

**APICULTURE AND AQUACULTURE WEEK 9: BIOLOGY AND
BEHAVIOUR OF FISH SPECIES AND IDENTIFICATION OF
COMMONLY FARMED FISH SPECIES**

BY

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Different systems of aquaculture

❖ Aquaculture practices are classified in several ways, depending upon the different aspects and situations involved in the culture practice. Some major and important classifications are given below based on the different factors involved in aquaculture ().

□ On the basis of salinity

▪ **Freshwater farming:** Farming of aquatic animals and plants in zero saline water, mostly fresh water farming is inland based. Catla, Rohu, Mrigal, Silver carp, Grass carp, Common carp and Fresh water prawn are mainly farmed in fresh water.

Different systems of aquaculture

□ On the basis of salinity:

- **Brackishwater farming:** Brackishwater is a mixture of seawater and freshwater with a salinity less than 30ppt. All estuaries, backwaters, creeks and mangrove waterways are brackish in nature. Over 25 species of commercially important fishes, shrimps, crabs and mollusks offer a wide scope for farming in brackishwater.
- **Marine water farming:** Farming of aquatic animals and plants in sea water is commonly known as mariculture. In mariculture rearing of commercially important fishes and shell fishes are done in open sea by installing cages.

Different systems of aquaculture continue ...

❖ On the basis of intensity:

▪ Extensive fish farming system:

Extensive fish farming system is the least managed form of fish farming, in which little care is taken. This system involves large ponds measuring 1 to 5 ha in area with stocking density limited to only less than 5000 fishes/ha. No supplemental feeding or fertilization is provided. Fish depends only on natural foods. Yield is poor (500 to 2 ton/ha) and survival is low. The labour and investment costs are low and this system results in minimum income.

Different systems of aquaculture continue ..

❖ On the basis of intensity:

▪ **Semi-intensive fish farming system:**

Semi-intensive fish culture system is more prevalent and involves rather small ponds (0.5 to 1 hectare in area) with higher stocking density (10000 to 15000 fish/ha). In this system care is taken to develop natural foods by fertilization with/without supplemental feeding. However, major food source is natural food. Yield is moderate (3 to 10 ton/ha) and survival is high.

Different systems of aquaculture continue ..

❖ On the basis of intensity:

▪ Intensive fish farming system:

Intensive fish farming system is the well-managed form of fish farming, in which all attempts are made to achieve maximum production of fish from a minimum quantity of water. This system involves small ponds/tanks/raceways with very high stocking density (10-50 fish/m³ of water). Fish are fed completely formulated feed. Good management is undertaken to control water quality by use of aerators and nutrition by use of highly nutritious feed. The yield obtained ranges from 15 to 100 ton/ha or more. Although the cost of investment is high, the return from the yield of fish exceeds to ensure profit.

Different systems of aquaculture

□ On the basis of fish species

- **Monoculture:** Monoculture is a fish production system in which only one fish species is reared in a culture system. The major fish varieties reared in monoculture system are trout, tilapia, catfishes, carps, shrimp etc.
- **Polyculture:** is a fish production system in which two or more different fish species are farmed or culture of fish along with some other aquatic animals like shrimp or prawn. In this system of culture species with different habitats and different food preferences are stocked together in such densities that there will be almost no competition for food or space.

The principal requirements of the different species in combination for poly-culture are:

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

Different systems of aquaculture

- **On the basis of enclosure used for culture**

Pond culture:

It is the most common method of fish culture. In this case water is maintained in an enclosed area by artificial construction of dike/bund, where fish is stocked and grown.

Ponds are usually filled by rain, canal water and by man made bores. They differ widely in shape, size, topography, water and soil qualities.

Types of fish ponds

1. Earthen Ponds: Earthen ponds are the most common and traditional type of fish ponds. They are constructed by excavating soil to create a basin. The shape and size of earthen ponds can vary, and they are typically lined with clay to prevent water seepage.

Earthen ponds are suitable for a variety of fish species and are cost-effective to construct. They are well-suited for extensive and semi-intensive fish farming.

2. Concrete Ponds: Description: Concrete ponds are constructed using concrete walls and floors. They are more durable and have a longer lifespan compared to earthen ponds. These ponds are often used in intensive fish farming systems.

Concrete ponds are suitable for tilapia and catfish farming, and they allow for better control of water quality. However, they are more expensive to construct compared to earthen ponds.

Types of fish ponds

3. Plastic-Lined Ponds: Description: Plastic-lined ponds involve using high-density polyethylene (HDPE) or other plastic liners to create a barrier between the soil and water. This helps to prevent water seepage.

Plastic-lined ponds are suitable for areas with high seepage rates and can be used for both extensive and intensive fish farming. They are relatively easy to install.

4. Tank Ponds: Description: Tank ponds are essentially large tanks or containers used for fish farming. They can be made of fiberglass, plastic, or other materials.

Tank ponds are suitable for small-scale fish farming, especially in areas with limited space. They are often used for raising specific fish species, such as ornamental fish.

Cage culture

Cage culture involves confining fish within floating cages in natural water bodies such as lakes, reservoirs, or large ponds. The cages are usually made of netting or mesh.

Cage culture is suitable for open water bodies, and it allows for the cultivation of fish in a controlled environment while utilizing existing water resources.

Advantages of using cages in aquaculture

- **Efficient Space Utilization:** Cages maximize the use of available water bodies without land requirements.
- **Improved Water Quality:** Natural water flow removes waste, improving water quality and reducing maintenance.
- **Easy Monitoring:** Cages allow easy observation of fish health, feeding, and growth rates.
- **Reduced Disease Spread:** Controlled environments help manage disease outbreaks and isolate affected stock.

Advantages of using cages in aquaculture

- **Enhanced Feeding Control:** Targeted feeding within cages minimizes waste and improves feed efficiency.
- **Reduced Predation:** Cages provide protection against predators, reducing stock losses.
- **High Stock Density:** Cages support higher stocking densities compared to open water.
- **Portable:** Cages are easy to relocate based on water conditions and temperature

Advantages of using cages in aquaculture

- **Low Initial Cost:** Cage aquaculture is less capital-intensive than pond or tank systems.
- **Accessibility:** Easier access to fish for harvesting or treatment.
- **Flexibility in Species:** Suitable for multiple species, enhancing biodiversity.
- **Environmental Integration:** Minimal environmental footprint with reduced land modification

Limitations of using cages in aquaculture

- **Pollution Risk:** Waste buildup around cages can degrade water quality.
- **Disease Spread:** High fish densities in cages can increase susceptibility to disease outbreaks.
- **Feed Loss:** Uneaten feed disperses in open water, causing wastage.
- **Predation:** Vulnerable to predator attacks like birds and larger fish.

Limitations of using cages in aquaculture

- **Escapes:** Fish can escape from cages, affecting wild populations.
- **Environmental Dependency:** Reliant on natural water bodies, making it sensitive to water quality changes.
- **High Maintenance:** Requires regular cleaning to prevent algae and biofouling.
- **Weather Vulnerability:** Cages are exposed to storms and rough water, which can damage infrastructure.

Limitations of using cages in aquaculture

- **Limited Species:** Not all species are suitable for cage culture due to environmental needs.
- **Overcrowding:** High-density stocking can lead to stress and lower growth rates.
- **Initial Setup Costs:** Although lower than tanks, initial cage setup can still be costly.
- **Regulatory Restrictions:** Permits may be required, limiting access to some water bodies.

Pen culture

- Pen culture is defined as raising of fish in a volume of water enclosed on all sides except bottom, permitting the free circulation of water at least from one side. This system can be considered a hybrid between pond culture and cage culture. Mostly shallow regions along shores and banks of the lakes and reservoirs are used in making pen/enclosure using net/wooden materials where fish can be raised.
- In a fish pen, the bottom of the lake forms the bottom of the pen. Pen has the advantage of containing a benthic fauna which serves as food for the fish and polyculture can be practiced in pens as it is in ponds. The environment in fish pen is characterized by a free exchange of water with the enclosing water body and high dissolved oxygen concentrations.

Advantages of using pen in aquaculture

- a. Intensive utilization of available space : Stocking density can be increased compared to that of a pond culture system
- b. Safety from predators: Within the enclosure the predators can be excluded. In the larger pens this would be more difficult, but in smaller pens this can be done as efficiently.
- c. Suitability for culturing many varied species : Due availability of more space and the natural water system

Advantages of using pen in aquaculture

d. Ease of harvest : In the large pens the harvest may not be as easy as in cage rearing but it more controllable and easier than in the natural waters.

e. The flexibility of size and economy : When compared with the cage, pens can be made much larger and construction costs will be cheaper than that of the cages.

Availability of natural food and exchange of materials with the bottom : Since, the bottom of the pen is the natural bottom, the pen cultured organisms are at an advantage that they can procure food/exchange materials from the natural bottom.

Disadvantages/limitations of using pen in aquaculture

- a. High demand for oxygen and water flow
- b. Dependence on artificial feed
- c. Food losses : Part of the feed is likely to be lost uneaten, and drifted away in the current, but the loss here would be less than in floating cages.
- d. Pollution : Since a large biomass of fish are cultured intensively a large quantity of excrements accumulate in the area and cause a high BOD - also substances such as ammonia and other excreted materials, if not immediately removed/ recycled. They pollute the water and cause damages.

Disadvantages/limitations of using pen in aquaculture

e. Rapid spread of diseases : For the same reason of high stocking density in an enclosed area, any disease beginning will spread very quickly and can cause immense mortality of stock and production decline.

f. Risk of theft : Since the fish are kept in an enclosed area, 'poaching' and thefts can take place more frequently than in natural waters, but perhaps less than those from cages.

g. Conflict with multiple use of natural waters : In locations where a pen is constructed, if the water is used for multipurpose like irrigation and recreational activities, such as swimming, boating etc. may lead to conflicts.

Raceway

Raceway culture is defined as raising of fish in running water. It is a high production system in which fishes are grown in higher stocking density. Raceways are designed to provide a flow-through system to enable rearing of much denser population of fishes.

Raceway ponds are basically of two types:

Linear type : Ponds arranged in sequence. In a linear type, the volume of water entering each pond is larger and as the same water is used repeatedly from pond to pond, occurrence of disease in initial ponds may directly affect the other connected ponds

Lateral type : Ponds laid out in parallel. In a lateral or parallel type the volume of water entering each pond is smaller but a fresh supply of water is always ensured, and no transfer of disease from one pond to another.

Recirculating Aquaculture system (RAS)

A Recirculating Aquaculture System (RAS) can be defined as an aquaculture system that incorporates the treatment and reuse of water with less than 10% of total water volume replaced per day. The concept of RAS is to reuse a volume of water through continual treatment and delivery to the organisms being cultured (Marques et al., 2016).

Water treatment components used in RAS need to accommodate the input of high amounts of feed required to sustain high rates of growth and stocking densities typically required to meet financial outcomes.

Different systems of aquaculture

On the basis of different farm integration

Fish farming with agriculture

In the fish integrated agriculture system, fish culture is integrated with agricultural crops such as rice, banana and coconut, thereby producing fish and agricultural crops. Agriculture based integrated systems include rice-fish integration, horticulture-fish system, mushroom-fish system, seri-fish system.

Different systems of aquaculture

- **Rice-Fish integrated farming:**

In this system of farming fish is farmed in paddy fields, not all paddy varieties are suitable for integrated fish farming. Varieties with strong root system like Tulsi, Panidhan, CR260 77, ADT 6, ADT7, Rajarajan and Pattambi 15 and 16 are suitable for farming in combination with fish because it has strong roots to withstand flood conditions. The fish species such as Common carp, Tilapia and Murrells are most suitable for culture in rice fields.

Different systems of aquaculture

- **Horticulture-Fish integrated farming:**

The dykes and the adjoining areas of the ponds can be best utilized for horticulture crops. The top, inner and the outer dykes can be planted with dwarf variety coconut, mango and banana. And the side by land can be used for planting pineapple, ginger, and turmeric and chilly. The exchanging water can be used to water the plants which is rich in organic load. The residues from the vegetables cultivated could be recycled into fishponds, particularly when stocked with fishes like grass carp.

Different systems of aquaculture

- **Mushroom-Fish integrated farming:**

Cultivation of mushroom requires high degree of humidity and therefore its cultivation along with aquaculture tremendous scope. *Agaricus bisporus* , *Volvariella* spp. and *Pleurotus* spp., are commercially cultured mushrooms in India.

Different systems of aquaculture

- **Seri-Fish integrated farming:**
- In this farming system silk worm is cultured along with fish. Here the mulberry leaves produced is primarily consumed by the silk worm and the faeces of the silk worm is directly applied to the fish pond to increase of natural food organism-detritus and bacteria in fishpond.

Different systems of aquaculture

- **Livestock integrated fish farming:**

Livestock integrated fish farming system includes cattle-fish system, pig-fish system, poultry-fish system, duck-fish system, goat-fish system, rabbit-fish system. In this integrated farming the excreta of ducks, chicks, pigs and cattle are used directly in ponds to increase plankton production which is consumed by fish or serve as direct food for fish. Hence, the expenditure towards chemical fertilisers and supplementary feeds for fish ponds are totally avoided reducing the production cost.

Different systems of aquaculture

Cattle-Fish integrated farming:

Cow dung is the most widely used manure, in fish ponds all over the world. A healthy cow excretes over 4,000-5,000 kg dung, 3,500-4,000 litre urine annually. For 1 ha pond 5-6 cows can provide adequate manure. An additional income is generated from milk (9,000 litres/year) and fish production ranges from 3,000-4,000 kg fish/ha/year.

Different systems of aquaculture

- **Pig-Fish integrated farming:**

In this farming system 60-100 no of pigs are enough to fertilize one hectare area fish pond. A floor space of 3-4m² is required for a single pig. Five tones of pig manure is required for manuring 1 ha fish pond for 1 year. Pigs are fed with kitchen waste, aquatic plants and crop wastes. The waste produced by 30-35 pigs is equivalent to 1 tonne of ammonium sulphate. Exotic breeds like White Yorkshire, Landrace and Hampshire are reared in this farming system. Grass carp, silver carp and common carp (1:2:1 ratio) are suitable for integrated farming with pigs.

Different systems of aquaculture

- **Poultry-Fish integrated farming:**

Chicken droppings are rich in phosphorus and nitrogen, so chicken manure is an effective fertilizer. For 1ha fish pond 25,000 chicks can be reared. Poultry shed is constructed above the pond with bamboo flooring to facilitate the direct fertilization of the pond (Margues et al., 2016). One chicken produces 25 kg poultry manure per year. From poultry 90,000 to 1,00,000 eggs and 2500 kg meat can be produced and 3000 – 4500 kg of fish can be produced without any chemical fertilizer and supplementary feeding.

Different systems of aquaculture

- **Duck-Fish integrated farming:**

In Duck-fish integrated farming, ducks provide a safe environment to fish by consuming juvenile frogs, tadpoles and dragonfly in the pond. As the duck spends most of its time swimming in the pond the dropping goes directly in pond, which in turn provides essential nutrients to stimulate growth of natural food in the fish pond.

The duck dropping contain 25 per cent organic and 20 per cent inorganic substances with a number of elements such as carbon, phosphorus, potassium, nitrogen, calcium, etc. Hence, it forms a very good source of fertilizer. To fertilize 1 ha fish pond number of ducks required is between 100 and 3,000, depending on the duration of fish culture and the manure requirements.

Small ruminants such as goats and sheep are integrated with fish culture is practised, but on a very small scale. Integrated rabbit-fish farming is also practiced only on a very small scale. This system has up to now not received much attention.

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