D.N.R COLLEGE (A)BHIMAVARAM

DEPARTMENT OF AQUACULTURE

SEMESTER -I

PAPER-I BASIC PRINCIPLES OF AQUACULTURE

Unit-I Essay questions

SCOPE AND SIGNIFICANCE OF AQUACULTURE

Scope and definition

Rearing and propagation of selection of economically important species culture under controlled or semi controlled conditions is called Aquaculture.

The word 'aquaculture', though used rather widely for the last two decades to denote all forms of culture of aquatic animals and plants in fresh, brackish and marine environments, is still used by many in a more restrictive sense. For some, it means aquatic culture other than fish farming or fish husbandry, whereas others understand it as aquatic farming other than mariculture. It is also sometimes used as a synonym for mariculture. However, the term aquaculture is sufficiently expressive and all-inclusive. It only needs a clarification that it does not include the culture of essentially terrestrial plants (as, for example, in hydroponics) or of basically terrestrial animals. However, when it needs to be used to denote

The type of culture techniques or systems (e.g. pond culture, raceway culture, cage culture, pen culture, raft culture),

The type of organism cultured (e.g. fish culture or fish husbandry, oyster, mussel, shrimp or seaweed culture),

The environment in which the culture is done (e.g. fresh water, brackish water, salt water or marine aquaculture or mariculture) or

a specific character of the environment used for culture (e.g. cold-water or warm-water aquaculture; upland, low land, inland, coastal, estuarine), the use of restrictive terms would probably be more appropriate.

While aquaculture is generally considered a part of fisheries science, there is now a tendency to denote the distinction between the two by using the term 'fisheries and aquaculture', because of some of the basic differences in development and management.

Significance of aquaculture

1. Alternative food source

Fish and other seafood are good sources of protein. They also have more nutritional value like the addition of natural oils into the diet such as omega 3 fatty acids. Also since it offers white meat, it is better for the blood in reducing cholesterol levels as opposed to beef's red meat. Fish is also easier to keep compared to other meat producing animals as they are able to convert more feed into protein.

2. Alternative fuel source

Algae are slowly being developed into alternative fuel sources by having them produce fuels that can replace the contemporary fossil fuels. Algae produce lipids that if harvested can be burn as an alternative fuel source whose only by products would be water when burnt.

3. Increase Jobs in the market

Aquaculture increases the number of possible jobs in the market as it provides both new products for a market and create job opportunities because of the labor required to maintain the pools and harvest the organisms grown. The increase in jobs is mostly realized in third world countries as aquaculture provides both a food source and an extra source of income to supplement those who live in these regions.

4. Reduce Sea Food Trade Deficit

The sea food trade in America is mainly based on trade from Asia and Europe, with most of it being imported. The resultant balance places a trade deficit on the nation. Aquaculture would provide a means for the reduction of this deficit at a lower opportunity cost as local production would mean that the sea food would be fresher.

* ANY THREE AQUACULTURE SYSTEMS *

Definition of Aquaculture

Rearing and propagation selection of commercially important aquatic organisms culture of under artificial conditions.

Fresh Water Culture Systems

Cultivable organisms are cultured in different types of culture systems. Many culture systems are based on traditional ideas that have been used for years, but some encompass new and sometimes radical concepts that make them unique. There are three major culture systems - **open, semi-closed and closed culture systems**. Each has its special characteristics, advantages and disadvantages.

The choice of system is largely dependent on the function of the organisms to be grown and the resources and ideas of the farmer.

1. **Open culture systems**

Open systems are the oldest and its farming is the use of the environment as the fish farm. Natural resources can be used as culture systems and organisms to be cultured are stocked in the water body. Capital expenses are low for the open culture systems. There is less management than in the other systems. The conditions are more natural and uncrowded in the culture environment, less time is required in monitoring the condition of the culture organisms in open systems. The disadvantages like predation and poaching are common. The growth rate and the uniformity of the product are variable compared to other systems. Cages, long lines, floats, rafts, trays and clam beds are examples of open system techniques.

Cage culture:

It is the culture of fish or other organisms in a river, lake or bays by holding them in cages. Cages are built of metal rods, bamboo mesh or PVC pipes and covered by mosquito cloth or nylon net. Cage culture, in recent years, has been considered as a highly specialized and sophisticated modern aquaculture technique, receiving attention for intensive exploitation of water

bodies, especially larger in nature, all over the world. In India, cage culture was attempted for the first time in case of air breathing fishes tike *Heteropneustes fossilis* and *A. testudineus* in swamps.

Pen culture:

Pens are the specially designed nylon or bamboo made enclosures constructed in a water body into which fish are released for culture. Such type of culture is referred to as pen culture.

Raft culture:

Rafts are generally made of bamboo poles or metal rods with buoys at the top for floating in the water. These are used in the culture of oysters, mussels and seaweeds in open seas.

Rack culture:

Racks are constructed in brackishwater areas and inshore areas for rearing oysters, mussels, seaweeds, etc.

2. Semi-Closed Culture Systems

In semi-closed culture systems, water is taken from natural sources or ground water and is directed into specially designed ponds and race ways. These systems offer an advantage over open systems in that they allow greater control over the growing conditions. A greater production per unit area is possible in addition to crop being more uniform. Water can be filtered to remove predators, diseases can be observed and treated more easily in semi-closed systems. The main disadvantages are more expensive and require more complex management. Ex:- ponds and raceways.

a) Pond Culture:

The majority of aquaculture throughout the world is conducted in ponds. Earthen ponds or reinforced concrete ponds are used for culturing the fish, shrimp, prawn, etc. in both freshwater and brackishwaters.

b) Raceway culture:

A series of earthen or cement tanks are constructed along the course of a river or stream and are used for fish culture. Raceway is a culture chamber that is generally long and narrow. Water enters at one end and leaves through the other end in most cases.

3. Closed Culture System

In closed culture systems, no water is exchanged and the water is subjected to extensive treatment. Extremely high densities of organisms may be raised under these conditions. Farmer has complete control over growing conditions in closed systems. The temperature is regulated, parasites or predators are not found and harvesting is simple. Food and drugs can be added efficiently into the system to grow quickly and uniformly. Fish or prawn culture in water recirculation systems is good example for closed systems

Water recirculation systems:

Here the water is conserved throughout most or all of the growing season by circulating in the culture tanks after purifying it through biological filters. Closed recalculating water systems are being used primarily for experimental work and for the rearing of larval organisms in commercial or research facilities. Closed systems are generally comprised of four components; the culture chambers, a primary settling chamber, a biological filter (biofilter) and a final clarifier or secondary settling chamber for purification of water for reuse.

* POLYCULTURE AND ITS SIGNIFICANE *

- Polyculture or mixed fish farming or composite fish culture is the culture of fast growing compatible species of fishes of different feeding habits (or different weight classes of the same species) in the same pond so as to utilise the various available ecological niches in order to obtain high production per hactare of water body.

- A pond according to its depth can be divided into three distinct zones — upper surface zone, middle column zone and bottom zone. A particular species exploits food of a particular zone. For example — Catla catla is a surface feeder, Labeo rohita a column feeder and Cirrhinus mrigala is a bottom feeder.

- **Principle of Polyculture:**
- When different species of fast growing compatible fishes, occupying different ecological niches of a pond or any water body, are cultured together, they most efficiently utilises all the food sources available in the pond for fish production without harming each other.
- **Objectives of Polyculture:**
    - To obtain maximum yield or fish production.

- To utilise all the available niches.
- The fishes cultured should not cause any ecological disbalance.
- The fish species cultured should not have any serious competition between them but each species may have a beneficial influence on growth and production of the other. For example, grass carp by consuming aquatic vegetation, converts plant tissue into fish flesh but its excreta fertilises the pond which benefits all other species.
- Some species of fishes are cultured which have specific roles to play in maintaining water quality in ponds by feeding on wastes accumulated in it. For example common carp and mrigal consume the faeces of grass carp and silver carp, which contain large amounts of undigested plant matter.
- Recent combination of fish species cultured are based on one or two species as the main ones and the others as subsidiary compatible species which would be utilising those parts of the food resources that would have been wasted.

- **Charcters of species selected for polyculture**
- Market value should be considerable
- . High demand in the local market. Climate is suitable/Favorable.
- Food habit is different.
- Growth of a single species is not hampered by others.
- Fry of two or three species, one commercially important, are available in the nature.
- **stocking rate in polyculture**. Fish combination
- Each combination is based on 1 or 2 major producing species, other species are only complement of major species. Better utilization of vertical water column, natural food mutual benefit between species achieve with stocking of reasonable proportion and species. Some of species in combination play roles in maintenance of oxygen regime and ponds sanitary condition. (exp : silver carp consume on algae, grass carp consume on aquatic plant)
- Example of fish combination comprises of surface, column and bottom feeder Catla is surface and column feeder feed on algae, plankton, rotifer, protozoa, mollusk and macrophyte. Rohu is column feeder mainly feed on decaying macrophyte and algae. Mrigal is bottom feeder feed on algae, diatom, higher plant and detritus. Composite carp culture introduces grass carp and silver carp to improve production and control pond environment condition

- **Pond fertilizing and supplementary food**
- Organic and inorganic fertilizer Organic fertilizer (Cow, poultry and pig manures) readily availability low cost directly contribute to food source (small organic particle and bacteria) for aquatic invertebrate type of supplementary food feed is added to depending on fish ages and size. Ex: ground cereal, whole grain and fermented cereal.
- **Harvest and marketing**
- Different countries vary in the period to produce marketable size due to vary in fish size demand, climatic condition Israel 4 to 6 months (0.5-0.6kg) Europe, 2 to 3 years (1-1.5kg) Marketable size in most countries is 1-1.5kg, except South East Asia countries which accept smaller size of carp .

CAGE CULTURE

Cage culture uses existing water resources (ponds, rivers, estuaries, open ocean, etc.) but confines the fish inside some type of mesh enclosure. The mesh retains the fish, making it easier to feed, observe and harvest them. The mesh also allows the water to pass freely between the fish and surrounding water resource, thus maintaining good water quality and removing wastes.

Characters of species for cage culture

Availability of suitable feeds

- Fast growth in confined waters
- Ready availability of fish seed or juvenile fish for stocking
- Hardiness (in terms of ability to adjust to high density culture, disease and handling).
- Value of fish and market demand
- Cultivable Species Criteria for selecting fish for use in enclosures:

Brackish Water Species for Cage Culture

Milkfish , Sea bass ,Mullets , Sea eel , Crustacean ,crabs.

Types of cages

1. Floating cages, 2. Mid-water cages with buoyed "feeding neck" 3. Bottom cages; 4. Single and multiple units, 5. Rigid and flexible cages; 6. Self-supporting and raft-supported cages;

Linkage of multiple units-Flotation structure: use of rigid collars of metal or plastic (air- filled, foam-filled or fiber-filled), discrete buoys or polydrums. Walls, bottom and roof; mesh netting of natural fiber, synthetic fiber, galvanized chain-link or galvanized weld mesh; site fouling tests with different materials to select the material most suited to the area. Framework; materials used (wood, bamboo, galvanized scaffolding, aluminium, etc.); support and lifting ropes; frameless cages; shape of net.

Shapes and dimensions- determination of shape and size in relation to hydrographical conditions, species to be stocked, stocking rate, production target, etc.; relative merits and demerits of large and small cages

. **Advantages of Cage Culture**

1: **Resource use flexibilit**y -Established on suitable body of water, including Lakes, ponds, mining pits, streams or rivers with proper water quality, access and legal authority. This flexibility makes it possible to exploit underused water resources to produce fish. (Specific state laws may restrict the use of public waters for private fish production).

2: **Low initial investment-** Relative to the cost of pond construction and its associated infrastructure (electricity, roads, water wells, etc.), cage culture in an existing body of water can be inexpensive. At low densities (relative to pond surface acreage) cages often do not require aeration or any electrical source.

Simplified cultural practices

The observation of fish behavior, especially feeding behavior, is critical to anticipating and avoiding problems. With stress and diseases, which often occur in cage culture. Simplified harvesting Cages are usually harvested by moving them into shallow water, crowding the fish into a restricted area, and simply dipping the fish out of the cage. Or, the cage can be lifted partially out of the water and then the fish dipped out.

Multi-use of water resources

The confinement of fish in cages should not hinder other uses of the water resource, such as fishing, boating, swimming, irrigation or livestock watering. These advantages are appealing, particularly the low capital investment required. A farmer could try producing fish in an existing pond or other water resource with minimal financial or environmental risk. If successful, the farmer could expand production with additional cages or intensify production by increasing aeration or fish densities.

Disadvantages of Cage Culture

- Complete diets needed Feed must be nutritionally complete and kept fresh. Caged fish will get no natural food and so depend on the manufactured diet for all essential nutrition. Feed must provide

all necessary proteins (down to specific amino acids), carbohydrates, fats (including essentially fatty acids), vitamins and minerals for maximum growth. Nutrients start to deteriorate quickly when exposed to heat and moisture.

- Diseases: Diseases are a common problem in cage culture and they can cause catastrophic losses. Wild fish around the cage can transmit diseases to the caged fish. The crowding in cages promotes stress and allows disease organisms to spread rapidly.

Unit-II Essay questions

POND ECOSYSTEM

- A pond as a whole serves a good example of a freshwater ecosystem.
- A pond indeed exhibits a self-sufficient, self-regulating system. P
- Pond water or a scoop full of bottom mud, which shall show the living organisms (plants as well as animals) and a mixture of inorganic and organic compounds.
- Some larger forms of life are also present in pond. Thus, whole system becomes much complex indeed. However, we may study the pond as an ecosystem by making its convenient division in some basic components, as shown in Figure 3.1 These components are as follows.

Abiotic Components

- The chief substances are **heat, light, pH value of water**, and the basic **inorganic and organic compounds, such as water itself, carbon dioxide gas,oxygen gas, calcium, nitrogen, phosphates, amino acids, humic acid etc**.
- Amounts of variousorganic compounds (carbohydrates, proteins, lipid etc.) are also estimated forbiomass determination.

Biotic Components

The various organisms that constitute the biotic component are as follows:

1. **Producers**
2. **Consumers**
3. **Decpmposers**

1. **Producers**

- These are autotrophic, green plants-and some photosynthetic bacteria.

- The producers fix radiant energy and with the help of minerals derived from the water and mud, they manufacture complex organic substances as carbohydrates, proteins, lipids etc. producers are of the following types

i. Macrophytes

- These are mainly rooted larger plants which include partly or completely submerged. Eg.*Typha, Nymphaea, Chara, Hydrilla, Vaillisneria, Marsilea,*
- Besides them some free-floting forms as *Azolla, Salvinia, Wolffia, Eichhornia,*. etc. also occur in the pond.

ii. Phytoplanktons

- These are minute, floating and drifting lower plants.
- Majority of them are such filamentous algae as *Zygnema, Spirogyra, Cladophora* and O*edogonium.*
- Besides them there are also present some *Volvox, Diatom, Anabaena, some Microcytstic, Oscillotoria, Chiamydonionas, Spriulina* etc. and also some flagellates.

2. Consumers

- They are **heterotrophs** which depend for their nutrition on the organic food manufactured by producers, the green plants.
- Most of the consumers are herbivores, a few as insects and some large fish are carnivores feeding on herbivores.
- Some fish also feed on other carnivores as well.
- The consumers in a pond are distinguished as follows:

i. Primary consumers (herbivores)
ii. Secondary consumer (carnivores)
iii. Tertiary consumers (carnivores)

i. Primary consumers (herbivores)

- Also known as primary macroconsumers, these are herbivores feeding directly on living plants (producers) or plant remains.
- These may be large as well as minute in size.
- The herbivores are further differentiated as:

(i) **Zooplanktons**.

- These are chiefly the rotifers *as Brachinous, and copepods* etc., They feed chiefly on phytoplanktons.

(ii) Benthos:

These are bottom living organisms or living on water floor. These are two types, Epifauna and Infauna.

(i) the animals associated with living plants (producers), (ii) thos bottom forms which feed upon the plant remains lying at the bottom of pond.

- These are known as detritivores.
- Benthic populations include fish, insect larvae, mollusks, crustaceans etc.
- weight of benthic fauna is estimated in different zones of the pond, and the biomass

expressed as g/m^2 of water.

ii) Secondary consumer (carnivores)

- They are the carnivores which feed on the primary consumers (herbivores).
- These are chiefly insects and fish. Most insects as water beetles feed on zooplanktons.

iii) Tertiary consumers (carnivores)

- There are some large fish as game fish that feed on the smaller fish, and thus become the tertiary (top) consumers.

3. Decomposers

- They are also known as micro consumers, since they absorb only a fraction of the decomposed organic matter.
- They bring about the decomposition of complex dead organic matter of both — producers (plants) as well as the macroconsumers (animals) to simple forms.
- Thus they play an important role in the return of mineral elements again to the medium of the pond. *Rhizopus, Penicillium, Fusarium, Saprolegnia* etc. are most common decomposers in water and mud of the pond.