sedimentation tanks** so as to remove or reduce suspended solid content

## Biological treatment

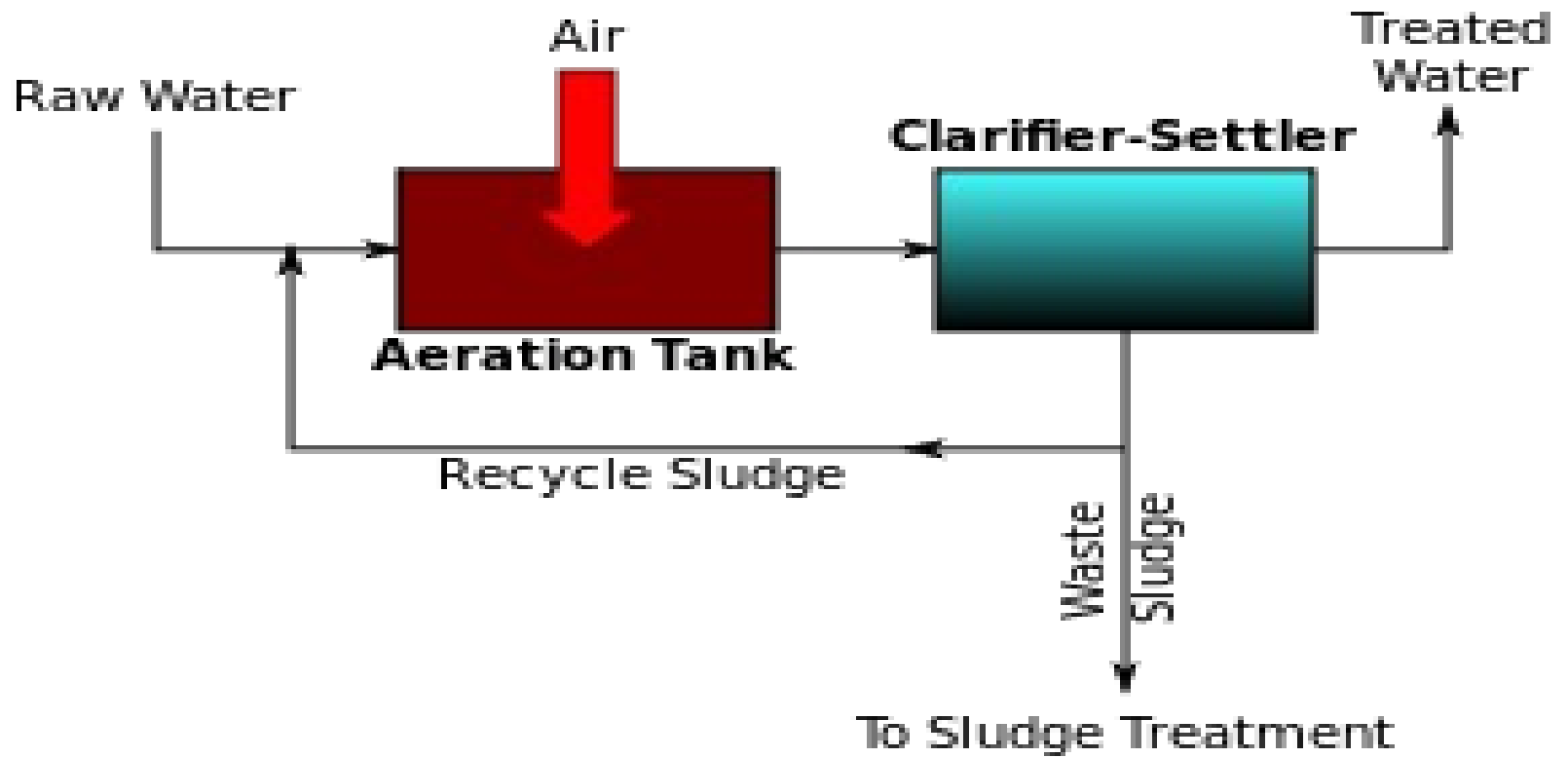
After removal of suspended solid content, the waste water is put to biological treatment for further process:

# Activated sludge process

- It is a process for treating sewage and industrial wastewaters **using air , bacteria and protozoa.**

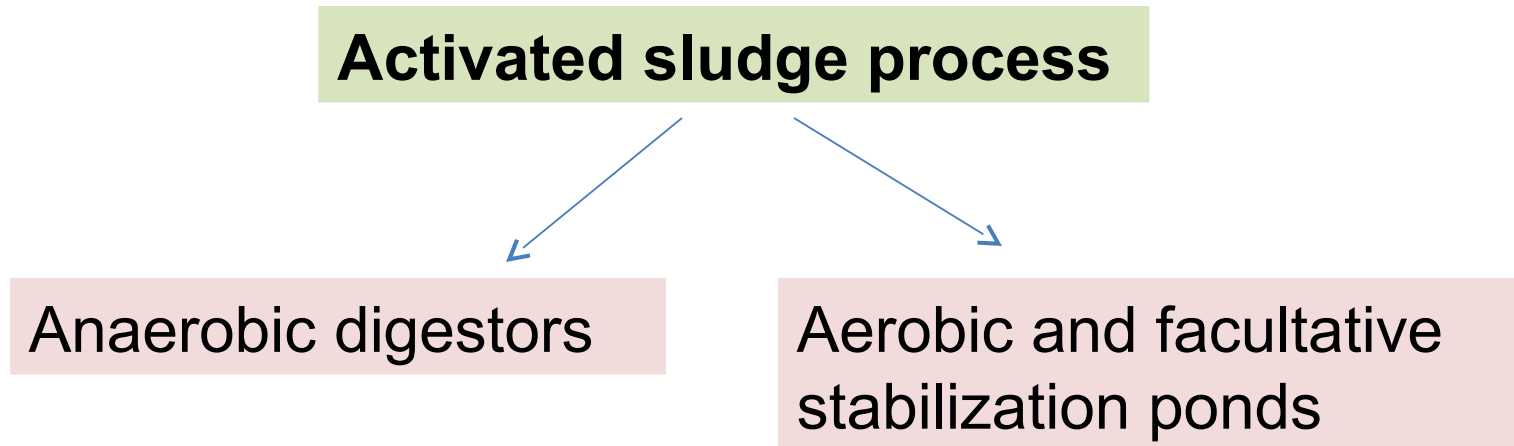
Activated sludge process for removing carbonaceous pollution includes :

- **Aeration tank** where air (or oxygen) is injected in the mixed liquor.
- **Settling tank** (final clarifier or secondary settling tank) to allow the biological flocs (the sludge blanket) to settle, thus separating the biological sludge from the clear treated water.



Activated sludge process

Organic waste brought to reactor (active microbes), oxygen provided, taken to settling tank. In this process **aerobic and facultative bacteria play a very important role.**





# Anaerobic stabilization ponds or anaerobic digestors

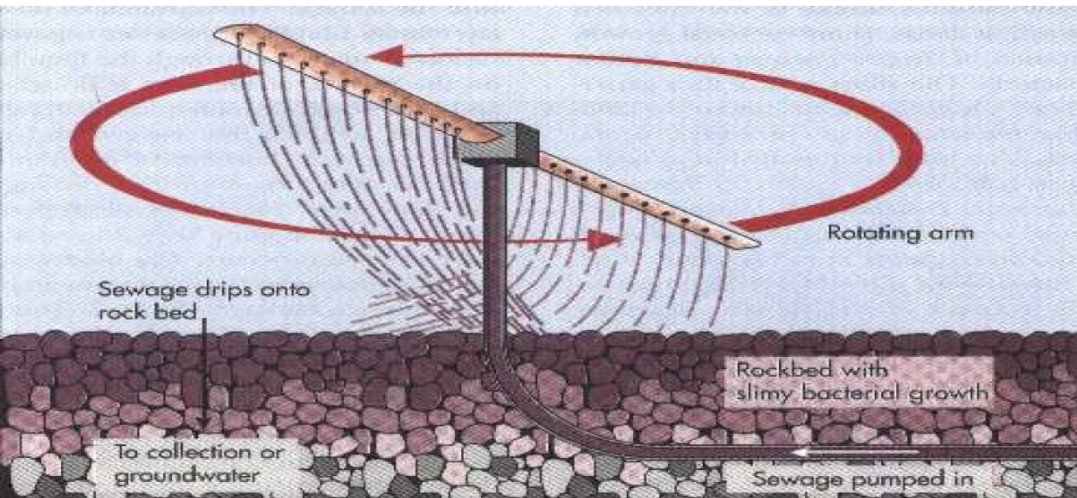
- Used for **high strength organic waste**, containing high quantity of solids.
- Degradation is carried out through anaerobic bacteria.
- After degradation, solid settle, gases escape and final effluent is discharged for another treatment or passed into a fish pond.

# Aerobic and facultative stabilization ponds

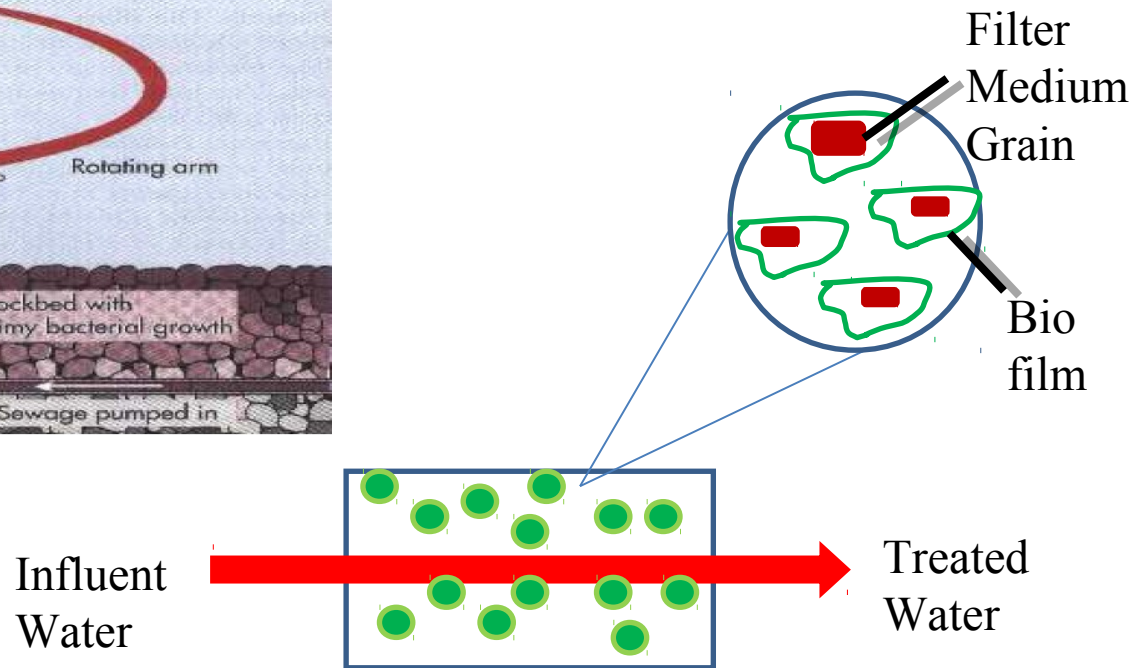
- **Mineralization of organic matter** takes place in **presence of oxygen**, involving an algal-bacterial combination, where the oxygen is supplied by algae for bacteria which carry out the decomposition process.

# Filtration

There are two types of filtration process, viz., mechanical filtration and biological filtration such as trickling filter which uses filter medium grains covered with biofilm.



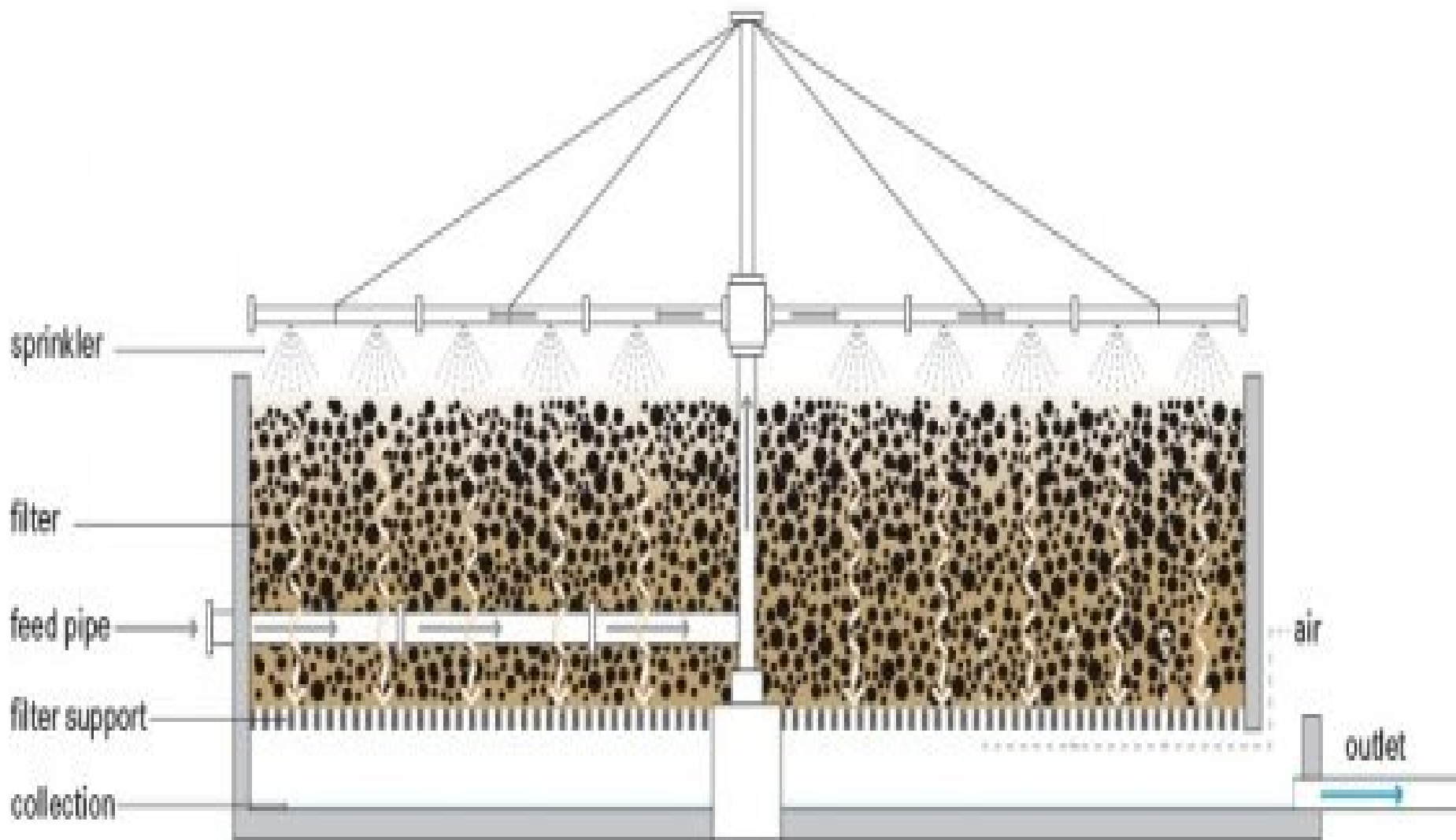
Trickling Filter.



carbon removal through biological filter.

# Trickling filter

- A *trickling filter*, (trickling biofilter, biofilter, biological filter and biological *trickling filter*) is a fixed-bed, biological *reactor* that operates under ***aerobic conditions***. Pre-settled *wastewater* is continuously ‘trickled’ or sprayed over the filter. As the water migrates through the pores of the filter, ***organic waste are aerobically degraded*** by the *biofilm* covering the filter material.



Trickling filter

- The *trickling filter* consists of a cylindrical tank and is filled with a high *specific surface area* material, such as rocks, gravel, shredded PVC bottles, or special pre-formed plastic filter media. A high specific surface provides a large area for *biofilm* formation.
- Organisms that grow in the thin *biofilm* over the surface of the media oxidize the *organic* load in the *wastewater* to carbon dioxide and water, while generating new *biomass*.

# Chemical treatment

- This process aimed at coagulation or chemical precipitation.

Involves:

- Deodorization
- Disinfection

Chemicals like ferric chloride, chlorine, copper sulphate are used.

# PROCESSES ADOPTED FOR SEWAGE TREATMENT BEFORE RELEASING IN FISH POND

**Dilution** A positive DO balance is maintained and the concentration of harmful ingredients such as  $\text{CO}_2$ ,  $\text{H}_2\text{S}$ ,  $\text{NH}_3$  etc can be kept below lethal limit by introduction of sewage in a freshwater body in various proportions like 1 parts of sewage to 5 parts of freshwater or 10 parts of freshwater with 4 parts of sewage are practiced.

**Storage** The oxygen required for biochemical reaction is obtained from freshwater so sewage is stored with freshwater for few days to oxidize the organic matter which make the fluid fit for pisciculture.



# Dilution of sewage

- Diluted by adding freshwater.
- Should be done effectively, to maintain DO balance and CO<sub>2</sub>, NH<sub>3</sub>, H<sub>2</sub>S kept below lethal limits.

# Waste stabilizing ponds

- Ponds where sewage is retained until the waste are rendered stable and inoffensive for discharge into receiving waters.

Types of  
oxidation pond

Aerobic ponds

Anaerobic  
ponds

Facultative  
ponds

# Aerobic Pond

- 0.3 m deep.
- Aerobic conditions are always maintained.
- Waste material is stabilized through micro-organism.

## Anaerobic pond

- 2.5- 3 m deep
- High organic load
- Anaerobic conditions prevailing throughout pond

## Facultative pond

- 0.9- 1.5 m deep
- Aerobic-during day and some hrs during night.
- Anaerobic –at bottom in late hrs of night.
- Used in India.

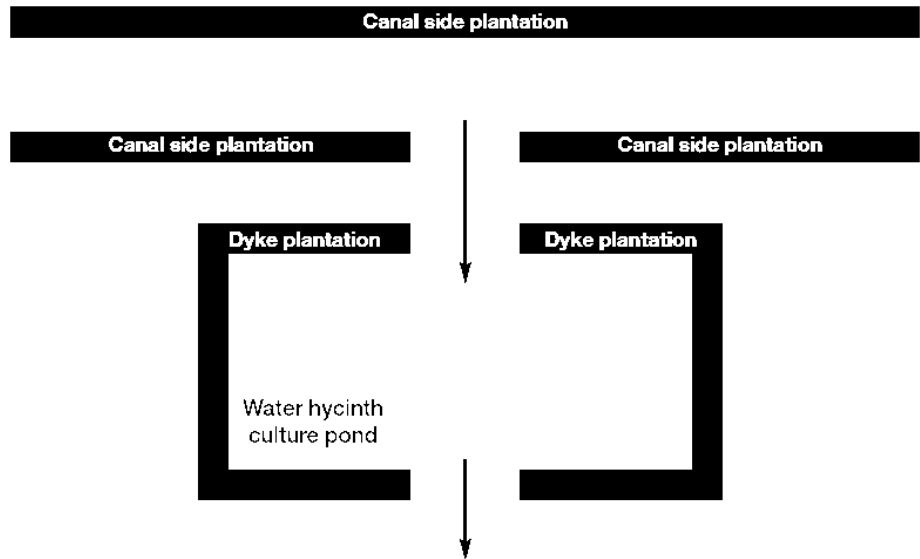
# Permissible physico-chemical parameters

Physico-chemical parameter	Optimum value
Turbidity	12-250 mg/l
pH	8.4-8.6
Total alkalinity	85-96 ppm
DO	8.4-11 ppm
Free Carbon -dioxide	nil
Hydrogen sulphide	nil
Phosphate	0.1 ppm
Chloride	17-22 ppm
Ammonia nitrogen	0.37-0.74 ppm

- i. Sewage is passed in to the pond from the canal through bamboo sluice. It is left to stabilize for 15 to 20 days.
- ii. The self purification of sewage takes place in presence of atmospheric oxygen and sunlight.
- iii. When the water turns green due to photosynthetic activity, the pond is considered as ready for stocking



Open channel through which sewage is flown to the pond.



A schematic diagram of sewage – fed farming.

# **ADVANTAGES**

1. The sewage fed fish culture uses the waste recycling process and maintains the good environment around the urban area.
2. Manuring and supplementary feeding is not required due to high content of nutrients in sewage.
3. Input cost is very low and production is very high.
4. This is the biological method of treating waste water before its final disposal in river.

# **DISADVANTAGES**

1. The sewage contain high load of organic and inorganic matters and toxic gases which may harm fish consumers.
2. As the raw sewage is used in fish ponds, there is a chance of infection and pollution to enter into human body through food chain. But this risk can be minimized if good managerial practice is followed.

### III) Monoculture

- Only one fish species is reared in a culture system
- Trout, tilapia, catfishes, carps, shrimp

### IV) Polyculture (Composite fish farming)

- Two or more different fish species are farmed
- Polyculture practices give higher yield than monoculture

The principal requirements of different species for polyculture are

- Different feeding habits
- Should occupy different columns in a pond system
- Should attain marketable size at the same time
- Should be non predatory in behaviour



# Organic farming using organic fertilizers

- Organic fertilizers- plant and animal origin. Nutrients in them are available directly or after decomposition and transformation by microbes.

Organic fertilizers

**With lil or no carbohydrates**

**With carbohydrates content only**

**With carbohydrates & nitrogenous matter**

# 1. Organic manures with little or no carbohydrates

Includes: liquid manure from stable, byres, dried blood, slaughterhouse offal, guano

- Ponds treated with **Liquid manure** procured from stables and byres (Cow-shed) imparts fertility for good fish yield.
- Applied in **small doses once or twice every 8 days** in deeper parts of ponds → **stimulated growth of phytoplankton, filamentous algae and zooplankton.**

Increased yield through use of

- **Guano** (manure from birds excreta)
- Blood meal
- Mixture of **slaughterhouse offal** and superphosphate

# Organic manures containing mainly carbohydrates

Includes: Mustard oil cake, mahua oil cake, cotton seed meal, soybean meal, compost

- I) **Mustard oil cakes**, used singly or in combination with cowdung are suitable.
  - Mahua oil cake serve as fertilizer leading to the development of plankton.
- II) **Green manuring**: Undecomposed green plant tissue is turned into soil by sowing a nitrogenous or other crop on dry pond bottom.

In Orrisa, green manuring is practised by growing *Sesbania* sp (leguminous plant) on pond beds.

# Merits of green manuring

- Induces microbial activity in soil, thus raising the productivity.
- After the decay, the humus compounds produced increase the absorptive capacity of soil, promoting aeration, drainage, granulation.
- If leguminous plants are used, the soil nitrogen is restored.
- It increase availability and solubility of lime and phosphoric acid.
- After decomposition, it provides inorganic nutrients directly to soil.

- III) Compost: formed by dumping organic wastes, vegetables debris, cut grass, cow dung, aquatic weeds etc. in large pit covered by soil.
- While dumping the layer of about 30 cm high are alternatively dusted with superphosphate of lime.
- The anaerobic bacteria, in the presence of nitrogen, cause effective humification → results in ↓ % of C/N (1:10). (Done by adding sodium nitrate /1000 kg of compost).
- Water is also added to maintain humidity.
- Compost is up-turned after 5-8 weeks and ready to use after 3 months.
- Dose recommended: 5000 kg compost/ha

# Organic manures with carbohydrates and nitrogenous matter

1. **Farmyard manure:** widely used. Cow dung and pig dung are useful for conditioning the soil of a new pond and providing a readymade mass of organic matter containing necessary nutrients.
2. **Poultry manure:** has imp soluble inorganic salts required for imparting productivity to water. Leads to integrated fish farming.
3. **Sewage as fertilizer**
4. **Sludge as fertilizer**