IVC Course Code : 111

FISHERIES

SECOND YEAR

(w.e.f.2019 – 20)

Intermediate Vocational Course

Paper I : POND MANAGEMENT

Paper II : AQUA CULTURE

Paper III : RESORVOIR FISHERIES

STATE INSTITUTE OF VOCATIONAL EDUCATION

BOARD OF INTERMEDIATE EDUCATION, A.P.

Text Book Development Committee

Paper -I Taxonomy, Ecology & Biology of Fishes

AUTHOR

Sri. M. Venkateswara Rao, M.Sc, B.Ed
Junior Lecturer in Fisheries
Govt. Junior College
Parvathipuram, VIZIANAGARAM DIST

Paper-II Principles of Fisheries & Aqua Culture

AUTHOR

O. Sudhakar, MfSc., Ph.D.,
Professor
College of Fisheries Science
Muthukuru, SPSR NELLORE DIST

Paper-III Resorvoir Fisheries

AUTHOR

Sri. Seelam. Sudhakara Reddy, M.Sc.
Junior Lecturer in Fisheries
Govt Junior College
Tiruvuru, KRISHNA DIST

EDITOR

Prof. K.S.Krishna Prasad,
Retd. Prof. & University Head,
S.V.Veterinary University

FISHERIES

TEXT BOOK DEVELOPMENT COMMITTEE

S.No	Name	Designation	Signature
1	Prof..K.S.Krishna Prasad Retd. Prof. & University Head, S.V.Veterinary Universit	Editor	
2	M. Venkateswara Rao Junior Lecturer in Fisheries Govt. Junior College Parvathipuram, VIZIANAGARAM	Author	
3	O. Sudhakar Professor College of Fisheries Science Muthukuru, SPSR NELLORE DIST	Author	
4.	Seelam Sudhakara Reddy Junior Lecturer in Fisheries Govt Junior College Tiruvuru, KRISHNA DIST	Author	

Smt. B.UDAYA LAKSHMI, I.A.S.

Commissioner & Secretary

Intermediate Education

ANDHRA PRADESH

GUNTUR

S.I.V.E Co – Ordinating Committee

Sri. Podili Yerraiah, M.Sc., B.Ed.
Professor
State Institute of Vocational Education
Commissioner of Intermediate Education, Guntur

Sri. B. Nageswara B.Com, B.L.,
Joint Secretary (Vocational)
Board of Intermediate Education, Vijayawada

Sri. Dr.G.V.S.R. Murthy, M.SC., Ph.D.
Lecturer
State Institute of Vocational Education
Commissioner of Intermediate Education, Guntur

DTP

Thuraka Ravi Kumar BA,B.Ed., PGDCA

FISHERIES

Paper – I

Seed Production Technology

INDEX

UNIT 1

Introduction to Pond Management

Structure

1.1 INTRODUCTION

Before discussing about pond management we have to know what is a pond? Ponds are very small and shallow of quiet standing water with slight wave action and may be naturally created or man-made. Naturally created ponds show the same geological history as lakes.

Man-Made or artificial ponds are created to serve different purpose ses Vix, Fish Farming, Duck Rearing, Ornamental Cultivation of Nelumbo or any aquatic weeds. The ponds used exclusively for fish culture purposes are designed and managed scientifically these are better called as fish ponds.

Maintaining a good pond fish culture is important for growing healthy fish , reducing fish mortality, achieving satisfactory production and improving culture efficiency. Good pond management including adequate precautions, monitoring and contingency response can be put in place. The scientific based technology of fish culture aims at maximum utilization of the pond productivity. Fast growing non – predatory, non – compatible species of food fishes or culture together with complementary feeding habits and cable of utilizing both natural and supplementary fish food.

1.2 Good pond fish culture environment:

Fresh water pond fish culture has a long history. Traditional species under culture are cyprinids like Catla, Rohu, Mrigal, Silver Carp, Grass carp and Common carps. These fishes have varied feeding habits and live in different water depths.

Catla(IMC): found in middle (surface column) upper water, filter feeder mainly feed on zooplankton.

Silver Corp(Exotic Carp): found in middle upper water filter feeder mainly feed on phytoplankton.

Labeo rohita and Grass Carp: found in middle water feed on aquatic plants.

Mrigala and Common Carp: found in lower water on pond beds and feed on organic debris annelid worms and aquatic insects.

Plankton feeders of pond fish species may clean up zooplankton and phytoplankton flourished by nutrients released from fertilizers, excessive fish feed and fish waste, whereas omnivorous species can consume organic matters like feed debris, dead organisms and benthic organisms. Herbivorous species can consume aquatic plants they control the growth of aquatic vegetation. Poly culture of these species in fish ponds ensures full utilization of water space and effective us of fish feed and organic matter. Ecological balance in water bodies is maintained as a result to enhance culture effectiveness, fish are fed with rice bran, oil cake or pellet feed.

1.3 Poor fish pond management:

Such as over – stocking, over – feeding or improper disposal of dead fish, gives rise to large amount of organic matters in the water body environment. They accumulate on the pond bed decomposition of organic matter by bacteria consume a large amount of oxygen. The water body may become anoxic, resulting in fish mortality, reduced growth and poor resistance to disease, moreover, organic matters support propagation of bacteria which can increase the risk of fish death.

1.4 Good pond fish culture practices: there are ten good pond fish culture practices their importance and related management measures are explained below.

1.4.1 Regular inspection: conduct inspection every morning, noon and evening to check fish activities. Check the fish appetite, whether there is residual fish feed in the pond, whether the fish come to the surface to breathe and whether there are unusual changes caused by sudden weather changes, by keeping watch, problems can be detected early and prompt remedial action can be taken.

1.4.2 Water quality management: water quality has a direct impact on the survival, growth and yield of pond fish. In an over stocking environment, organic matter such as residual fish feed, fish waste, and algae, often effect water quality. It is therefore necessary to monitor pond water quality closely, take appropriate measures to prevent quality deterioration and solve any problems promptly. The following are some important factors effecting water quality and their control measures.

Colour;Under normal circumstances, a fish pond should be light green in colour.

- Large amount of organic matter like residual fish feed and fishwaste will turn in to nutrients and support proliferation of algae, turning water in to dark green,bright green or rust colour.pond water colour change is an indication of deterioring water quality.
- Bluegreen algae will add amuddy taste to the fish stock apart from turning pond

water in to bright or rust colour. Mitigation measures;If water colour is too dark, reduce the quantity of feed, change water and remove the algae from the pond

Transparency:

- Transparency is about 30cm(1ft).
- A very transparent pond indicates water quality abnormalities. eg: low nutrients level or high acidity making algae unable to survive.
- Without algae to produce oxygen, the dissolved oxygen level of the pond will drop.
- Mitigation measure: apply an appropriate amount of fertilizer or use lime to neutralize acidity.

Suspended solids:

- Suspended solids should be less than 50mg/L
- When flooding occurs after heavy rain, fish may be effected by backflow of muddy stream water.
- If the pump inlet is placed too close to stream bed of stream water is loaded with sand and silt, it is likely to take in turbid stream water to the pond.
- If water is visually turbid or muddy yellow in colour, observe the fish bahaviour.
- A high concentration of suspended solids prevents the fish from breathing normally and reduce sun light penetration. It also affects algal photosynthesis resulting in a lower dissolved oxygen level in water.

Mitigation measure:

- Stop pumping water from the stream, change the pond water and apply fish feed sparingly.

P^H:

- P^H level of fish pond water should be between 6 and 8.5.
- Use a litmus paper or P^H meter (P^H tester) to measure.

Acidic Pond Water:

- Inherent soil acidity may turn the pond water acidic.
- Rain itself is slightly acidic. Pond water will become more acidic after heavy rain.
- The decomposition process of organic matters like residual fish feed, fish waster and algae makes the water acidic.
- Metabolism of fish slows down in acidic water (below P^H 6). They appear sluggish. Their feeding and digestive ability are weakened and their growth is inhibited.
- Acidic water lowers fish blood's P^H value and oxygen carrying capacity. When P^H value drops to 4 or below, deaths may occur.

Sprinkling Lime:

Acidity in soil or water or accumulation of organic matters may make pond water acidic. Use lime as a neutralizer.

After draining and sun drying the fish pond. Sprinkling and adequate amount of lime on the edges before filling water. If necessary, put lime appropriate adjustment to avoid excessively high acidity or alkalinity.

High alkalinity:

Large quantity of algae will be proliferated. Pond water will be over saturated with oxygen and alkalinity will go up accordingly.

Dissolved oxygen level:
For good water quality, maintain the dissolved oxygen level at above 4mg/L
Measure dissolved oxygen level with dissolved oxygen meter or reagent test kit.

When stoking density is too high, the dissolved oxygen may not be sufficient to provide for all the fish. Anoxia is likely to occur.

When water is serious anoxic, fish will come to the surface to breath with their mouth, in severe case fish will die.

Mitigation measures: closely monitor the weather conditions and record dissolved oxygen levels. Apply aeration, stop feeding and reduce stocking density. Change the water and remove sediment from the pond bottom.

Ammonia NH_3: ammonia level should be lower than o.1mg/L. Reagent test kit can be used to test the content of ammonia in pond water.

Organic matters generate ammonia salt, nitrite NO2 nitrateNO3 when they decompose. In highly alkaline water, non toxic ammonium will turn in to ammonia. which is toxic to fish.

Mitigation measures: Apply aeration, stop feeding and reduce stocking density, change the water, and remove sediment from the pond bottom.

Water temperature: the suitable water temperature range common cultured fish is 28 - 32c. water temperature can be measured with a thermometer.

Sun Screen – Device against high water temperature:

In summer months when temperature is high and sun light is strong. Erect a light weight. Nylon screen above the fish pond to reduce exposure to sunlight. This measure can reduce the fish pond temperature by $1 – 2^0$ c and prevent growth of algae.

Wind shelter – Device against low water temperature:

It is best to position the fish pond in a place sheltered from wind. This can slow down the dropping of water temperature when there is strong wind during winter.

1.4.3 Good feeding management measures:

- Use dry pillet feed to reduce the content of organic matters in water.
- Apply feed in phases and in appropriate quantities if fish are not eating. Stop feeding to avoid water pollution by residual fish feed.

1.4.4 Proper disposal of dead fish and garbage:

To avoid water contamination and spreading of germs removal all rubbish residual feed and dead fish on the water surface and put them in a rubbish bin with lid.

1.4.5 Regular disinfection of culture gear:

Culture gear which has com into contact with sick fish or new fry may be contaminated by pathogens.

Disinfect gear thoroughly and regularly by bleaching, streaming and drying them under strong sun light.

1.4.6 Quarantine for newly stocked fish / fry:

Introducing new adult fish or fry to a new environment may result in pathogenic contamination. It is essential to quarantine their fish to avoid large scale disease out break.

1.4.7 Isolation / proper treatment of sick fish:

To avoid spread of disease fish affected by disease should be islation promptly for proper treatment

1.4.8 Proper use of feed additives and drugs:

Excessive use of feed additives or drugs will lead to pathogens like increasing organic matters in water. Excessive fish drug residues, drug resistance in bacteria and wastage. It has adverse impacts on both the environment and the health of fish.

1.4.9 Regular monitoring of water quality and fish health:

As precautionary measures, water quality and fish health monitoring help to detect disease at an early stage and reveal the cause of heavy mortalities, so that appropriate treatment can be given.

1.4.10 Maintenance of farm management records:

Fish farmers / culturists should get into a good habit of keeping records of water, feeding quantities, water temperature, dissolved oxygen level day wise and fish growth (length, weight wise) health conditions. These records month wise provides useful information for analysis and to know the culture efficiency.

Short Answer Type Question

1. Define pond
2. How good pond fish culture is important?
3. Write the main aims of scientific based technology of fish culture
4. Write the factors which leads to poor fish pond management
5. How useful of varied feeding habits of poly culture species in fish pond?
6. Write any two good pond fish culture practices
7. How to disinfect the culture gear?
8. Write the effect of excessive use of feed additatives and drugs
9. When the fish will come to the surface to breath with their mouth?
10. Write the migration measure of ammonia in fish culture pond
11. Write any two good feeding management measures
12. Write the use of sun screen in culture pond

Long Answer Type question

1. Write an essay on good pond fish culture practices

--- # ---

UNIT 2
LAYOUT OF FISH FARMS

Structure

2.1 Introduction

Fish farm is the site where different types of ponds are constructed for rearing various stages of the selected species on scientific lines. Pond is nothing but a very small very shallow body of quiet standing water. A depth of about 2m is considered congenial from biological productivity point of view.

Aquaculture activities starts with the construction of ponds till the har- vest of table-sized fish. Important aspects of the planning of fish farms, is the selection of the site for the fish ponds . Sites should be selected taking into the consideration the agro climatic conditions access to markets, suitable communications of skilled and unskilled labour public utilities security etc.

2.2 Component (ponds) of a fish farm

An ideal fish farm should contains at least 4 different types of ponds, each for a specific purpose. Some times the number of ponds may be increased to 6.

1. **Breeding (Spawning pond) :** Fore breeding of cultivable fishes.
2. **Hatching ponds (pits) :** For putting the spawn for hatching into fry.
3. **Nursery ponds :** For keeping fry to develop to fingerling stages.
4. **Rearing ponds :** For transferring fingerling to develop up to adult hood.
5. **Stocking pond :** For keeping adult sized (table sized) fishes.
6. **Marketing ponds:** For keeping market able size fished to be marketed.

Important activities at a fish farm : Right from the establishment , important activities at a fish farm may be summarized as under.

Choice of site : Soil characteristics, water resources

↓

Layout plan: Design of Ponds: Drains: Laboratory Store house, watchman huts: Residential Quarters: Necessary Implements: Chemicals: Fertilizers Etc.,

↓

A Fish Farm is Established

↓

Activities

↓

Procurement of Stocking Material from Natural Resources and Hatcheries

↓

Nursery Ponds

↓

Rearing Ponds

↓

Stocking Ponds

↓

Harvesting

↓

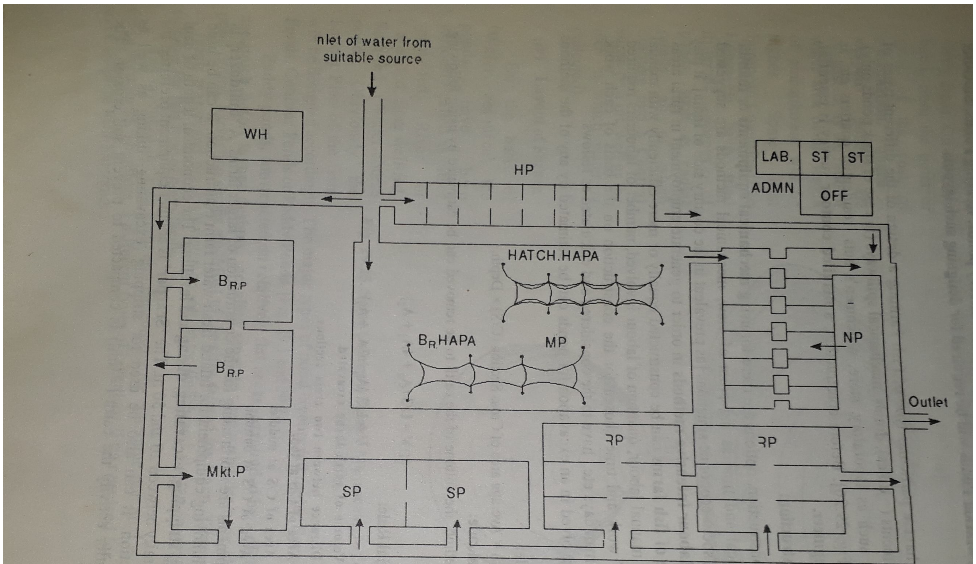
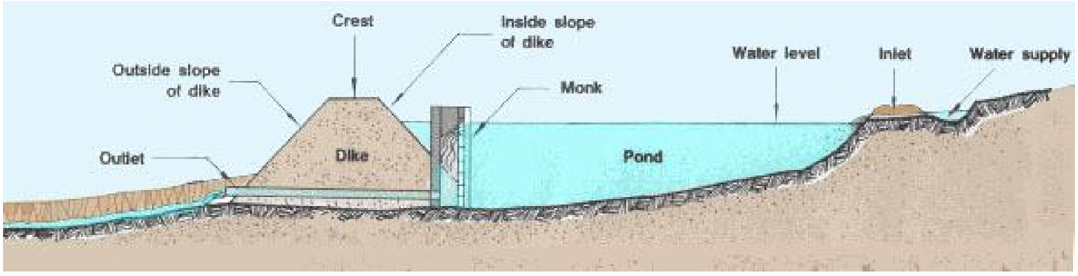


Fig. 29.26. Diagramatic Presentation of the Lay-out of a Fish Farm showing various components.

WH = Watchman's Hut; **HP** = Hatching Pits/Ponds
ADMN. = Administrative Block with provision of office (**OFF.**), Laboratory (**LAB.**), Store (**ST.**) etc.
HATCH. HAPA = Cloth–made double '**Hatching Hapa**' fixed in a row in the Main Pond (**MP.**)
BR. HAPA = Cloth–made '**Breeding Hapa**' fixed in a row in the main pond. (Pl. also see Fig. 32.6)
BR. P. = Breeding or Spawning Ponds.
N.P. = Nursery Ponds.
R.P. = Series of Rearing Ponds.
S.P. = Stocking Ponds.
MKT. P. = Marketing Pond.



2.3 Site selection criteria for fish farm

2. Availability of land in a continuous suitable shaped plot of optimum size with all facilities.
3. The site oshould have assured water supply of adequate quantity either surface or ground water.
4. Soil and water of the site must be suitable for fish culture.
5. The site should be free from floods
6. The site should have good transport facilities and approach roads
7. The site should have electrical and telephone connections
8. The fish seed should be available easily and in plenty in that area
9. The site should be away from populated areas
10. The site should be connected to a drainage system
11. The fisherman or labour should be available near the site.

The following are the major that work together to make a good site for a fish farm.

Topography

The term topography means the surface features of the area , and it important both from the point of view of construction and for future mainte- nance. The ideal topography of a fish farm site a gently slopping terrain of wide valley or a bowl. Shaped area with high lands on the three sides and a narrow outlet with fourth . Such a place can be chosen for constructing the farm, pro- vided the desirable type of soil and suitable water supply is available.

Soil type

The soil must be impervious so as not allow any seepage. Rocky and sandy soil as well as limestone areas are to be avoided. Generally heavy clay and silt clay are suitable and fish ponds constructed in such as area store water for long periods as the loss of water in only to evaporation. Porous soil is con- sidered unsuitable for constructing ponds. Acorrect identification of soil can be done by a soil analysis, and a good soil would result in a fertile pond.

Water supply

The availability of adequate supply of water is an important requisite for site selection. The dependable sources of water supply are.

(a) Lake or Reservoirs

(b) Springs

(c) Rivers

(d) Streams

(e) Canals

(f) Surface runoff

(g) Wells

(h) Tube wells

Big tanks reservoirs and lakes are perhaps the best source of water. Dams provide the cheapest and canals are also satisfactory source of water, provided the flow is enough to fill the ponds. The source of water should be free from all pollution.

2.4 Design and Construction of Fish Farms

2.4.1 Design (Plan)

There are three types of Design

1. Layout planning
2. Man-power planning
3. Material planning

1. Layout planning

Layout planning is an important factor. It helps as how to utilize the available area to its fullest extent for the production purpose at the same time

economizing the construction as well as management aspects. Layout planning consists of allotting positions to different types of ponds, water and drainage channels. Buildings etc. Depending on the topography of the area layout planning requires a boundary map, contour map and soil profile charts.

Design Consideration

(a) For Dyke : The embankment should be designed very carefully. Before designing a thorough surveying regarding the type of soil and its proper- ties such as a permeability and bearing capacity should be made.

(b) Height and Breadth : Height and breadth of dyke should be de- termined in accordance to the depth of water and nature of water source. Usu- ally the heights of dyke is kept at least 50 cms above the expected water level in the ponds . Top width and bottom width will be determined depending upon the slope.

(c) Free board : Extra space provided between maximum water level in the pond and crest level of embankment is called as free board. The free board is generally kept 0.5 mm for heights of embankments 3.0 m and under.

(d) Top Width : Top width or dyke can be determine by using the empirical formula.

$$W = \frac{H}{5} + 3$$

Side Slopes

The table given below shows the safe slopes required to provided for different types of soils and height of dyke.

Nature of soil	**Height up 2.5 m H:V**	**Height Up to 2.5 m 4.5 m H:V**
1. Ordinary earth soft clay, dry sand	1.5 :1	2 : 1
2. Loose earth loose sandy loam	2 : 1	3 : 1
3. Wet sand	2 : 5 : 1	4 : 1

Design of ponds

The nursery pond are generally shallow and small in size (0.5 ha. To 0.10 ha) and stocking ponds are 1 to 2 ha., and rectangular in shape with 0.7 to 1.2

h . A provided between pond bottom and embankment top should be fail. Born also makes netting operation easy.

A ratio of 1 **:** 2.5 should be kept in breadth and length of pond. A slope towards outlet and inlet should be given to provide better drainage and easy harvesting.

The pond embankments should have 2 to 3 width with side slops 1 : 2 or more at outer side that of inner side should be slightly more than that of o u t side.

Design of Water Channel

There are two types of water channels

1. Main water channel

2. Subsidiary water channel

Through the main water channel the farm receives the water, which in turn distributed to the different ponds through the subsidiary channels.

The depth of main channel should be more for easy draining out of water from ponds. The position of main water channel should be position, above the main water sources.

2.4.2 Constructions

The following sequence of operations are to be followed

a. Land Clearing

Deep rooted trees, bushed shrubs cause leakage and lead to crack in the embankment , stones, rocks mat pose problems at the time of excavation . Hence eradication of vegetation and removal of stones, rocks.

b. Construction of embankment

The side should be cleared of all types roots, grass etc. The surface should be roughed by ploughing all over. The centre line should be drawn.

The foundation of embankment should be stable to with stand erormoius weight of dyke . The dyke should be built in layers of 256 to 35 cms in thickness over the across the whole section. Water should be sprinkled over the previous layers. Each layer should be rammed well until clods are flattened to have a good adhesion between successive layers.

The dryke should be strengthened by plating tress to protect from wind. Grass turf should be grown to provide vegetation.

c. Construction ponds

The depth of pond should be such that, it should retain adequate water even in lean months. The pond should have its inner side embankment wide enough are side slopes of the pond embankment on its inner side. The pond at its outer and slightly more on its inner. The pond should have a berm in between pond into the pond. This will also ease the netting operations.

The size of nursery point is generally small (0.5 to 0.10 ha) and that of stocking is rectangular in shape and of 1 ha to 2 ha. Lining of the ponds may be done to reduce the seepage.

d. Linings

It has got many advantages such as reduction of seepage losses, increased water holding capacity etc. It also resists the erosion of dykes and channel banks. Lining also facilities maximum harvesting especially in the case of prawns.

Lining can be done in following ways

1. Concrete lining
2. Soil cement lining
3. Polyethylene film lining
4. Compacted earth lining
5. Brick or cement tile lining
6. Plaster lining etc.

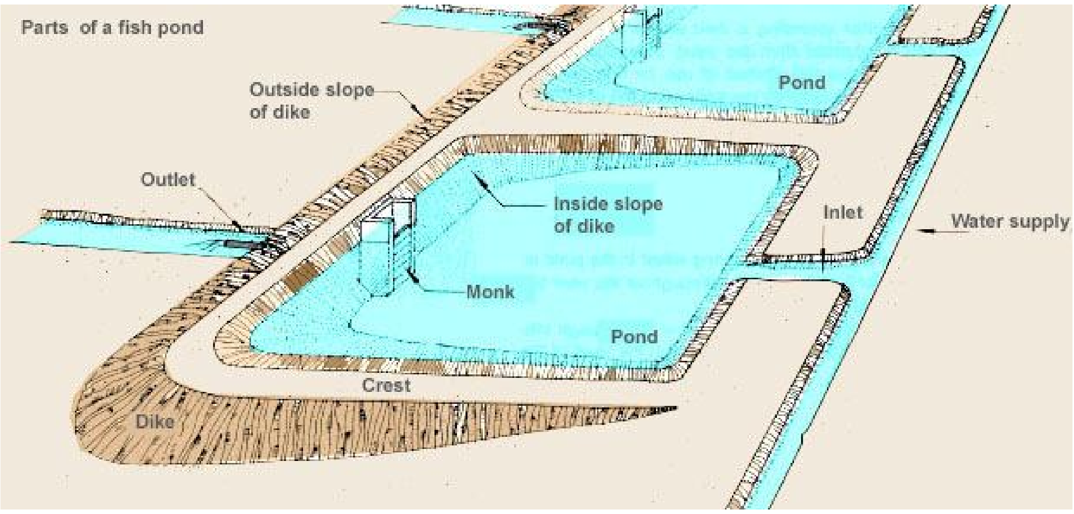
The plan should induce provision for handling normal flow ofwater as well as for complete drainage. The drainage pipe should be large enough for quick drainage. The inlet pipe. Should be 6-8 above the water level and provided with some kind of screen to prevent entrance of wild fish and escape of fish from the pond. Alternatively "SLUICE" can also be used at the desired to point of the pond.

The water supply to the pond is to be monitored through the inlets and outlets and for that different types of water control structure are in use. Monk is used as outlet structure.

e. Monk construction

It is most efficient water control structure used for both inlets and outlets . The MONK is a soft of "U"-Shaped vertical tower comprising three walls, two lateral wall and a back wall. The side wall of the monk have 3 pairs of grooves for inserting screens and stop logs or flash boards. The groove facing the pond is inserted with a screen often made of metal sheet and perforated as to prevent debris from entering the pond and fish from escaping. Stop logs or flash boards are inserted in rest of two grooves behind the screen. To prevent leakage of water the space between the boards can be filled tightly with wet clay or com- post.

At the base of the back wall of the monk is fitted a horizontal pipe which passes through the base of the dike for drain water . The diameter of the pipe depends upon the size of the pond.



Short Answer Type Question

1. Define fishfarm.
2. Write the types of ponds and their purpose?
3. Define "topography".
4. What type of soils are suitable for constructing pond ?
5. What are the dependable source of water supply for fish farm.
6. What is free boards ?
7. In what ways lining of the pond can be done ?
8. Draw the diagram of layout plan of a fish farm ?
9. Draw as the diagram of dike cross section and a monk?

Long Answer Type Question

1. Describe the site selection criteria for fish farm .
2. Describe the design of the fish farm.
3. Describe the construction of the fish farm.

--- # ---

UNIT 3

NURSERY POND MANAGEMENT

Structure

3.1 Introduction

With the fish culture operations having gained its full momentumwith its proven economic returns, there arose an ever increasing demand for fish seed of different sizes, spawn (5-6mm) fry, (22-25mm) finger lings (36-55mm) the rearing of which is highly a technical work of the three the rearing of spawn to tender is a very delicate technical work as the of spawn to fry it spawn tender and succumb to abrupt changes in the physico chemical condition of water and can be easily in preyed upon. Hence their rearing is to be done in specially prepared ponds the nursery ponds. Even the small perineal of seasonal water bodies domestic pond c an be used for the dame purpose.

The best manageable size of nursery pond is 20 x 10x 1 mts. Aperqui- site of nursery pond maintenance is study water level of one meter throughout the rearing period, and sufficient fertility of soil and water to augment the pro- duction of natural fish food organism. The basic guiding principle of nursery pond management is to provide a proper ecological condition therein for the survival and growth of the spawn in it involves prestocking , stocking and post spawn stockingmanagement.

Definition: the pond which is used for growing hatchlings,spawn,fry to advanced fry(fingerlings) for a period of about 15 to 45 days is called nursery pond.

Characteristics of nursery pond:

The nursery ponds should have the following charecters:

*Type of pond:seasonal ponds are better for nursery management *shape: pond should be rectangular

*slope:1.5:1 or 2:1(per unit length : per unit depth)

*size: an area of 0.02 to 0.05 ha.

*depth: shallow ponds 1meter depth is preferable with an arrangement of drainage.

*pond dyke: pond dyke should be compact and high enough to protect from flooding.

*place of pond: pond should get enough sun light trough out the day.

*soil Ph:6.5 to 8.5

*water : nursery pond water should be more oxygenated, non pollutant and free from aquatic insects,predatory fishes,aquatic weeds.

3.2 pre stocking management:

It involves pre stocking , and post stocking management.

Pre-Spawn stocking nursery pond management

(a) Dewatering drying

The nursery pond management operations starts right from the sum- mer. As the stagnant water is highly unproductive which may harbour predatory species. It is essential to dewater the ponds, which is then subsequently ex- posed for drying. Drying of such water bodies in summer helps mineralization and removal of excess organic material.

(b) De-silting (The Removal of Sand from Pond Bottom is called De-Silting)

When silted water is used for the nursery pond the silt settles at the bottom which contain the excess organic matter. This silt which is reinforced by the organic decomposition of manures has to be removed ,which enables the pond bottom contacts with the pond water so as to release nutrients in to the pond water thus pond water becomes more productive.

Minor repair pertaining to inlet-outlet is to be attended during this time.

(c) Control ofpredators

In cases the ponds could not be dewatered and dried, the possible predatory and weed fauna in the water body is to be eradicated by netting or using fish toxicants. Channa species, clarias batrachus, Glossogobius gyur is form the main predatoryfishes.

The customary method of drag netting is not absolutely fool proof may easily succumb to chemicals. Hence a toxicant which is effective at a very low dose leaving not residual effect in the water body is to be selected.

Fish Toxicant

The common fish toxicant used for killing predators fails into three categories.

Poisons of plant origin

(a) Derris root powder

The application of derris root, powder as fish toxicant is widely preva- lent among fish culturists. It is a contact poisons with 5% rotenone, damages the respiratory system of the fishes and a concentration of 4 ppm is effective against age of all fishes. This is not an added advantages of a toxicant on the aquatic insect fauna such as dragonfly nymphs, back swimmers. The required quantity of derris a root powder si applied 12 days prior to stocking. It is mixed thoroughly with water and sprayed over the water surface.

(b) Mahua Oil Cake

Mahua oil cake at 200-250 ppm is applied 15 days before stocking and pond effectively kills in predatory fishes. Mahua oils cake containing -6% saponin enters the blood stream of fishes causing hemolysis and subsequent mortality. The application of mahua oil cake has gained wide popularly due to its fertilizing effect after toxic effect.

Chlorinated hydrocarbons

(a) Endrin

Endrin in the form of Tafadrin -20 is found on ideal chemical fish in toxicant however due to its hazardous residual effect, it is not advised for application in nursery ponds.

(b) Organophosphates

The usage of organophosphate as fish toxicant is preferred over chlori- nated hydrocarbons as they degrade easily in water medium. Thiometon DDVP, Phosphamidon are some of the commonly used fish toxicants in India.

(d) Control of Aquatic Weeds

Perennial water bodies is used for nursery operations maycontain luxu- rious growths of various aquatic weeds which should be removed manually considering the small size of nursery ponds.

(e) Watering

Water from any source can be used for nursery ponds. After passing it through a fine sieve to get rid of predators and insects in any stages. Generally nursery ponds are watered raising before stocking initially to 30 cm and subse- quently raising it up to a 1 meter.

(f) Fertilization

The fertility of a pond depends on its soil base, which can be greatly enhanced by applying artificial fertilizers which provides the required nutrients, vitamins , leading to a sustained production of plankton biomass. Nitrogen , phosphorous potassium, calcium, play a significant role in pond fertility along with trace elements like Manganese, Boron, Iron, Copper Zinc, whose real part of yet to be established. Fertility of pond is achieved through inorganic fertilizers or organic fertilizers or a combination of both.

Fertilizers

(i) Inorganic fertilizers

The different inorganic fertilizers used in fish ponds are

(a) Phosphate fertilizers

Phosphorous is the single most important element controlling organic productivity in natural waters, and has been proved in different experiment. According to Saha and Chatterjee (1979) triple experiments (40% .p2) can maintain more soluble phosphorus in the water phase then single superphos- phate in the soil phase.

(b) Nitrogenous Fertilizers

The role in nitrogen in fishery waters is correlated with the level of organic nitrogen. This important nitrogenous fertilizers used are sodium nitrate, Ammonium sulphate, Ammonium , Urea.

(c) Potassium fertilizers

Potassium finds its application in pond waters with nitrogen and phos- phorous popularly known as NPK fertilizers in the ration 6:8:4.

(ii) Organic Manures

Organic manures are enriched with all the nutrients required for a fish- ery water and an addition to it slowly decompose imparting the nutrients con- tained in it for the biomass production in the water body. But their use has to be cautiously administered because the may act as possible carriers of diseases.

The organic manures belong to three categories depends upon the car bohydrates content as.

(a) Organic manures containing little or no carbohydrates

E.g : Liquid manure from stables and byres.

(b) Organic manures containing carbohydrates and Nitrogenous matter.

E.g : (Farmyard manure)

(c) Organic manures containing mainly carbohydrates

E.g : Ground nut oil cake , Mustard oil cake , Mahua oil cake.

Methods offertilization

Nursery ponds are fertilizers in the following way

(a) Manuring

In the customary way of manuring the pond can initial dosage of 10,000 kg/ha of Raw Cattle Dung 15 days before stocking the spawn followed by 5,000 kg/ha 7 days after stocking of pond produces ofgood zooplankton bloom. But the later technological advancement aimed to modify the methods of ma- nuring yielding better plankton production and subsequent high survival. The following methods have gained wide ground and is popularly practices.

(i) Shirgur method : Raw Cattle Dung 5000 kg/.ha ground nut oil cake 250 kg/ha single superphosphate 250kg/ha are mixed together with water to form a thick paste and subsequently spread. Uniformly on the water column three days before stocking , yields good zooplankton production on the 3rd day. Manuring the required number go ponds after assessing the expected spawn from the number of good eggs is in advantage of this method.

(ii) CIFE Method : The combination of organic and inorganic manures is given in two split doses in this method.

(a) Raw Cattle Dung 5000 kg/ha : Ground Nut oil cake 500 kg/ha single superphosphate 250 kg/ha after mixing properly with water to form a thick paste in applied uniformly in the water column 5 days before stocking.

(b) Raw Cattle Dung 2500 kg/ha : Ground nut cake 250kg/ha is applied as mentioned above two before stocking . A sustained zooplankton production is an advantage of this method.

(c) Insect Control

A high survival in nursery pond can be expected only if the insect popu- lation is completely eradicated which otherwise will prey upon with span in addition to being competitors for the food. Among the insect beetles back swimmers water bugs, water scorpions, dragnofly nymphs cause considerable harm to the span in nursery ponds.

(a) Repeated drag netting using a fine method (1/16) on the previous day of commissioning the one can eradicate the insect population in nursery pond in to a considerable extend.

(b) Most of aquatic insects utilize the atmospheric oxygen for respira- tion which if cut off from the water column will lead to its mortality by suffoca- tion. This is achieved through. ‘Oil emulsion’ by producing and uniform oil firm over the water surface.

The customary method of using soap and cheap oil being very costly the following recent method of widely practiced and found to be very effective. In this “Hyoxide 1011” manufactured by HICO pvt. Ltd. Bombay si used as emulsifier in combination with high speed diesel oil. The application doses per hector of water body is.

H.S.D	50 Liters
Hyoxide	50ml
Water	5 liters

The emulsion is spread over the water surface during still weather condition a day prior to spawn stocking in the pond.

The prepared nursery pond is ready to receive the spawn. However for the proper management the water is to be analyzed for different physicochemical parameters and plankton is to be assessed qualitatively and quantitatively.

Water Quality

Wide variations in the physicochemical nature of the water from the optimum range will lead to mass mortality of the seed. When all the steps in the nursery pond management are done in scientific way the physico chemical con- dition of water are expected to very within the optimum range.

Turbidity temperature depth are important physical factors controlling productivity in an pond. Some of the chemical parameters of the pond water in the following range are considered to be conductive for the nursery pond.

DO	5-710ppm
PH	7.5 - 8.5
Free Co2	Below 16ppm
Alkalinity	100-200 ppm
Phosphate	0.2 - 0.4 ppm
Nitrate	0.06 - 0.1 ppm

Plankton : The water sample from the pond is analyzed for plankton for its qualitative and quantitative content. For assessment of the plankton 50 liters ofwater collected fromdifferent parts ofthe pond flittered through a plankton made of bolten silk cloth No.21 or organdy cloth. The plankton sediment of
1.0 to 1.5 cc in 50 liters of filtered water is sufficient for nursery rearing. Cla- docerans . Diameters are the choice food of Indian major carp spawn.

3.3 Stocking:

Nurseries are stocked in the morning hour before the water gets heated up or in the evening hours when water gets cooled. The buckets bags with spawn is slowly dipped in the pond so that the spawns gets acclimatized to the pond water and voluntary comes out of the buckets.

The nursery ponds are generally stocked at the are of 5 million/hector . However a stocking density of 5-10 million/ha is found to yield survival and growth over a period of 15 days of rearing.

3.4 Post Stocking Management

(a) Feeding

Soon after the entry into the pond the spawn starts voracious feeding on the plankton .Within a couple of days the plankton population gets depleted.Hence a supplementary diet si resorted so as to keep up the plankton biomass, An artificial feed should be have nutrients and energy level close to that of natu- ral food. A better survival can be obtained in a nursery if both are present in the optimum level.

The artificial feeds are given from the second day onwards. Nursery ponds are fed with rice bran and finely powdered ground nut oil cake in 1 : 1 by weight . The following feeding schedule is more economical and gives better survival.

First 5 Days **:** Equal to the initial body wt of spawn stocked. Second 5 Days **:** Double the initial body wt ofthe spawn stocked. Third 5 Days **:** Thrice the initialbody wt ofthe spawn stocked.

For better utilization half of the feed is given during the morning hours and half during the evening hours in every day.

(b) Harvesting

After 15 days of rearing the fry attains a size of 20-25 mms and the stock is ready for harvesting .Using 1/16 mesh cotton drag net pond is har- vested repeated netting the survival range would be 60-85% with an average of 75%. The harvested fry required to be transferred to larger rearing ponds.

Short answer type questions

1) Define nursery pond.
2) Write the shape and size of nursery pond.
3) Write use of de watering and drying in nursery.
4) What is de silting? and writer its use.
5) Give any two examples of predatory fishes.
6) Name any two fish poisons of plant origin.
7) Write any two control methods of insects in nursery pond.
8) What is shirgur method of manuring?
9) How you can estimate the plankton productivity in nursery pond?
10) Write the feedin schedule in nursery pond.

Long answer type questions

1) Describe the nursery pond management.

--- # ---

UNIT 4

REARING AND STOCKING POND MANAGEMENT

STRUCTURE:

4.1 Introduction

Rearing of the 15 days old fry(25 to 30 mm) to the fingerlings (100- 150mm) size in a large pond with in shortest period of 3 months time si called rearing pond management.

A rearing pond should have an area of 0.8 to 0.1 ha preferably rectan gular in shape with water depth ranging from 1.5 to 2 mts.

The utility of the rearing pond culture is to provide more space to fry reducing stocking density and at the same time providing a larger pond than the nursery pond for their proper growth and development. On the other hand, the 15 days old fry are reared in the same small nursery pond, their growth will be retarded and hence production will be hampered.

The management of rearing pond is broadly discussed in three stages

4.2.1 Pre -Stocking management
4.2.2 Stocking management
4.2.3 Post stocking management

4.2 Pre-Stocking management

Eradication of Aquatic Weeds

Being some what deeper and longer than nursery ponds, rearing ponds are more liable to get infested with weeds. An overgrowth of weeds deprived the pond soil of nutritive elements, restrict movement of fish interferes with net- ting operations and harbours predatory and weed fishes and insects . Weeds occupying different habitats and insects have to be controlled in different ways.

Floating weeds like Eichornia and Pistia are best removed by manual labour. Chemicals like 2,4-D are quiet effective and economical against Eichornia
. When mixed with common domestic detergent 2,4-D effectively against weeds like Pistia Nymohaea and Nelumbo. Taficide 80, at a dose of 2.2kg/ha is also effective against Eichornia.

Marginal weeds like typha, grasses , sedges, Ipomea, sagittaria and colocasia are effectively controlled by ploughing grazing by live stock burning during dry season or repeated cutting.

Rooted emergent weeds like Trapa, Myriophyllum etc, are successfully removed by repeated cutting leaves before fulling at weekly intervals for about sic to eight weeks. Alternately spraying once or twice with 2,4-D (at 5.6 -11.2 kg/ha) kills these plants.

Rooted submerged weeds like Hydrilla Vallisneria, Potamogeton, Najas and Ceratophyllumare mostly trouble some and their remove anymanual labour is tedious and costly. The submerged weeds are killed if the water is made turbid for a long time. Copper sulphate in combination with ammonium is also found to be effective . Sodium arsenide at 5-6 ppm si also found to be effective in killing submerged weeds.

Some of the better known fishes that are used for biological control of weeds are the grass carp. Ctenopharyngodonidella and Puntius Javanicus . Grass carp feeds most control infestation of Ottelia Valliharia, Utricularia, Trapa and Myriophyllum.

Anhydrous ammonia gas, obtained in gas cylinders control Hydrilla, Najas, Wolffia, Nymphae , Ottelia and Nelumbo when injected in the surface layers with an application and 112-334 kg/j or 6.9 - 19 ppm.

Eradication of Predatory and weed fishes

Weed fishes (e.g Puntius spp. A.mola, E. Danricus etc.) Are those which compete with the culturable species of fishes for food, space and oxygen and causing serious problem to fish culture.

Predatory fishes (e.g. Channa spp, Clarias sp, Wallago attry etc.) Are those which besides causing the above mentioned problems also directly prey upon the fry and fingerlings of the culturable species.

According to Alikunhi (1957) a single fry of Waljagoattu consumes as much as 1094 carp fry in 40 days.

Thus eradication of predatory and weed fishes is an essential step in rearing pond management.

These fishes may be controlled by repeated drag netting or by complete dewatering of the ponds. However when this is not possible and effective the unwanted fishes may be killed by the application of Mahua oil cake an effective fish toxicants a 2000-2500 kg/ha (at 1 meter water) to 200-250ppm/ Which kills toxicant fishes of the pond with in 4-6 hours . The effect of the toxicant lasts for about 21 days after which it acts as 5% votenon content at a dose of 4.20 mg/1 is perhaps the commonest pond toxicant used.

Liming

The advantage of liming pond are numerous enhances pond productiv- ity and improves its sanitation. It is both prophylactic and therapeutic specific advantages.

(a) Kill, pond bacteria fish parasites and their intermediate life history stages.

(b) Builds up alkaline reserve and effectively stops fluctuations of PH to alkaline levels.

(c) Renders acidic waters usable for aquaculture by raising their PH to alkaline levels.

(d) Neutralizes iron compounds which are undesirable to pond biota including fish.

(e) Improves pond soil quality by promoting mineralization.

(f) Precipitates excess of dissolved organic matter and thus reduces chances, of oxygen duplications .

The commonly available and used forms of lime are

- Calcium carbonate (Ground lime stone)
- Calcium Hydroxide (Slaked lime)
- Calcium oxide(Quick Lime)

Can be applied to the pond bottom 200-250 kg/ha-added to water at inlets or uniformlyboard cast on the water surface depending on the form of limeused.

Pond Fertilization

The next step in rearing pond preparation is fertilization , the objective of which is to have sustained production of adequate quantities of zooplankton which forms the natural food of carp fry.

The production of zooplankton rearing ponds are treated either with organic manures (such as cattle, pig or chicken manure droppings)alone and or with organic fertilization are used they may be applied either one following the other or as a mixture.

(a) Organic manuring : Organic manures raw cattle dung is generally used as 10,000 organic manure raw cattle before the anticipated of stocking.

(b) Inorganic Fertilization : Inorganic manures such as super phos- phate can be used @ 250 kg/ha before stocking.

Eradication of Predatory aquatic insects

Among allpredatory aquatic insects most harmful insects to the carp fry are Notonecta and Cyblister larva which directly feed on fry, apart from these other insects are also having harmful effects such as theycompete for food and apace saryto get high production yield.

Aquatic insects can be eradication by repeated drag netting and by spraying an emulsion of high speed diesel oil 50 li/ha with hyoxide 50 cc/ha along with water 5 li/ha on water surface.

Stocking management

In rearing ponds the fry of IMC and Chinese are stocked in various combination at densities ranging from 2-3 lakhs/ha in the following rations.

Species	Ratio
Catla + Rohu + Mriga	2 : 4 :4
Silver carp +Grass carp	1 : 1
Catla +Rohu+ Grass carp + Mrigal	4 : 3 : 1 : 5 : 1 : 5
Silver carp + Grass carp	3 : 1 : 5 : 2 : 5 : 3
Common carp +Rohu	

Post stocking management

Supplementary

Supplementary feeding consisting of a mixture of ground nut /. mustard oil cake and rice brain at 1 : 1 ratio by weight in powders form broadcasted everyday in the pond during morning hours from the first day of stocking. The feeding schedule as shown below may be followed for 3 months rearing period.

Period	Quantity of Feed day/Lakh of Fry First
Month	6 kgs
Second Month	10 kg
Third Month	15 kg.

It is always desirable to stock fry, harvested from the same pond and of the same age and size groups. The seed should always be released in early morning when the temperature is some what cooler. Before releasing into the pond , the seen should be taken in a piece of cloth and dipped once each in potassium permanganate and saline solution for a few seconds and then re- leased gently into the pond. This helps to prevent the young fishes from any sort of infection. The artificial feeds may be suspended when the pond water turns thick given or bloom develops.

Manuring

During the culture period both organic and inorganic manures should be applied at 15 days interval in order to enhance zooplankton and pytoplankton respectively.

1. Organic manure : Single supper phosphate
40kg/ha/ month.

2. Inorganic manure : Raw Cattle Dung should be applied 1000 kg.ha
Month.

Liming

During the culture period liming should be done 25kg/ha/ month liming should be followed on bright days and should be avoided on cloudy or rainy days.

Netting Operations and Harvesting of fingerlings

Netting should be done regularly at least once a month, the more the netting in a pond the better will be the yield of good sized fingerlings in pon

After 3 months the fingerlings can be harvested by which time they at- tain an average weight of 150-20gms. Supplementary feeding should be stopped a daybefore, harvesting . Harvesting should be done during coolmorning hours.

4.3 Stocking Pond Management

Introduction : Raising of fingerlings to table sized fish in large ponds (0.25-10.0 ha area and 0.8-3.0 depth) is referred to as the stocking pond man- agement . Most of the following activities in the stocking pond management are similar to those of nursery and rearing ponds. To get maximumproduction of fishutmost care should be takenthrough the most economic management mea- sures. The principles in the rational management of stocking ponds are increas- ing the carrying capacity or the maximum standing crop. A pond can support a fish biomass up to only certain level or limit . This limit is called the carrying capacity or the maximum standing crop.

Carrying capacity of ponds are increasing by fertilization and supple- mentary increasing by fertilization and supplementary feeding, optimum utiliza- tion of ecological riches in the pond by good management of water quality, the culture of first growing species and fish health monitoring .The management of stocking pond is broadly discussed in three stage as in rearing ponds.

1. Pre-stocking management
2. Stocking management
3. Post stockingmanagement

1. Pre-stocking management

In this management the steps have taken before stocking the fish seed into the culture pond. Such management si called pre-stocking management pre-stocking management which involved following steps.

1. Dewatering : (Removal of water)

2. Desilting : (Removal of sand)

3. Ploughing : (To improve soil condition)

4. Manuring : Fertilization of pond byorganic and inorganic manures.

5. Liming : Liming increases the productivity of a pond and improves sanitation.

6. Watering : After the lime has been applied to the pond bottom for at least two weeks, the water should be in slowly. The water should free from all pollutants . Physical and chemical parameters of pond water should maintained.

(Fro detail study refer nursery and rearing pond management).

2. Stocking management

Stocking is used to describe the act of placing the fish seed into the pond. The stocking density is used to describe the total number of fishes, which can be stocked in a pond. The stocking ponds are generally stocked with fin- gerlings are about 75-100mm in size. The stocking rate depends on the volume of the water and size of the pond. The ratio of fish to the volume of water should not be less than 1 fish to 2m3 of water where there is no forced acceleration.

Generally pond should be stocked with the surface feeders (like catla, silver carp). This should not be more than 30-35% . Rohu and grass carps are column feeders and it should not be stocked more than 15-20% . Bottom feed- ers such as marginal and common carp together can be stocked to extent of 45%.

If fish seed in stocked in a pond. There is enough oxygen, no tempera- ture difference between the stocking water and pond water. When the finger- lings are transported from a far away place, in order not to stress the fish, the bags with fingerlings are placed in the pond unopened until the water tempera- ture inside the bags is about the same as the . Temperature in the pond when it is same the fingerlings are allowed to swim out of the bag in to the pond water by themselves. This process is called acclimatization. The fingerlings should not be poured into the pond water, as they die because of the shock of hitting the new climaticwater.

3. Post stocking management

The management followed after stocking the fingerlings of fish seed is called post-stockingmanagement.

Feeding

It is discussed in rearing pond management.

Manuring

During the culture period both organic and inorganic manures should be applied at 15 days interval in order to embrance growth of planktons .

(a) **Organic manure :** Raw the dung should be applied @ 1000 kg/ha month.

Liming

During the culture period liming should be done @ 25kg/ha/month.

Growth and health care

The health of the fish needs to be checked periodically. Acheck on the water quality and hygienic condition of the pond is mandatory for healthy growth of fish. The stress factors and rough handling causes diseases periodi- cally trail netting should be done to check the growth and health condition of the fish. Application of lime improves the pond sanitation.

Harvesting

Harvesting is collection of the fully grown fish from the pond. If the pond can be drained, the fish can be harvested by draining the pond and col- lecting the fish with scope nets. If the pond cannot be drained repeated netting should be used to catch

Short Answer Type Question

1. Define rearing pond management.
2. Write the size and shape of the rearing pond
3. What is the use of rearing pond?.
4. Write the control measures of floating weed.
5. Write any two disadvantages of predatory and weed fishes in pond. ?
6. Write any two examples of weed fishes
7. Define acclimatization
8. What is post stocking management ?
9. Write the stocking density and various combinations of fish seed in rearing pond.
10. What is train netting in culture pond

Long Answer Type Question

1. Explain the important steps involved in rearing pond managment.
2. Describe the stocking pond management.

--- # ---

UNIT 5

Culture Pratices

Structure

5.1 Introduction

The management techniques is rearing and stocking are almost similar. To get maximum production of fish utmost care should be taken through the

good management practices. Good management so stocking ponds leads to good production of fish. The success of fish a pond depends upon careful plan- ning .The carrying capacity of stocking pond can be increased by liming fertili- zation, supplementary feeding maintenance of water quality the culture of fast growing species and fish health monitoring . Pre stocking management includes liming, monitoring and eradication of aquatic weeds. Predator and insects etc.

5.2 Lime and its application

Lime is frequently applied in aquaculture to improve water quality. Af- ter the pond is ploughed, cleared and smoothed, it should be conditioned with lime. Liming increases the productivity of a pond improves sanitation. It is both prophylactic the and therapeutic . The main uses of lime are

(a) Naturalize the acidity of soil and water

(b) Increase carbonate and bicarbonate content in water

(c) Counteract poisonous effects of excess Mg, K and Na Ions.

(d) Kills bacteria, fish parasites and their developmental stages.

(e) Build up alkaline reserve and effectively stops fluctuations of PH by its buffering action.

(f) Neutralizes Fe compounds which are undesirable to pond biota.

(g) Improve pond soil quality bypromotion mineralization

(i) Acts are general pond disinfectant for maintenance of pond hygiene.

(j) Presence of Ca in the lime speed up composition of organic matter and release Co_2 from bottom sediment.

(k) Lime matters non-availability of K to algae.

Lime stone, calcium carbonate under prolonged heating in calculating process gets converted into quick lime of calcium oxide. This quick lime under- goes hydrolysis and changes into the calcium hydroxide or slaked lime.

Calcining process

$Ca\,Co_3$ (Lime stone) -----> $CaO + CO_2$ (Quick lime)

Hydrolysis

$CaO + H_2O$ -----> $Ca(OH)_2$ (Slaked Lime)

The most common liming material are agriculture lime stone and hy- drated lime. Hydrated is the cheapest to use because it is more concentrated. Other forms of lime are ground lime stone and quick lime. In many areas, lime stone can be found locally it is soft stone.

New ponds cab en limed before they are filled with water. The lime- stone should be evenly spread over the dry and pond bottom. In pond with water, it is better to spread evenly on surfaced of water. Whether the pond is new old, a layer of lime should be placed on the bottom of the pond. The lime should be added to the pond two weeks before the water is pumped into the pond. The best time for lime applications is during the period when fertilization has been stopped. Lime should not be applied while the pond is being fertilized.

Different doses of the following types of lime can be calculated as fol lows the cement and lining tanks.

$Ca\ Co^3$(g/lit) = Q (10^{-x} - 10^{-y}) 110/2

CaO (g/lit) = Q (10^{-x} - 10^{-y})

56/2 $Ca\ (OH)_2$ (g/lit) = Q (10^{-x} - 10^{-y})

74/2.

Where Q is the total quantity of water

(lit). X is the PH of sample

Y is the required PH of sample of water

The highly acidic soils (PH 4-4.5) need a dose of 1000 kg/ha lime. Whereas slightly acidic soil (PH 5.5-6.5) need about 500 kg/ha. Nearly neutral soil (6.5 to 7.5 PH) requires only 200-250 kg/ha lime. The pH of the pond soil should be brought following rate for a new pond.

Ground limestone -

1140kg/ha Agriculturallime -

2270 kg/ha

Hydrated lime - 114

kg/ha Quick lime (CaO) -

200 kg/ha

Quick lime must be used carefully. It can burn if it touches the skin and is harmful to the body if inhaled. Calcium hydroid and calcium oxide are best applied to the pond bottom after is has been drained.

5.3 Manures and their application

Fertilization

Fishes requires certain elements to grow and reproduce. These ele- ments are C, H2, O2, N2, K, P, S, Ca and Mg. Some other elements called trace elements like Cu, Zn present is very low quantities the fish will not grow well. Fish get these elements from the pond soil, the pond water and the food eat. Some fish ponds lack elements that are necessary for fish growth and productivity. In these cases, it is necessary to add fertilizers to the water. The fertil- izers are simple materials which contains the missing elements. The elements most often missing or short supply in fish ponds are N2,P and K. Fertilizers consisting these missing elements are added to the fish on to help the growth of the fish and the plankton , which the fish use as food.

Apond rich in phytoplankton is often bright green in colour. The colour indicates a bloom of algae. In a normal bloom, these secchi disc appear at about 30cm depth, when the secchi disc disappears at 20-40 cm depth, the pond is very productive and fertile. Not fertilizers is needed in a pond under these conditions.

Sometimes a pond can be become too fertile . If the secchi disc disap- pears at only 15 cm, the bloom is too thick. The thick layer of green blocks the sunlight in the pond and no oxygen can be released by the phytoplankton. In the case there is too much fertilizers in the pond, and hence some of the thick layer of algae formed at the surface of the water should be removed. These ponds do not need any fertilizers.

The secchidise readings determines the need for fertilizers is the quality of the soil . If the soil if highly productive, the need for fertilizers is less, if the soil is not so productive the need for fertilizers is greater.

Type of Fertilizers

The fertilizers which are used in fish ponds are of 2 years.

Organic fertilizers

These are obtained from plant and animal products such as vegetable and animal manures and household scarps. Organic manures are available at cheaper rates.

1. Vegetables matter

Chopped manioc, sweet potatoes, banana leaves , napier grass and other such material have been allowed to rot for a while. This matter is used as fertilizers at the rate of 5,00 kg/ha.

2. Liquid manure

Most of the animals are ureotelic which excrete , a rich source of N2. It is used of sheds, where the animals are kept into ponds of mixed with other organic fertilizers cattle orpig dung.

The compositions are organic manures

Manure		Nutrient contents	
	N	**P2**	**K2**
Cow Dung	0.60	0.16	0.45
Pig Dung	0.60	0.45	0.50
Sheep Dung	0.95	0.35	1.00
Poultry Dung	1.60	1.5-2.0	0.8-9.0
Farm yard Manure	0.50	0.4-0.8	0.5-1.90

3. House holds scraps : These are also used as fertilizers. These include garbage , rice husk, sewage, which are also called 'night soil'.

4. Animal Manure : This is the most important fertilizers. Any kind of animal manure can be used as fertilizers, The important manures are cattle, pig, duck and poultry dung (Table 4.3) . Organic manures are regarded as complete fertilizers because of the presence of all the three major nutrients N,P and K. The manure also consist of organic carbon, trace elements micro organisms and vitamins. These are slow acting but long lasting. Proper care should be taken in their use, other wise depletion of oxygen results in the pond water due to decay causing high mortality of fish due to asphyxiation.

Inorganic Fertilizers

These are chemical fertilizers. They dissolve in water quickly and pro- vide their nutrients immediately. There are 4 major types of inorganic fertilizers.

1. Nitrogen fertilizers : N2 fertilizers have not given uniform results. N2 along with sodium nitrate - 16% N, Ammonium nitrate - 20%N

Ammonium sulphate - 20% N, Calcium ammonium nitrate -

15.5% N Acidic ammonium carbonate - 16% N, Ammonium

Liqour - 20 % N These can be applied at a rate of 200-275 kg/ha.

2. Phosphate fertilizers : P is required in very low quantities at the same time it is most important for enhancing fish production.Aamong phospohatic fertilizers single super phosphate (16%-20% P_2O_5) maintains higher levels of
available phosphorus to the sol. Triple superphosphate (40%-45% P_2O_5) is more efficient in acidic soils.

3. Potassic fertilizers : Soils are rich in K, hence less amount is re- quired in contrast to N and P. NPK is the best combination in the fertilizers. Application of 1 : 8 : 4 NPK at 500 kg/ha gave good results in nursery ponds. Now-a-days sulphate of potash.

(K_2SO_4) and nature of potash (KCI) are used in fish

culture K_2SO_4 - 48 % - 62 % K_20

KCI - 47% - 50 K_2O.

4. Trace elements : The trace elements like Cu, Mn, Zn, Co, B and Mo are useful for the productivity of the pond. Mn increases phytoplankton production . Cobalt chloride is used as growth promoter.

The choice of fertilizers can be decided on the basis of physical compo- sition of soil. In sandy or sandy loamy soils with low organic matter, fertilization is carried out with organic manures. In loamy soils with medium organic matter, a combination.

Multi micronutrient fertilizers are available in the market to improve the growth of cultivable fishes and prawns. These multimicronutrients mineral fertilizers contain in absolutely essential balanced mixture of chelated zinc, maganese, boron, potassium calcium and molybdenum. The uses of these fertilizers are

1. They act as an active stimulating agent for cell development.
2. Help in enzymatic reason as co-factor.
3. Increasing the rate of photosynthesis.
4. Increase oxygen evolving process during photosynthesis
5. Enhance active participation in both nitrogen assimilation and fixation as well as other metabolic process.
6. Help cells remain active and facilitate ion transport and exchange
7. Help in structural, functional and other metabolic integrity.
8. Enhance production of phytoplankton , zooplankton and bentic flora and fauna.
9. Boost up aqua production
10. Reduce annual production cost.

These above advantages of multimicronutrient fertilizers are very good for aquaculture in order to improve the production of fish an prawn.

5.4 Eradication of aquatic weeds

The aquatic weeds (fig 6.9 and 6.10) are classified on the basis of ha- bitual of plants, rooted weeds and floating weeds.

Rooted Weeds

1. Bottom rooted weeds : Plants are rooted at the bottom of the water and spread with in the bottom layer of water e.g. Vallisneria, Ottelia.

2. Submerged rooted weeds : The plants are rooted in the bottom soil and the deeper margins of the pond and ramifying in the volume of water. e.g. Hydrilla , Chara, Potamogeton.

Pistia Salvinia Azolla

Eichhornia Lemna Ceratophyllum

Chara Vallismeria Hydrilla

Fig 5.1 Aquati weed

Marginal rooted weeds : Plants are rooted on the marginal region of the surface layer of water and ramify on the surface of water and also on the adjoining land.

E.g : Marsilla, Ipomoea, Jussiaea.

3. Plants are marginally rooted and ramifying within the marginal re gion of the water column.

E.g : Typha, Scirpus, Cyperus, Panium.

4. Emergent rooted weeds : Surface plants which are rooted in the bottom of the pond but their leaves float on the water level. They prefer shallow parts and shores of the pond. E.g. Nyphea (Lotus), Nyphoides, Nelumbium.

Floating Weeds

1. Surface floating weeds : The plants are floating on the surface of water and with roots in the water. E.g. Eichhornia (water hyacinth), Pistia, Lemma, Azolla, Spirodele. Few surface plants are floating on water but without roots

Wolffia.

2. Sub merged floating weeds: The plants are floating but submerged in the water e.g. Ceratophyllum, Utricularia.

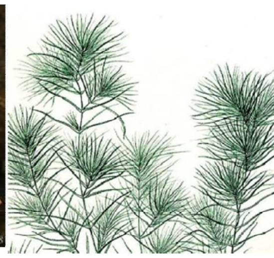
3. We can also divide the aquatic weeds broadly as floating emergent submerged marginal weeds and algal bloods and filamentous algae.

Nymphaea

Nelumba

Jussiaea

Marsilia



Potamogeton

Najas

Fig 5.2 Rooted Aquatic Weeds

Methods of Control

Based on the intensity of infestation and type of weeds, the aquatic weeds can be controlled by means of manual, chemical and biological methods.

Manual and mechanical method

When infestation is scanty and scattered the weeds can be controlled manually only in small water bodies. This is ancient method and is still practiced in most of the places. The pre-monsoon period (April-May) is more suitable for manual removal. In many parts of the country advantage is taken of the drought to control the weds as ponds are other water bodies, dry up or register a sharpfall in the water area, and the plants can thus removed . Where labour is cheap manual i often employed to remove aquatics weeds. The weeds are controlled manual by hand picking ,uprooting the emergent and marginal weeds and cut- ting the other with scythes.

Eradication of Aquatic

Weeds

Being some what deeper and longer than nursery ponds, rearing ponds are more liable to get infested with weeds. An overgrowth of weeds deprived the pond soil of nutritive elements, restrict movement of fish interferes with net- ting operations and harbours predatory and weed fishes and insects . Weeds occupying different habitats and insects have to be controlled in different ways.

Floating weeds like Eichornia and Pistia are best removed by manual labour. Chemicals like 2,4-D are quiet effective and economical against Eichornia

. When mixed with common domestic detergent 2,4-D effectively against weeds like Pistia Nymohaea and Nelumbo. Taficide 80, at a dose of 2.2kg/ha is also effective against Eichornia.

Marginal weeds like typha, grasses , sedges, Ipomea, sagittaria and colocasia are effectively controlled by ploughing grazing by live stock burning during dry season or repeated cutting.

Rooted emergent weeds like Trapa, Myriophyllum etc, are successfully removed by repeated cutting leaves before fulling at weekly intervals for about sic to eight weeks. Alternately spraying once or twice with 2,4-D (at 5.6 -11.2 kg/ha) kills these plants.

Rooted submerged weeds like Hydrilla Vallisneria, Potamogeton, Najas and Ceratophyllumare mostly trouble some and their remove by manual labour is tedious and costly. The submerged weeds are killed if the water is made turbid for a long time. Copper sulphate in combination with ammonium is also found to be effective . Sodium arsenide at 5-6 ppm si also found to be effective in killing submerged weeds.

Some of the better known fishes that are used for biological control of weeds are the grass carp. Ctenopharyngodonidella and Puntius Javanicus . Grass carp feeds most control infestation of Ottelia Valliharia, Utricularia, Trapa and Myriophyllum.

Anhydrous ammonia gas, obtained in gas cylinders control Hydrilla, Najas, Wolffia, Nymphae , Ottelia and Nelumbo when injected in the surface layers with an application and 112-334 kg/j or 6.9 - 19 ppm.

Biological Control

Of all weed controlling measures, biological control of weeds through stocking the water with weed-eating fish such as grass carp, Ctenopharnygodon idella, is found to be and effective and satisfactory method. Grass carp is a voracious weed eater and possess strong and pharyngeal teeth, which enables it to grasp and nibble to soft weeds like Hydrilla. The nature of its gill helps it to sieve large quantity of microvegatation from the water body. Because of its efficiency for weed consumption and convertibility into flesh it is preferred for stocking in weed infested waters.

Control of weeds especially the cost submerged type of weed, through biological control by stocking the water with grass carp has certain advantages. It is not only the most economical due to low cost of operation and easy appli- cation but also does not contaminate the water with toxic substances unlike

chemical used for control. More ever it gives economical returns by increased fish production.

Common carp, Cyprinus carpio and katti,Acrossocheilus hexagonalepsis and ducks are also used for biological control of aquatic weeds. Beatles and stemborers are also recommended for the purpose.

Biological control of weeds may be done by shading . Increasing tur- bidity , covering the surface by controlled floating weeds, shading the water area by canvas or coloured polyethylene sheets to cut down sunlight in order to check growth and vegetation are some of the methods

5.5 Eradication of Insects

also in use.

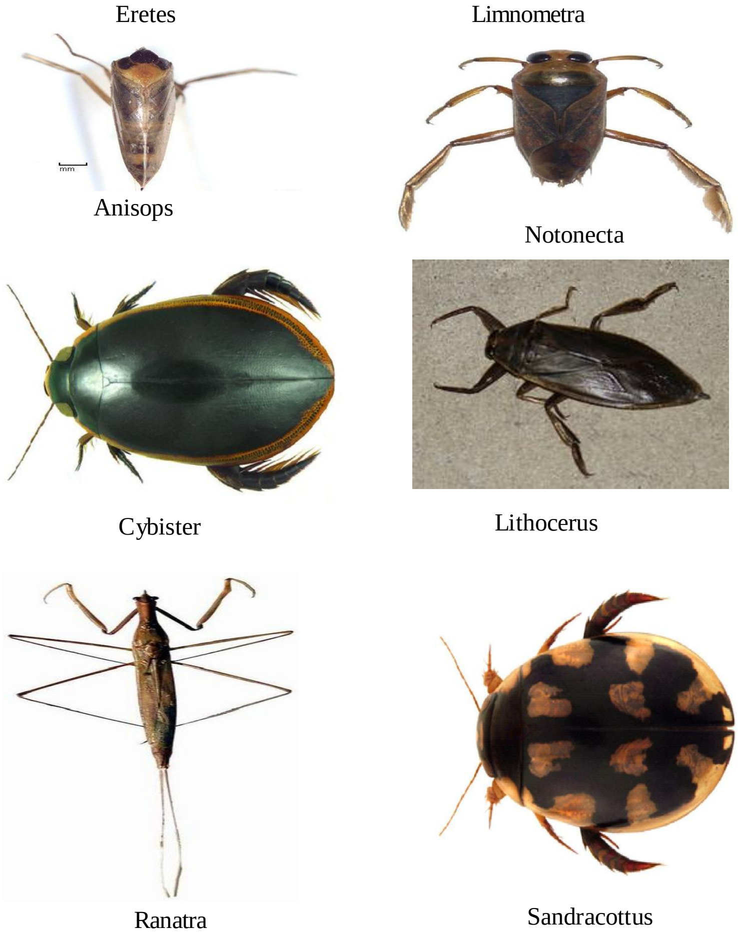


Fig 4.4 Aquatic insects

Insects are usually found in large number in ponds over the greater part of the year, especially during and after rains. These insects injure the spawn and so have to be eradicated. Hence the insects should be eradicated prior to stocking to ensure maximum survival of the span . Nottonecta, Ranatra, Cybister, Lethocoeros, Nepa, Hydrametrao and Belostoma are highly destructive to the carp seed. The insect can be eradicated by using oil emulsions . After manuring the nurseries they should be treated with oil emulsion.

The spraying of oil emulsion is 12-24 hour before stocking the spawn in nursery pond so as to eradicate the insects. The oil emulsion with 60 kg of oil and 20 kg soap are sufficient to treat one hector of water. The soap is dissolved first in water and it is added to the oil and stirred thoroughly to get brownish grey solution. It is then spread on the surface of the water. All the aquatic insects die because of suffocation due to the thin oil firm on the surface of the water. The spiracles of insects are closed by the oil firm so that they die.

An emulsion of 56kg os mustard oil and 560 ml of Teepol os also useful to treat on hector of water. An emulsion can also prepared with diesel boiler oil and any detergent. Since soap has become very costly one effective method is to use 50 cc of Hyoxyde -10 mixed in 5 litre of water with 50 liters of high speed diesel oil for a hector of water.

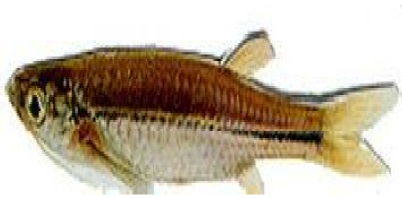
Application of biodegradable organophosphate like Furnadol,. Sumithion, Baytex, Dipteryx etc. (0.25 to 3 ppm) are useful to kill the insects.

Whenever an oil emulsion is applied there should be no wind as it disturb the oil film, and its effectiveness . Birds like kind fishers, herons and cormorants are destructive to fry and fish. Thin lines stretched across the pond are the most effective means of controlling them.

5.6 Eradication of weed fish and predatory fish

Notopterus

Mastacembelus



Esomus

Rosbora

Amblypharyngodon Moa

Ambasis

Puntius Ticto

Fig 4.3 Predatory and trash fishes of the pon

The real problem arises during the rearing of fish, when the other ani- mals eat the fish. Frog, snakes and birds eat young fish and must be kept out of ponds. The worst predators are carnivorous fishes, which should be prevented from entering into ponds by screening the water inlets.

The common predatory and weed fishes (Fig 4.3) in ponds are Channa sp. Clarius batrachus, Heterophenustes fossilis, Wallago attu, Netopterus notoptrus, Mystus sp. Ambasis ranga, Amblypharyngodon mola.

Table . Some Important fish poisons, dosage for fish kill.

Name of the chemical	Dosage (ppm)	Degraded after (days)	Time taken for fish kill
Bleaching powder	25-30	7-8	3-4
Tafadrin -20	9.2	30	7-8
Mahua oil cake powder	200-250	5-20	8-12
Derris root powder	4-6	7-10	6-10
Tea seed cake	75-100	10-12	6-12
Cotton seed powder	3-5	3-5	1-2
Milletioa root powder	2-6	2-3	1-3

Salmostoma SP , Esomus danricus sp etc. The weed fishes are small sized and uneconomical fishes are all usually in ponds. The undesirable fishes enter into ponds accidentally through incoming water long with carp spawn. The predatory fishes are harmful to all stages from the spawn to the adult stages of carps and prey on these carps as well as compete with them for food and space.

In any pond all trash food and predators must be removed before stocking the pond. The simple methods of draining and drying of the ponds and then pluohging them are most effective in controlling them. If the draining si not pos- sible the pond is completely as possible the undesirable fishes should be re- moved from ponds by repeated drag netting. However many fishes escape the net by staying at the edges of pond . The bottom dwellers like murrels, climbing perches , magur, singhi etc., which burrow themselves in the mud are difficult to be caught by netting.

Dewatering is the best method, wherein the water should be removed by pumping, although this is an uneconomical method. In case the best way to get of the undesirable fishes is poison the water in a pond which cannot be drained.

Poisons are lethal to aquatic life even at low concentrations. It is better is use degradable poisons, so that the growing fish will not be affected later on.

A suitable fish poison is one which is

1. Effective in killing the target organism an fairly low doses.
2. Quickly detofixed ion water and does not have cumulative adverse effect in the pond.
3. Easily available and economical.
4. I should not injurious to the people and cattle who may use the water.
5. It should not having a tendency to accumulative in fish, this making them unsuitable for consumption.

Various types of fish poisons are available in the market. These are classified into 3 groups chlorinated hydrocarbons , organophosphates and plant derivatives. Chlorinated hydrocarbons are most toxic to fish. These are accu- mulated in fish tissues and are stable compounds , which are not metabolized. Organophosphate are less toxic flora and fauna, The accumulation is less in fish tissues and relatively less persistent in water. Hence the plant derivatives are good fishpoisons.

5.7 Sanitizer

Introduction : The aquaculture sector in Indian emerged as an impor- tant export sector for the country. We are not only getting the food by cultivating aqua species but also getting revenue. We can enhance the above aqua species production by adopting modern scientific methods. Some of them are use of probiotics sanitizer and plant extracts etc, which are useful to maintain hygienic conditions in pond to treat the disease by which the fish , scampy and shrimp production can be enhanced. Excessive use of chemical and toxic substances adversely affected the coastal environment and there by productivity of a aquac- ulture. Therefore safest sanitizer are like plant, extracts are applied to increase output as well as to controlthe environmental pollution.

Intensive aqua farming is frequently depressed by disease due to bacte- ria and viruses. There are various causes of development of bacteria which in for long period of decomposing evaluate toxic gases mainly ammonia, hydrogen sulfide pollute the pond. Now a days certain sanitizer are available in the mar- kets.

Gascon : It is the latest concept where absorption / reduction of evolu- tion of gases are done by growing up friendly bacteria which slowly and gradually suppress the formation of toxic gases.

Yucca Schidigera : Is a plant belonging to the Agavaceae family, a plant native to the desert of the united states and Mexico. It has rich in phy- tochemical. It is used as natural sanitizer a farming agent and as food material for live stock. It is better solution to Ammonia pollution.

Zeolite and lime : Are act as good sanitizer for culture ponds. They helps purification water, kills germs and improve content biological sanitizer , Deteriorative , scavengers bottom feeders are at as biological sanitizer .

E.g : Common carp, cirrhinmvigala and prawns are bottom feeders they acts as scavengers, common carp generally known as sanitary fish .They keep the pond neat and clean.

5.8 Proboitics

Uses of Probiotics in Aqua Culture

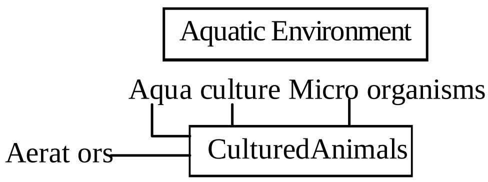
What are probiotics ?

Probiotic is an opposite term of antibiotic where total system of envi- ronment and health of the animals are systemized interacting with friendly bacteria's naturallyoccurring.

Role of Probiotics in Aqua Culture

It is found intensive shrimp culture frequentlydepressed byvarious dis- ease and attacked by harmful bacteria (vibrios). The high stocking density / prawns is conductive to the spread of pathogens. Frequent use of therapeutic chemicals e.g. antibiotics though kill pathogens but does not solve the underly- ing problems. Slowly and gradually shrimps/prawns who are physically very much delicate succumb to microbial attack and face mortal fate.

Probiotics appeared as an alternative remedy for disease control. Aqua control is successful when there is effective interactions of the aquatic environ- ment cultured animals and micro organisms. The effective results of proboitics are truly when mechanical devices like aeration is opted where total micro or- ganisms fully dispersed in the pond. D.O. Level in this type of practice is main- tained in heavily loaded culture ponds are hatcheries.



In aqua culture system the cultured animals have to adjust with complex aquatic environment where production of photosynthetic oxygen and BOD fluc- tuate from the atmospheric conditions in the morning day, evening and night. Fogs and clouds becomes an added loaded on the total aquatic systems which directly effects the animals the ponds. Probiotics since are friendlybacteria at- tempt to manipulate the factors that effect the said adverse on the cultured, organisms and try to bring the total system under controlyieldinghealthycrops with high production.

Pro-biotics play immense role in aqua culture they do.

- Remove organic load of pond bottom and reduce the pollution of pond.
- Reduce the toxic gases in the pond
- Reduce ammonialevel
- Improves DO
- Inhibits vibrio and other pathogenic bacteria and reduce bacteria toxins in the pond.
- Ensure healthyenvironment for the prawn fish and shrimp by reducing BOD and increasing DO levels.
- Reduce mortality rate of prawn fish and shrimp.

Composition of ProBase -AR.

Probiotics for aqua culture, usually in form of a mixture of several spe

-cies and strains they are

Group - A

1. Bacillus subtilies
2. Bacillus itcheniformis
3. Bacillus Megatherium
4. Bacillus Polymyxa
5. Aspergellus miger
6. Apsergilus orgyzae
7. Sacchuromyces cerevsace
8. Lactobacillus sporonges

Group B

1. Alealgenes faecalis
2. Celluslomona carte
3. Pseudomonas dentrificants
4. Psendomonas putida
5. Rhodococcus
6. Nitrobactor
7. Nitrosomonas

GroupAbacteria are having concentrating of 2.5 billion efu/gm whereas that of group B is 2 billion cfu/lit.

Onbrewing in jagnryonsugar for minimumof12 hours strength of the bacteria will be appreciably increased.

Note : Since the bacteria of group B are essential for total condition of pond soil and water and those bacterious do not survive in dry condition they have been kept in liquid.

Probities can be either applied to the feed or to the ponds.

(a) Feed probioties : Feed probioties are incorporated into the feed and get their way into gastrointestinal tract of the animal feed probiotics may be useful growth promoter, but for pelletized feed it is not feasible at present.

(b) Pond probiotics : In recent years, a number of probiotics have been introduced primarily for better water and pond management. They pro- vide help for enhance the beneficial bacterial population, and removal of toxic gases such as ammonia, nitrates and other from the water and pond bottom sediment.

Short Answer Type Questions

1. Write any two uses of Lime in culture pond.
2. Mention two types of Lime.
3. Write the two types of fertilizers used in fish pond.
4. Write any two types of inorganic fertilizers and give examples.
5. What are sanitizers in aqua culture? Give two examples.
6. What are Proboitics?
7. Write the use of Probiotics in aquaculture.
8. Mention two surface floating weeds.
9. Mention any two submerged rooted weeds.
10. What are weed fishes? Give two example.
11. What are predator fishes? Give Two examples.

Long Answer Type Questions

1. Describe the application of lime and manures in culture ponds.
2. Explain the typs of aquatic weeds and their control.
3. Write about the eradication of following
    a. Aquatic weeds
    b. Aquatic Insects
4. Write short note on
    a. Sanitizers
    b. Pro-biotics

UNIT **6**

Natural Food

Structure

6.1 Introduction

One of the most important features of fish culture in that the fish should have good food. Feeding and fertilization together make the pond culture suc- cessful. The growth of fish in the ponds is directly to the amount of food avail- able in the pond. The pond must provide all the food nutrients that the fish need. But all of not need the same kind of food. For different species feed on differ- ently types of food. Fish also feed on different foods depending on the stage of their lifecycle.

Newly hatched hatchlings absorb feed formtheir yolk and until the yolk in the yolk sacs is exhausted. The fry eat the smallest phytoplankton in the pond. Adult fish feed on a particular kind of food that fish enjoy plankton, aquatic weeds, worms insect larvae etc.

6.2 Food and Feeding habits of fishes

Different author have classified natural food and feeding habits of the fishes (Schaprclas 1933).

1. **Main food :** It is the most preferred food on which the fish will thrive best.
2. **Occasional food :** It has relatively high nutritive values and is liked and consumed by fish whenever the opportunity presents itself.

3. Emergency food : It is fed/upon /accepted when other food on the basis of their importance in the diets of fishes.

Nikolsky (1963) recognized 4 main categories of food on the basis of their importance in the diet of fishes.

Basis Food : It is normally eaten by the fish and comprises most of the gut contents.

1. Secondary food : It is frequently consumed in smaller quantities.

2. incidental food : It is consumed rarely.

3. Obligatory food : The fish consumes this food in the absence of basic food.

Based on the nature of food, Das and Moitra (1963) classified the fisher into 3 primary groups.

1. Herbivorous fishes : They feed on plant material, which forms more than 75% of gut contents.

2. Omnivorous fishes : They consume both plant and animal food.

3. Carnivorous fishes : They feed on animal feed, which comprises of more than 80% of the diet.

Herbivorous are divided into 2 sub groups.

(a) Planktophagous fishes : They consume only phyto- and zooplankton.

(b) Detritophagous fishes : They feed on detritus.

Omnivorous can also be grouped into 2 categories

(a) Herbi-omnivorous : Fish feed more on plant material than animal food.

(b) Carni-omnivorous : Fishes feed more on animal food than plant material.

Carnivorous are also classified into insectivores (feed on insects) carcinophagous (feed on crustaceans), malacophagous (feed on molluscans), piscivorous (feed on other fishes)and larvivorous (feed on larvae). Some fishes are cannibalistic.

The fishes consume a variety of food material, such as phytoplankton , zooplankton aquatic weeds, animals like annelids, arthropods, molluscs, other fishes and amphibians.

6.3 Food and Feeding of prawns

A wide range of feeding habits have been noticed in prawns in nature during their developing stages. The nauplius larvae do not feed at all as they depend on yolk reserves. But protozoa larvae food voraciously on minute food organism, mainly phytoplankton viz. Skeletoneria, Chaetoceres etc. As their oral appendages are not fully developed for the capture for larger food organ- isms, and they have a simple alimentary system. The myosis stage starts feeding small feeding on small animal food organisms, occurring plenty in the ecosys- tem. During the post larval stages , which follows the myosis stage the mouth parts on chelate legs are fully developed, and form now on, the prawn larvae are capable of feeding on a variety of animals as well as vegetables matter.

They then settle down to the bottom and browse on the substratum. Penaeus indicus has been reported to feed on plant material in the younger stages while the older ones prefer predominantly crustacean diet. Algal fila- ments also form part of the food of this species. P monodon feed on molluscs, crustaceans, polychaetes and fish remains.

6.4 Natural food organism in pond

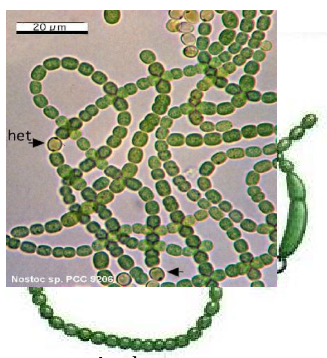
A variety of natural fish food organism are found in water body, which depend on the nutritive nature of the water body. The natural food provides the constituents of a compete and balanced diet. The demand of natural food varies from species to species and age group of individuals. For example catla prefer zooplankton and silver carp prefers phytoplankton. At younger stage, the fish may feed on plankton, and the same fish may prefer animal food as an adult. Fishes are on different natural food organism at all the different trophic levels. Natural feeds have high protein and fat contents which promote the growth of the fish. Hence, it is necessary to increase the live food in the aquatic ecosystem to improve the growth to improve the growth of the fish.

Plankton

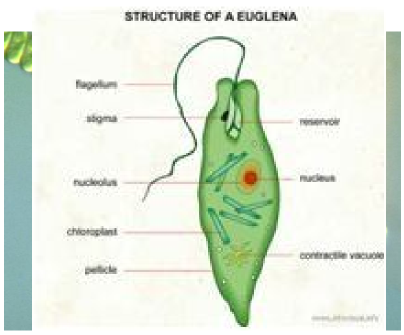
Fish production in water body is directly or indirectly dependant on the abundance of plankton. The physcio-chemical properties of water determines the quality and quantity of plankton. Thus during the study of plankton, a link in the food chain is pre-requisite to understand the capacity of the water body to support the fisheries and the need for introduction of additional selected species of commercially important fishes.

Phytoplankton

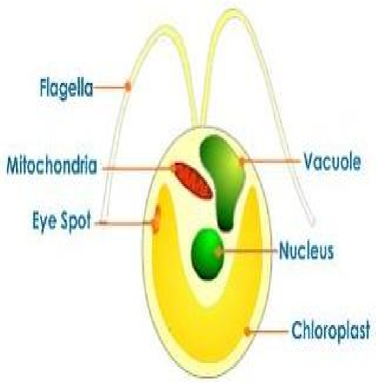
Fishes consume the phytoplankton which is found abundantly in well managed ponds. Phytoplankton gives green colour to the water due to the presence of chlorophyll. Plankton are generally made up of mostly unicellular algae which are either solitary or coronial. Phytoplankton are autotrophs. Algae of three major classes which from the main food in phytoplankton (fig 6.1.3) . These are chlorophyceae, cyanophyceae and bacillariophyceae.

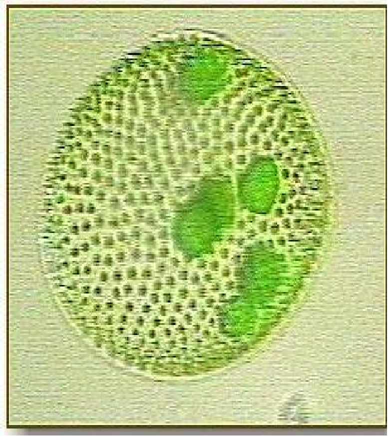


Anabaena



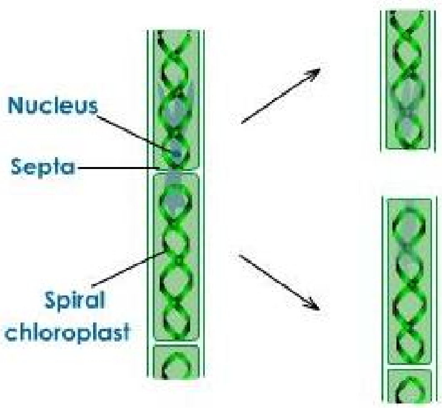
Spirulina





Chalamydomonas

Volvox



spirogyra

Nitella

Fig 6.1 Phytoplankton

Chlorophycaea

These are called green algae due to the presence of chlorophyll. The chlorophyceae members useful as fish food are Chlamydomonas, Volvox, Eudorina, Pandorina, Chlorella, filamentous algae like Ulothrix Oedogonium, Spirogyra, Pediastrum, Microspora, Cladophora, Clostridium, Scenedesmus, Cosmarium etc.

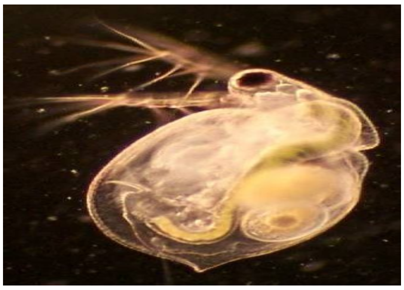
2. Cyanophyceae : These are also called as myxophycaea and are commonly known as blue green algae. This colour is due to the varying propor- tions of chlorophyll , carotenoids and biliprotiens, cyanophycean members are consumed by fishes. These are Nostoc, Oscillotoria, Anabaena, Microcystis, Spirulina, Merismopedia, Arthrospira etc.

3. **Bacillariophycaea :** These are called diatoms. They are unicellular organisms with different shapes and sizes. These may be yellow or golden brown or olive green in colour. The reserve food materials are fat or voluntin. The diatoms consumed by fish are Diatoma, Navicula , Cocconies, Synedra, Tabellaria, Meridion, Fragilaria, Nitzschia , Pleurosigma, Amphioleura, Rhiszoslenia, Cyclotella, Amphora, Melosira, Achnanthes etc.

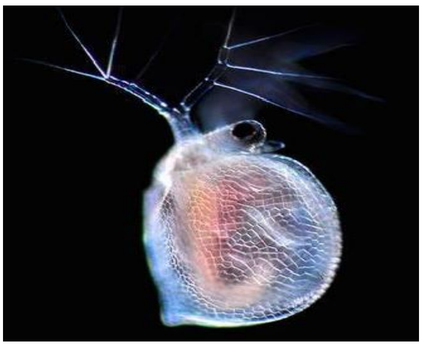
Zooplankton

Plankton consisting of animals is called zooplankton . Zooplankton is abundant in the shallow areas of water body.

Daphnia carinata



Moina



Ceriodaphina

Artemia

Fig 6.2 Zooplankton

Protozoa

Protozoans are most primitive unicellular and microscopic these or- ganism are provided with locomotory organella like pseudopodia , flagella and cilia. These organismare found abundantly in fish ponds are usefulas natural fish food

The protozoa with

pseudopodia. The

protozoans with flagella .

The protozoans with cilia.

Crustacea

The aquatic animals with 19 pairs of appendages and branchial respi- ration are included in the class crustacea. The crustaceans vary form micro- scopic to large animals . Crustacean form major component of zooplankton. In zooplankton the micro crustaceans are useful as food of fish and prawns. The important micro crustaceans are copepods and cladocerans. The crustaceans nauplii also constitute good food material for many fishes and prawns. For ex- ample , nauplii of Artemia are used in prawn hatcheries.

(a) Copepoda : The copepods inhabit many of the freshwater habitats such as lakes reservoirs ponds etc. The sizes of the body of the cope- pods is 0.3 to 3.5 mm. Copepods such as Cyclops, Mesocyclops, Diaptomus, Canthocamptus etc, are useful as fish food organism.,

(b) The animals : The greatest abundance of cla- docerans is found near the vegetation in lakes ponds etc. The size of these shelled crustacean varies from 0.2 to 3.0 mm. The cladocerans like Daphnia, Ceriodaphnia, Moina. Sinocephalus , Scapholebris , Sida, Eurycerus, Chydorus, Daphniosoma, Polyhemus, Macrothrix . Leydigia etc are useful as fish food organism.

(c) Ostracoda : The animals with bivalved carapace, which encloses the entire body, 4-6 trunk appendages and reduced trunk are included in ostracoda. These forms are well represented in both standing and running wa- ters. These are exclusively planktonic forms. Occasionallylike Cypris, Stenocypris etc, are consumed by fish.

Rotifera

Rotifera are readily from other planktonic material by the presence of their major ciliated wheel-like structure called corona and hence they are called wheel animalcules. Rotifers live in a variety of aquatic habits. They are micro- scopic , ranging from 40 microns to 2.5 mm in size. Usually rotifers like Keratella Phlodina, Rotaria. Hexarthra, Filinia, Brachionus Epiphanes etc., are useful as food organism.

Aquatic weeds

Though the aquatic weeds form undesirable vegetation, which cause damage to the fisheries these are helpful as food for few fishes. Many herbivorous fishes consume aquatic weeds. The grass carp is a fast growing fish that feed on aquatic weeds. This fish utilizes submerged weeds like Hydrilla, Najas, Ceratophyllum, Ottelia, Nechamandra, Vallisneria in that or der of preference . The young fish prefer smaller floating plants like Wolffia, Lemna, Azolla and Spirodela the other herbivorous fish utilize aquatic weeds

Annelids

These are found at the bottom of the water body are generally consumed by bottom-dwelling fish,. Common carp, catfishes , murrels, etc.. Tubifex , Glycera and earth worm are the com- mon fish food oligochaetes.

Insects

Animals with 3 pairs of legs of wings, jointed appendages and a chiti- nous body wall are included in class Insecta. Insects and their larvae form main food item of any fishes., Aquatic insects are often preyed upon by fish trout, catfishes murrels etc.

Mollusca

The animals with a soft body, shell and foot are included in the phylum Mollusca . The molluscans are found at the bottom of water body. Hence only bottom-dwelling fish consume them. The gastropodes are found in the diet of carnivorous and omnivorous fishes.

Fishes

Carnivorous (piscivorous) fish feed on a variety of other adult fishes fish egg fry an fingerlings . Fish like murrels, freshwater shark, seenghala, etc, feed on other fishes. The small fishes are like Salmostoma, Amblypharyngodon, Puntius, Labeo, chanda , Nuria, Lebistis, Gambusia, Esomus etc are consumed as food by larger fishes. Some fishes are cannibalistic in nature.

Prawns

Fishes are also feed on decapods (prawns) . The carnivorous and om- nivorous fishes feed on small prawns. For example , Macrobrachium Kitsuensis is found the gut is many fishes. Acetus prawn suspension is given as food tot he larvae and post-larvae of prawns in the hatcheries.

Role of Plankton and their Culture

- Plankton regulates transparency and dissolved oxygen thereby regulating sun’s ray and penetration and temperature and decreasing accumulation of CO_2 , NH_3 , NO_2 , H_2S etc, in water.
- Pond with a definite phytoplankton is observed to keep prawns calm and reportedly minimize cannibalism. They consume phytoplankton and thereby regulate NH_4^+ and tie up with heavy

metals.

Characteristics of Plankton as fish food

- It has easily availability
- It is easy to handle
- It performs as a food
- Its production cost to serve as feed is low and the rate of capital return is viable
- It has particle size of 10-500µm dia.
- It stays suspended in the water column for a considerable period.
- It does not pollute the water system
- It possesses attractability as a feed for the fish and prawn
- It is acceptable, palatable and possesses a low BOD, reducing any change of rapid microbial degradation
- It has an appreciable shelf life
- It is easy for culture / rapid propagation.

Culture of phytoplankton

The unialgae are obtained by the isolation technique and transferred in culture tubes containing suitable sterilized medium and then placed in an inocu- lation chamber under required light and temperature condition, and pH and salinity is maintained accordingly. Stock cultures can also be maintained in 200ml conical flasks. The growing cultures are poured into 1 litre conical flasks. These freshly inoculated flasks are placed in the same culture conditions . After one week sufficient concentration of growing cells can be achieved , Diatoms, Chlorella and flagellates are cultured in this way.

Culture of Zooplankton

Culture of zooplankton such as copepods, rotifers, cladocerans larval stages of molluscs and small larval are suitable for feeding prawn larvae and fish. As the zooplankton feed on phytoplankton they are either cultured along with phytoplankton.

Brachionus culture

The rotifer Brachionus plicatilis is cultured in a 2000 m concrete tank. Stock is maintained in 1 m fiberglass tank. The rotifers with a water slurry of Baker yeast and Chlorella . The culture tanks are stirred each morning after feeding but are not aerated which allows the tanks to becomes anaerobic. It has been found that anaerobic conditions are essential for rapid proliferation to ro- tifers. Population densities of 500 to 700 rotifers/ml/are reached within 15-20 days. Rotifer culture apparently can be harvested daily for a period of 45 days. It is harvested by drawing the culture through the a nylon net.

Moina culture

Miona culture in a 12 plastic pool by manuring with organic fertilizers inthe form of liquid manures. To start with , the plastic pool of 12 which has a capacity of 9,00 liters is manured with 18 liters of liquid manure and each sub- sequentlydaytillMoina are harvested . Manuring is done with half the original dose. In the culture system, Moina is inoculated at the are of 50 individuals per litre of water and on the fifth day, a carp of Moina with a count of 20,000-25,000 individuals per litre (Tiwari 1986) can be harvested. Harvesting of Moina is usually carried out a night when all the planktoncanbe easilyscooped up with a planktonnet.

Artemia

Artemia commonly known as fairy or brine shrimp or sea monkey is a crustacean belonging to the group branchiopoda. It inhabits highly saline water and is found in natural and man made saline pens, lakes

Generally Artemia is harvested from its natural habitats or is cultured under controlled conditions. The nauplii have 55.6% protein, 15.25% fat and 15.25% ash and ,meet all requirement of a nutritive live food. Artemia is om- nivorous and a non selective feeder and feeds on protozoa , micro-algae bacte- ria anddetritus.

Artimia Culture

Artemia cysts can be hatched out naturally by placing them in conical plexiglass hatching jar with natural sea water for 20-24 hours with continuous aeration. However at 5 ppt increase the salinity, the hatching rate increase and higher hatching efficiency is noticed. After incubation aeration is renewed for 10-15 minutes to allow egg capsules to float. The upper half of the conical tank is covered with a black cloth so as to concrete the nauplii at the bottom which can be drained out into a strainer or a basin. The nauplii are rinsed with seawa- ter remove remaining emptycapsules and are fed to the prawn larvae at the required numbers.

Culture ofLablab

Lablab is the most natural food for brackish water prawn and fish. It is a biological mixture of phyto- and zooplankton forming food the bottom feed- ers. It consist of myxophyceae, bacillariophyceae and bacteria among phy- toplankton and protozoans among zooplankton .

Lablab can be cultured in brackish water pond., the pond is dewatered and the pond bed exposed to sun. Pond bed in dried until the bottom soil is fully dried, cracks and crumbles are formed. The pond is then filled up to 10-15 cm with sea water. Generally sea water is rich in nutrients , even though it better to fertilizers the pond to get thicker lablab. The pond fertilized either with cow dung or chicken dung at the rate of 500kg/ha . It is also manured with rice bran or oil cake at rate of 300-500kg ha. The pond is then allowed to dry up com- pletely for 1-2 months. After drying a green mat is formed on the pond bed.

Short Answer Type Questions

1. Write the types of fishes based on the nature of food.
2. Define plankton.
3. Give any two examples of phytoplankton.
4. What are Zooplankton ? Give an example.
5. What are 'Rotifers' ? Write any two examples.
6. What are protozoans ? Give any two examples.
7. Name any two types of Micro crustratians. Give Examples.
8. Write the food organisms of protozoea larva.
9. Define lablab.
10. What is artemia ? Write its use.

Long Answer Type Question

1. Describe the food and feeding habits of fishes
2. Explain the food and feeding habits of shrimp larvae.
3. Write about the food organisms of fish.
4. Write the role of plankton and explain any one plankton culture.

UNIT 7

Artificial Food

Structure

7.1 INTRODUCTION

As fish and shrimp farming continues to expand, production methods have shifted from traditional extensive to semi-intensive or intensive system uti- lizing modern facilities , equipment and management techniques aimed at pro- ducing higher yields per unit area. Natural food constitutes an important source of nutrients for intensive culture. Whereas artificial feeds are required for semi- intensive and intensive practises. In intensive culture systems. Feed represents the major expense, often accounting for over 50% of total variable operating costs. This the development of feeds that are efficient and economical is funda- mental to successful shrimp farming. This requires the understanding of nutri- tional in items of protein, lipids, carbohydrates vitamins and minerals.

7.2 NUTRITIONAL REQUIREMENT

Proteins and amino acids

As the principle and most expensive component of diets, protein has received the maximum attention in nutritional requirement studies. Animals in- cluding fish and shrimp must consume protein to furnish a continuous supply necessary for replacing worn tissues and for the synthesizing of new tissues. Inadequate protein in the diet will result in retardation or cessation of growth, or loss of weight due to the withdrawal of protein from less than vital in order to maintain the functions of more vital done. If too much protein as supplied , however only a part will be used to build new tissues and the remainder will be converted into energy.

Carbohydrates

In fish carbohydrates is present in lower quantities in the form of glyco- gen sugars and their derivatives .In fish carbohydrates such as sugar, starch, gums and cellulose are digested and the products of their hydrolysis are taken to the tissues through blood circulation and serve as immediate energy sources. Carnivorous fish do not digest raw starch owing to their inherent digestive ca- pacity due to weak carbohydrates. On the other hand, herbivorous especially
grass carp, have the ability for rapid and efficient digestion of plant fibres and raw starch due to their cellulose and didastase enzymes. It is observed that 10- 50 percent of carbohydrates in fish feed enhances the growth of fish through their protein sparing action. However, the excess of carbohydrates when present in fish diet is either stored in the liver and muscle as glycogen or converted into visceral and muscular fat.

Fats

The fats and oils are high energy - yielding substances. The fat require- ment of any culturable fish depends largely on its digestibility ,quantity , amount of essential fatty acids present in the fat and the level of the fat can tolerate. Fish feed of profitable fish culture should have 4-18% of fat, and excess lipid in the diet may affect the fins, liver body colour growth rates of fish and may lead to mortality in culture system. The gross conversion efficiency of fat is about 90%
. The fat acids and esters of glycerol are used by fish for long-term energy requirement, particular during period of extensive swimming and inadequate food supply. Fresh water fish have higher level of poly-unsaturated fatty acids compared to their marine counterparts . Hence, marine fish require more poly- unsaturated fatty acids in their diet.

Vitamins

Qualitative and quantitative vitamin requirements for several commer- cially important finfish species such as salmon,. Trout, channel catfish and com- mon carp have been fairly well-defined but vitamin information for shrimp is very limited. However, the importance of vitamins in penaeid shrimp nutrition has long recognized as these nutrients have normally been included in experi- mental or production diet. The amounts of vitamins added have been varied due to lack of established requirement data.

Thirteen vitamins ,three fat-soluble vitamins (vitamins A,D, and K) and ten water soluble vitamins (thiamin, riboflavin, Pyridoxine, nicotinic acid, biotin , folic acid, vitamin B12 inositol choline , and vitamin C) have been shown to be dietary essential for shrimp based on weight gain. Survival rate, tissue storage and other specific deficiencysings.

Minerals

Minerals have many important function in the animal body. They are essential components of hard tissues (bones, teeth and exoskeleton), soft tis- sues (protein and lipids) vitamins, enzymes hormones, and respiratory pig- ments. They are also required for the maintenance of osmotic pressure , acid - base balance (e.g. regulation of blood pH, haemolyph, urine and other body fluids) and the proper functioning of muscles and nerves.

7.3 Supplementary feed and their application

In the raising of stable fishery there is a need regular supply of sustained and balanced food for growing fish. Suitable food has to be provided for healthy growth of fish.

The food which is added in the pond for better growth of fish is supple- mentary food. The typical supplementary food are rice bran, ground nut oil cake, bread crumbs fish meal ,maize powder ,broken rice, soybean cake, pea- nut cake, corn meal, cotton seed oil cake, oats, barely, rye, potatoes ,coconut cake , corn meal, cottonseed grass, wheat , silkworm pupae, left over animal feeds and animal manures.

Formulated feed

Rearing of spawn, fry and fingerlings until they become stock able size and their subsequent culture in grow out ponds require appropriate and nutri- tionally balanced diet for enhancing production. This is been of the essential requisites in the development of aquaculture. The advantages of formulated feed are

1. Proper formulated feed are in replica of exact nutritional requirement of fish. Therefore by understanding the nutritionally well balanced feeds which could be formulated using low cost feed stuff available locally.

2. Ingredients of formulated feeds can complement one another and arise the food utilization rate.

3. Proteins can supplement one another so as to satisfactory improve most of the essential amino acids content of the feed, thereby raising the proteinutilization.

4. Large quantities of feeds can be prepared at a time good shelf-life so to be convenient to preserve, which can be used at the time of supple mentary feeding.

5. Feed ingredient sources can be broadened with preferred and less preferred ingredients with additives like antibiotics and drugs to con trol fish disease.

6. High efficiency of feed can be achieved by judicious manipulation of feed ingredients and can be made commercially feasible.

7. By adding a binding agent to produce feeds, the leaching of nutrients in water is diminished and wastage is reduced.

8. Dispersing over large farm area is quite possible as formulated feedsare convenient transport. These are suitable for automatic feeding, for which automatic feed dispensing devices could be successfully employed.

9. Supplementary feeds can be given by feed bag method in ponds.

7.5 FOOD CONVERSION RATIO

Fish production cost may incrases and water quality may deteriorates due to imporper protein and nergy levels in feed for proper growth, net protein utilization by fish should be around 27%. Fish feed should also contain suitable amounts of energy source, minerals and vitamins.

FCR $$FCR = \frac{\text{Feed Given}}{\text{Animal weight gain}}$$

FCR is the mathematical relationship between the input of feed that has been fed and the weight gain of a population.

- Lower the FCR the weight gain obtained from the feed
- There are no measurements units
- When applied to aquatic animals, this FCR is generally lower than that of land animals,

FCR calculation required the following variables:

- The initial biomass: i.e, the number of fish in a farm population multiplied by their individual weight of the production unit under study.
- The final biomass of the same production unit
- The amount of feed distributed

The FCR is simple and objective. For these reason, it is a valuable indicator in the context of fattening farms (stocking ponds). It is determined by comparing the initial input of feed with the final output of the shrimp or fish that are produced.

7.6 QUALITY OF FEED

These properties includes: actual diameter, expansion rate, surface area, volume, weight bulk density, durability, floatability, moisture content, water stability, repose angle and crushing load.

Criteria for selection of feed:

- Feed should be readily available from local areas.
- Feed should be low cost
- It stores for long period
- Raw materials should be available locally
- Feed should have low FCR
- It should be nutritionally balanced diet.

Storage of fish feeds:

Fish feed properly dried following pelleting or extruding and stored in cool and dry conditions will remain in good condition for relatively long periods. Generally, 90 days is the maximum storage time recommended for a complete fish feed stored at ambient temperature. High moisture conditions cause mold growth. Some mold produce toxins that are detrimental to fish. Mold inhibitors may be added to fish feed that are prepared for use in warm, humid areas. Propionic acid may be used for the purpose at a level of 0.25% of ratio.

- Some nutrients are sensitive to oxidation and decrease in activity with storage time. Some ingredients are strongly pro-oxidative, such as fish oils, blood meal or trace-mineral additives. Fish feed should contain antioxidants to protect the oxygen – sensitive nutrients from such agents.
- Ascorbic acid is the most sensitive vitamin to detoration during storage. The half life for ascorbic acid in pelleted fish feed is approx 3 months at 26^{O}C and 50 to 90% relative humidity.

7.7 BIO-ENRICHED FEEDS

Bioenrichment is the process involved in improving the nutritional status of live feed organism either by feeding or incorporating with in them various kinds of material such as micro diets , microencapsulated diets, genetically engi- neered baker's yeast and emulsified lipids rich in w3HUFA(Highly Unsaturated Fatty Acid) together with soluble vitamins.

Factor to be considered prior to bioenrichment

(a) Selection of the carrier of biofeed : This is very important aspect taking into account the acceptability of the organism and its size.

Commonly used carriers and their sizes ranges are listed as under

1. Microalgae : 2-20 U

2. Rotifers : 50-20 U

3. Artemia : 200-

400 U 4. Moina :

400-1000U

5. Daphnia : 200-400U

(b) Nutritional quality digestibility and acceptability before and after en- richment. This requires extensive studies on all commercial species. The study will form a base line to conclude upon whether to go in for bioenrichment or not.

(b) Fixing up the level of the enriching media to be incorporated into the carrier organism. The depends on the nutritional quality of the carrier before incorporation and also based on the feeding trials conducted in the laboratory.

(c) Fixing up the level of the enriching media to be incorporated into the carrier organism. This depends on the nutritional quality of the carrier before incorporation and is also based on the feeding trails conducted in the laboratory.

(d) Economic feasibility of enrichment

(e) Purity of the culture of the carrier organism

(f) The other criteria that the carrier should satisfy include,

(i) It should be easily procurable

(ii) Culture should be economically viable

(iii) Catchability of the varier by the target species.

7.8 Feed Attractants

Freed attractants used in fish, shrimp, crab and eel culture systems. These are supplied in the form of pellets. Free amino acids and possibly small peptides serve as attractants for aquatic animals. These produces naturally oc- cur in fish-shrimp head, crab, squid and clam meal.

Short Answer Type Question

1. Name nutritional requirements of supplementary feed.
2. What are energy releasing nutrients in feed.
3. What is supplementary feed.
4. Write any two advantages of formulated feed.
5. Mention the ingredients of traditional feed
6. What is FCR.
7. Mention any two Criteria for selection of feed.
8. How to store the fish feed for long time.
9. What are Bio-enriched feeds
10. Mention any Two chemoattrctants feeds.

Long Answer Type Question

1. Write an essay on artificial feed in fish culture.
2. Write short note on

   a) FCR b) Bio-enriched feeds c) Feed Attractants

UNIT 8

Health Management

Structure

8.1 Introduction

8.2 Classification of fish diseases

8.3 Common fish diseases

8.4 Common Shrimp diseases

8.5 Good Health Management

Learning Objectives

After completion of this unit the student will able to

- Understand the classification of disease
- Learn the common disease of fish and prawn and their control mea sures
- Understand the methods of disease diagnosis
- Know the importance of health management aquatic organism like fish and prawn.

8.1 Introduction

Fish are prone to hundred of parasitic and non parasitic disease espe- cially and grown under controlled conditions. Adverse hydrological condition often precede parasitic attacks, as the resistance of fish si thereby lowered. Mechanical injuries sustained by a fish when handled carefully during fishing and transport may also facilitate parasitic infection.

8.2 Classification of Fish Diseases

The disease of fishes are classified as parasitic disease and non-para- sitic disease.

Parasitic disease in fishes

Parasitic disease are also called as pathogenic disease or infectious dis- ease of communicable disease. The important parasitic disease are vital ,bacte- rial, fungal ,protozoan, helminthic, annelid and crustacean.

The parasitic are mainly are two types

1. These are found on the body surface , fins and gills.

Ex : Argulus , Lernaea, Ergasilus, Leaches

2. **Endoparasites :** These are found inside the body. These are further divided into 3 types

(a) Cytozoic parasites : These are found in the cells .

Ex : Microsporadia, Glugia

(b) Histozoic parasites : These are found in the tissues

(c) Coennozoic parasites : These are found in the body cavity or inside the alimentary canal.

Ex : Diphyllobothrium , nematodes

Non parasitic disease

These disease also occur in fishes mainly due to environmental and nu- tritional problems . These are further divided into environmental fish disease and nutritional fish disease.

8.3 Common Fish Disease

1. Viral disease in fishes : Viruses are transmitted from one host to the other through a structure called virion. Viruses are classified mainly based on external structure, shape, size, capsid structure , RNA and DNA nucleic acids.

Viruses cause disease by weakening the host tissue or by forming tumors in the host tissues. There is no treatment for viral disease, which can only be con- trolled.

2. Lymphocystis : Woodcock (1904) identified this disease in fishes. Marine fresh water and aquarium fishes are susceptible to this disease. Tumor formation is the important character of this viral disease. The external lesions are raised, and made up of the growing of granular, nodular tissue which is composed of many greatly enlarged host cells. Matured lesions may be become slightly hemorrhagic . Within 6-15 days of infection the tumors grow to 50 thou- sands times It caused a lot of damage in the Baltic sea area in America.

3. Infective Hemopoietic Necrosis (IHN) : IHN was observed for the first time in trouts in British Columbia (Canada) in 1967. Necrosis is ob- served in the hemopoietic tissue of kidney in infected fish. This disease occur more in fry and fingerlings and occasionally in adults. The symptoms are pale gills, reddish fins, black colouration of the body, abdomen swelling , and huge mortality. The symptoms and clear in 12-45 days after the entry of virus into the host body.

4. Channel cat fish virus disease : This disease occur in fingerlings of cat fish (Lactalurus Punctatus) . The symptoms are the fish show abnormal swimming and rotating, hemorrhagic areas on fins and abdomen. Fluid accu-mulation in abdomen and pale gills. There is no treatment for this disease. De- struction of infected fish may prevent spread of the disease.

5. Bacterial disease in fishes : Bacteria are responsible for many fatal disease in fishes like, furunculosis, columnaris, fin or tailrot. Vibriosis, dropsy, cotton mouth disease and tuberculosis.

6. Furuculosis : Furuculosis disease in caused by Aeromonas salmonicida in salmon fishes. It is a non-motile, gram-negative bacterium. This disease frequently appears to infect fishes living in the dirty waters containing a large amounts of decaying matter. This disease is also observed in few other fishes. The first symptoms of this disease is appearance of boil-like lesions. Other symptoms are blood-shot fins, blood discharge from the vent hemor- rhages in muscles and other tissues and necrosis of the kidney.

Sulfonamides like sulfadiozine or sulfaguanidine are given orally with food at the rate of 22 gms/100kg, of fish/day other. Other antibiotics like chloromycetin and tetramycin are most effective at a dose of 2-7.5 gm/100 kg of fish/day. Disinfect the egg with 0.015% solution of merthiolate or 0.185% acriflavine.

7. Columnaris disease : Columnaris disease is caused by Chondroccus columnaris and cytophaga columnaris in fresh water aquarium fish. It is long thin, flexible gram negative slime bacterium (myxobacteriales). This disease is often associated with low oxygen level. Initially it is marked by appearance of greyish white or yellowish white patches on the body. The skin lesion change to ulceration and fins may becomes frayed. Gill filaments are de- stroyed and eventually lead to the death of fish. Addition of 1 ppm copper sulphate in the pond to control this disease is effective Tetramycin administered orally with food at a rate of 3gm/100 pounds of fish/day for 10 days is very effective . Dip treatment in malachite green (1:15000) for 10-30 seconds and one hour bath in 1 ppm furanase is very effective to control this disease.

8. Fin or tail rot : Tail or fin rot disease is caused by Aeromonas salmonicid and . A liquefacient . However protozoans and fungi may also be involved. It is progress towards the base of white lines along the margins of fins, the opacity usually brittle towards the base eroding them, and causing hemor- rhage. The fin rays become may also spread on the body surface. Fin and tail rot are associated with poor sanitary conditions in fish ponds and with water pollution innature.

The fin or tail may be checked art an early stage by keeping fishes in

0.5% copper sulphate solution for 2 minutes. Control may be achieved with 10- 50 pp, tetramycin and 1-2 ppm of benzalkonium chloride.

9. Vibriosis : Vibrio bacteria are the causative agents of vibriosis dis- ease in salmon and many other fishes. This disease may occur in water with low oxygen. These bacteria are small gram-negative bacilli characteristically curved. Diseases fishes show large, bright coloured bloodylesion in the skin and muscles

, hemorrhage in eyes, gill may be bleed with slight pressure and inflammation of the intestinal tract. Sulfamethazine at a rate of 2gm/100 pounds if fish/day gives good results 3-4 gm 100 pounds of fish / day for 10 days tetramycin also gives satisfactory results.

10. Dropsy : Pseudomonas punctata is the causative agent of the dis- ease. It is characterized accumulation of yellow coloured fluid inside the body cavity, protruding scales and pronounced exophthalmic conditions. This is known as intestinal dropsy. In case of ulcerative dropsy, ulcers appears on the skin, deformation of back bone takes place and show abnormal jumping. This si fatal disease in culture systems.

Removal and destruction of fishes, followed by draining, drying and disinfecting the pond with lime are preventive measures to control the disease. The infected fishes may be cured with 5 ppm potassium permanganate for 2 minutes dip bath. Streptomycin and oxyetracyclin give good result.

11. Cotton mouth disease : The filamentous bacteria, fexibacteria is the causative agent of this disease. The main symptom is appearance of fungus like tuft around the mouth. This can be treated with antibiotics like 10 ppm chloramphenicol for 2-5 days and 0.3 ppm furnace for long term bath.

12. Tuberculosis : Mycobacterium is a disease causing agent which is difficult to diagnose without pathological examinations. The symptoms are ul- cers on body. Modules in internal organs fin or tail or, loss of appetite and loss of weight of fish. This can be cured with dip treatment in 1:2000 copper sul- phate for 1 minute for 3-4 days.Antibiotics are not successful. The fishes should be destroyed and potassium permanganate or lime used in the pond.

13. Bacterial gill disease : This disease is caused by Myxobacteria in salmon fish. Many bacteria are found in swollen gill lamellae which slow prolif- eration of the epithelium and symptoms are lack of appetite. This disease is transmitted through water from infected fish. It can be treated with 1-2 ppm timsan or 1 ppm copper sulphate.

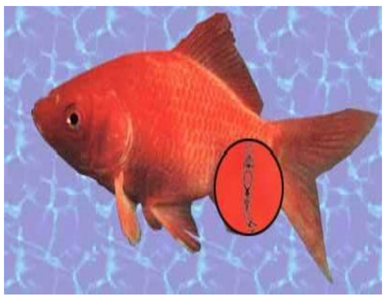
Cotton wool disease

Tail or rot

Boil disease

Dropsy disease

Cotton mouth disease



Dactylogrosis

Fig 8.1 Common disease of fish

8. 3.1 Fungal disease

Saprologniasis : This is also called as cotton wool or water mould disease. This disease is caused by Saprolignia parasitica. It is most common fungus affecting fishes especially major carps. The fry and fingerlings when trans- ported over long distances to get bruises on the body, and unless properly dis- infected , becomes sites of infection resulting in large scale mortality. Whenever fish get injuries the fish becomes weak and lethargic, and gradually die after ulceration, and exfoliation of the skin followed by hemorrhage exposure of jaw bones blindness and inflammation of liver and intestine . This can be treated with 1-3 ppm malachite green for one hour or 1:500 formalin for 15 minutes.

Protozoan

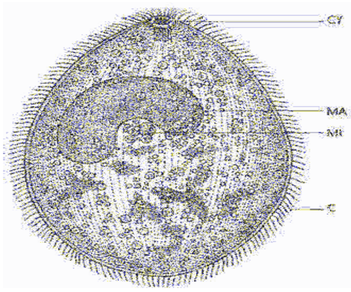
disease Whirling

disease

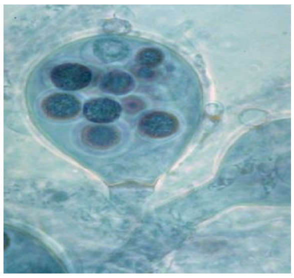
This disease is caused by a myxosporidian protozoan , Myxosoma cerebralis only in salmon fishes. The symptoms are pancreatic necrosis lesions and disintegration of the cartilaginous skeletal support of organ of equilibrium. If the pond contains all infected fish, it is better to destroy them by deep burial. Then the pond should be cleaned thoroughly and disinfected with calcium cy- anamide, quick lime or sodium hypochlorite.

Costiasis

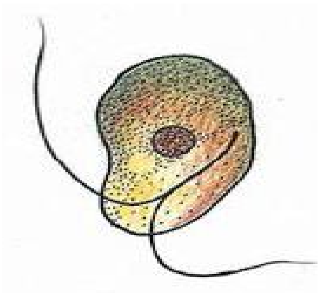
This is caused by a Mastigophore costia necatrix in culture fishes. This is common disease in ponds where fishes live densely in water with a low pH and poor condition of food. The parasites live in large numbers on fish skin, fins and gills. The symptoms turns to red patches in severely affected cases. The infected fish become weak, loss of appetite occur and they finally die. They can be treated with 3 % common salt for 10 minutes or 1 :2500 formalin solution.



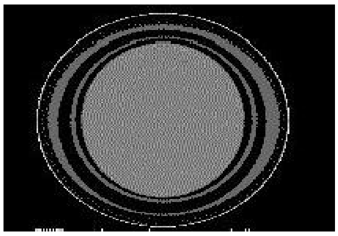
Ichthyophthirius



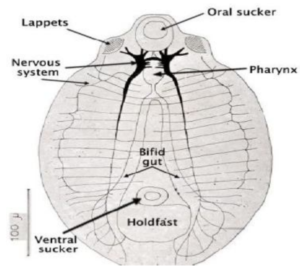
Saproleginia



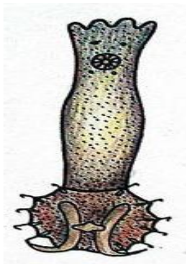
Costia



Trichodine



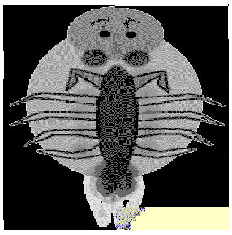
diplostomum



Dactylogyus

Ligula

Hemiclepsis



Argulus

Ergasilus

Fig 8.2 Common fish parasites

(a) Achlya

(b) Aphanomyces

(c) Saproleginia

(d) Dactylogyus

(e) Costia

(f) Trichodine

(g) Diplostomum

(h) Dactylogyrus

(i) Ligula

(j) Philometra

(k) Camallanus

(l) Hemiclepsis

(m) Clavellisa

(n) Lerhaea

(o) Caligus

(p) Ergasilus

(q) Larnaenicus

(r) Caligus

(s) Pseudocyonus

Ichthyophthiriasis

This disease is caused by ciliate, Ichthyophthirius multifilis. This disease is also called as ich or white spot disease. Infected fish develop small white spots on the skin and the fins. These parasites attack the gill also. Fish respond by jumping in the water and rubbing their body against the water objects. Res- piration gets effected and they finally die. Dip treatment in 1.5 ppm of malachite green or in 10 ppm of acriflavine gives good results. 3% salt solution, 1:4000 formalin , 1:1000000 quinine hydrochloride , 1:5000000 methyl blue are also useful to treat the fish.

Coccidiasis

Coccidia or Eimeria carpella and E. epithilialis are cytozoic parasite in the intestine of fresh water and brackish water fishes. It forms white tumors in fishes. Fish become weak and the infection caused by this parasite gives the opportunity to bacterial and fungal disease to manifest themselves. 100 mg.1kg of fish or furazolidin gives good results in the control of this disease.

Helminthic

disease

Dactylogyrosis

The monogenic trematode, Dactygyrus is reported to cause serious infection in fishes. Infected fishes are rest near the surface of the pond margin swim very slowly, feel suffocation are more slimy, dropping chloride of fins and pale gills. Alternative baths with 1:2000 acetic acid and 2 % sodium chloride are effective. 10ppm of potassium permanganate bath for 1-2 hour and 5 ppm the pond may give good results.

Gyrodactylosis

Another monotreme trematode, Gyrodactylus also cause disease in culture ponds. This is also lives on he fins and on the body of fish. The symp- toms are production of more slime, damage of fins and fading ofthe body colour. The medicine used in control of dactlyogyrosis are also effective to control this disease.

Leeches disease

Leeches like Piscicola, Myzobdella and Hemiclepsis hold the skin of the fish and such fish blood. After the blood meal they detach themselves, leav- ing the wound open for secondary fungal infections. The growth of fish is af- fected and they become weak. A popular control method is dip treatment in 2.5% sodium chloride for 30 minutes. Disinfect the pond with lime of destroy the eggs and adult leeches.

Crustacean

disease Argulosis

Argulus or fish lice is a common copepod parasite in fishes. It is large ectoparasite and can move over the bodysurface of the fish. Argulus picture the skin and inject cytolytic toxin through the oral sting to feed on the blood. The feeding site becomes a wound and hemorrhage , providing ready access to secondary infection of other parasites, bacteria, virus and fungi. Argulus trans- mits dropsy in fishes. In advanced stages fish swim erratically show growth loss and loss of equilibrium.

To controlArgulus, remove the submerged vegetation, wooden lattices placed in the pond will serve as artificial substrate to deposit its eggs. Which can be removed in intervals to kill the eggs. 500 ppm of ammonium chloride, 410 of balsam, 10 ppm of DDT for 25 seconds dip 0.25 ppm id dylox and 2000 ppm of lysol for 15 second dip are effective to killArgulus.

Lernaeasis

It is caused by a copepod parasite, Lernaea or anchor worm. This disease si mostly caused by L. Cyprinacea. The larval stages are temporary parasites that feed on mucous and blood fish. The adult female is special fish parasite work like which burrows into the fish. Keeping its egg cases protruding out of the fish body. Male Lernae do not attach the fish and are unspecialized for parasitic life. Early infected fish swim erratically flashing against the sides and bottom of ponds. Heavy infected fish swim inside down or hand vertically in the water.

Only partial control of Lernae is possible with chemical because the head i buried in the fish tissues and there are no exposed respiratory organs. Hence prevention is more effective than control. 1% common salt eliminates larvae in 3 days, 250 ppm formalin for 30 to 360 minutes 0.2 ppm gammexane for 72 hours , 2ppm of lexone 0.1 ppm lindane for 72 hours and 1pm chlorine for 3 days amy give good results.

Ergasillus and salmincola

These two parasites are responsible for huge mortality of fishes in the culture systems. These two parasites are found attached to the gill filaments and feed on blood and epithelium. Later they may also be found on the fins and body. The infection results in impaired respiration, epithelial hyperatrophy, anaemia, retarded restlessness and finally death.

Ergasilus can be treated successfully with a combination of 0.5 ppm copper sulphate and 0.2 ppm ferric sulphate for 6 to 9 days. Salmonicola can be controlled with 0.85 calcium chloride, 0.2 % sulphate , 1.7% magnesium sulphate , 0.2% potassium chloride ad 1.2% sodium chloride for 3-4 days.

Algal disease

Cyanophyceae member, Oscillatoria si responsible for fish mortality it si found on gill and fish body in large numbers and produce toxic substances which are responsible for fish kill. Chlorella and Pharmidium also cause discomfort in fishes.

Epizoic Ulcerative Syndrome (EUS)

Epizoic ulcerative syndrome popularly known as EUS has caused servedamage to India's aquaculture especially at the moment when the Indian fisheries industry is poised for a great leap forward with high input based hitech production systems. Widespread outbreaks of the disease, occur suddenly and often cause mass mortality in freshwater and brackish water fishes causing anxi- ety and tremendous concern. Although the disease has been known in the Asia- Pacific region since the seventies , it appeared for the first time in India in 1988 and has now covered almost the entire length and breadth of the country.

One common feature of the disease is that initially affects the bottom - dwelling species like murrels, followed by catfishes and weed fishes. Subse- quently the Indian.

Clinical signs and gross pathology in the affected fishes are similar in almost all the species with moderate to severe ulcerative skin lesions. The lesion starts as small gain to pea-size hemorrhagic spots over the body which ulti- mately turn into big ulcers to the size of coin with greyish, slimy central necrotic area surrounded by a zone of hyperemia. The disease affects the fish to such an extent than they start rotating while still alive and eventually die.

The mixture has been named Cifax. The yellowish brown liquid is ad- vised to be diluted in a sufficient quantity of water before being sprayed over the water body evenly for a throughout mixing. Appreciable changes are noticed in the affected fish with in 3-4 days and marked improvements of the ulcerative condition is noticed within 7 days.

Health Management : The principle fo fish health management incor- porates minimizing stress in cultivated fishes, confinement of disease outbreak to affected ponds and minimizing losses from disease outbreak. This could be achieved thought prophylaxis and positive treatment to the outbreak of epi- demics. Because of the aquatic ambience, it is not easy to be aware of the activities of fish. It is difficult to conduct a correct diagnosis and timely treat- ment. This necessitates prevention of fish disease which is more important con- trol of fish disease. The signifies the importance of the statement “prevention is better than cure”

Prevention of fish disease

(a) Importance : It is difficult the appearance of disease in its initial stage on account of the gregarious nature of fish in water which causes difficul- ties in observation diagnosis and timely treatment. Apart form his ,some effec- tive drugs and measures to cure certain fish disease are still not known well. Therefore, perfect prevention measures must be taken since this is a key link fish disease control.

(b) General preventive measures : Increasing the internal resistance of fish is important in the prevention of diseases. Therefore, some important in fish culture should be given special attention.

1. Selection of healthy fish seed.
2. Proper density and rational culture.
3. Careful management
4. Qualitatively uniform ration and fresh food.
5. Good water quality
6. Prevention of fish body from injury.

8.4 Common Shrimp Diseases

Viral disease

The viral infections of prawns heavy losses in culture ponds. There are more than a dozen prawn virus, out of which half a dozen of them cause major economical losses. Prawn viruses are broadly classified into two types

1. Virus with endoderm derived tissues

Ex : Hepatopancreatic parvo like virus (HPV) , Monodon type of Baciilovirus (MBV) and type c baculovirus, Baciilovirus penai (BP) and Baculovirus midgnt glad necrosis virus (BMNV).

2. Viruses systemic endoderm or mesoderm derived tissue

tropism . Ex : Infections hypodermal and haematopoitic necrosis

virus (IHHNV),
Yellow head virus (YHV) and systemic ectodermaland mesodermal baculovirus (SEMBV).

Yellow head virus (YHV or YHV or YHD) Disease

It is commonly known as yellow head disease or yellow baculovirus. YHV mostly affect shrimp juveniles of all ages. Head looks yellowish or organ yellowish in colour. Feed intake is almost nil prior to the serious disease out break. Shrimp become inactive and move slowly at the inner edges of the pond bund. Mass mortality occur with in 3-5 days of the first clinical signs.

Systemic Ectodermal and Mesodermal Baculovirus Disease (SEMBV)

The SEMBV cause infection in all penaeid species. It is able to cause acute epizootics of 2-7 days duration with mortalities from 10-70% up to 100% and massive systemic pathology. The clinical history and signs, histophathology

rein infection studies transmission electron microscopy (TEM) and DNA probe in growing pond reared panaeid species is revealed that the acute mass mortali- ties are due to SMBV. The SEMBV is commonly known as 'white spot or white patch' disease . The clinical sign of SEMBV include white spots at an early stage on the carapace later on the posterior abdomen and the body; lethargic movements reduced feed in take gill and antennule rot, gills become yellowish or rarely in colour. In some of the cases mortality occurred with out clinical signs of SMBV and almost look normal.

Prevention and control

There is no known control therapy for viral disease in the shrimp . No medicines , chemicals can disinfectants are effective against viral disease.

Preventive measures

1. Dry the pond soil at least for 15 days.
2. Disinfect the soil water by administering bleaching powder (calcium hypochlorite) at required (10-30 ppm) dosage.
3. Adapt the closed and recycle system of water.
4. Minimize the water exchange.

5. Select and stock healthy post larvae.

6. Avoid high stocking density

7. Maintain the optimum water parameters to minimize the stress on shrimp.

8. Avoid feeding prefer nutritionally balanced pelleted feed.

9. Prevent the entry of crabs, birds and other vectors.

10. Destroy the viral infected shrimp by burning.

Bacterial disease

The important bacterial disease of prawns are Vibriosis, Shell disease (Black spot disease). Tail rot disease and Filamentous bacterial disease.

Vibriosis

The Vibriosis in shrimp is known to be the major bacterial disease. It is almost found in all the shrimp culture ponds at same time or the other. The infected shrimp revealed the occurrence of various species of Vibrio. The clini- cal sign of vibriosis in shrimp include the infected part becoming red in colour,

sluggish movements the nerve chord become red in colour, lack of appetite leading to reduced feed in take the digestive tube is found empty, mortality starts with in 2-3 days of infection and large number of shrimps die at once.

The vibrio sp, infect at all stages ages and sizes of shrimp. The Vibrio infection in larvae is known as larval septicaemia. The infected are inactive re- luctant to feeds and light. In some of the cases infection of vibrio and SEMBV were found.

Shell Disease

It is also known as black spot disease due to the presence of black spot/specks on the shell. The black spots are caused by the Aeromonas sp Flavobacterium sp, Spirellum sp, and Staphylococi bacteria. The black spots on the shell of shrimp occur in many other cases also . Confirmation of the causative agents depends on the bacterial culture test.

Tail Rot

The uropods and telson possesses cuts on their edges. The tail look ugly. The diseased Shrimps move in zigzag manner., The feed in tale is normally good. The antennules and the squama are also rotten or swollen in shape. The tail rot disease is caused by the detritus bacteria and Flavobacterium species.

Filamentous Bacterial Disease

The filamentous bacteria, Leucothrix, sp infect gills, and appendages around the mouth . The respiration become difficult. The infected shrimps are move in surface waters, the feed intake may be reduced. The movements may be sluggish. In case of severe infection on the entire body the shrimp posses a fuzzy mat and looks ugly.

Prevention and control

The pond soil should be thoroughly sundried and ploughed before chemical fertilizers are ap- plied to the pond. There should be reservoirs tank for every shrimp . The water in the reservoir tank should be disinfected by administering chlorination/formalin treatment. The settled hygienic , clear surface and middle waters of the reser- voirs tank only should be pumped into the culture ponds.

The feeds should be nutrients less in moisture free from all contamina- tions. The rate of feeding should be as per the size age of the shrimp and thier total body weight. Excess feed administration should always be avoided as ti leads to organic load in the soil and pond water.

The bacterial disease of shrimp are being controlled by treating with benzylkonium chloride at 0.5 to 1.0ppm, formalin at 20 ppm or iodine at 0.2 to 1.0 ppm to the pond waters and administering oxytetracycline at 3 to 5 gm/kg, nitrofurans 1.5 to 2.5 gm kg or chloramphenical at 1.5 to 2.5 gm/kg of feed and fed for to 7 days.

Fungal disease

The fungi Leginidium sp. And Fusarium sp., cause severe infections on larvae and shrimp in culture ponds.

Legenidium

The legenidium so is mainly found in larval mycosis. The larvae is hatch- eries can also be affected by the fungi Syrolipidium. Helipthorus and Atkensilla sp. The fungi spread on the whole body of the larvae. The infected larva be- come yellowish green in colour inactive reluctant to feed and light. The fungi spreads to almost all the larvae in the tank, leading to more larval deaths. The clinical sign of shrimp infected by Leginidium are the gills becomes black in colour, and the larvae of shrimp lethargic movements 1-2 infected shrimps die/ day during the early days infection .If no control measures are taken, large scale mortality may result.

Fusarium

The clinicalsigns of Fusariumsp infected shrimps are presence offuzzymat on the body which is white of light yellow in colour and lethargic movements. The infected shrimp swim in surface waters, and may lie down on the grass or on any substance at the inner edges of the pone bund. The mortality rate may start with in 3-5 days after infection at the rate of 1-2 shrimp which gradually increases to 5-10 shrimp/days.

Control : The fungal infections of shrimp can be confirmed by observ- ing the sample of the infected part on slide under a compound microscope . The fungal infections ofshrimp are being controlled by administering malachitegreen at 0.01 ppm of formalin at 10-20 pp, to the pond waters.

Protozoan disease

The protozoan , Zoothamnium, Epistyllis, Vorticella,Acinata,. Thelohania , Pleisthophora , Nosima, Laginofress, sp cause disease in shrimps. The proto- zoans grow over the shrimp body. They may be present on the eyes , antenna, appendages gills and in server conditions may spread all over the body. Some of the protozoans penetrate deep into the body and cause injuries. This facili- tates infection by bacteria, virus a and fungi. The protozoans cause tress and irritation to the shrimp. The protozoans on the gills cause difficulty in respiration. The prolific and colonial growth as cotton shrimp disease. The protozoans on the shrimp body look like cotton and because of this. It is also known as cotton shrimp disease. The movements with reduced feed intake resulting in decreased growth rates. The severity of protozoans can be reduced by treating the pond waters with formalin at 20-25 ppm or Chloramine Tar 0.3 to 0.5ppm or Glut- araldehyde at 0.2 to 0.5 ppm dosage .

Nutritional disease

The nutritional disease are caused due to deficiency of the nutrients proteins, carbohydrates , fats, vitamins, and minerals. The important nutritional disease of shrimps are scurvy)black death disease), blue shrimp disease and soft / loose shell disease.

7.4.5.1 Black death disease or scurvy

Shrimps like manyother animals cannot synthesize ascorbic acid and its non inclusion in shrimp feed lead to deficiency this resulting in reduced growth
,poor feed conversion efficiency poor injury and wound repair, incomplete moult- ing and presence of white / black lesion beneath the exoskeleton. The ascorbic acid deficiency for a continuous period result in the death fo shrimp. The mortal- ity rate can be prevented with in 5-7 days by administering ascorbic acid at 2- 5 mg/kg in feeds.

Blue shrimp disease

The minerals and astaxanthene (pigmented substance) deficiency in supplementary feed in result in to blue shrimp disease . The shells become soft l thin and blue in colour . The supplementation ofmineraland astaxanthene through feeds improve that natural colour of the shrimp.

Soft Shell Disease

The deficiency of calcium and phosphorous in shrimp nutrition result in the soft shell disease. The shell become soft the shrimp look weak and growth is stunted.

Environmental disease

The change in environmental parameters of shrimp results in stress, weakness, poor growth rates are reduced feed intake. The known environmen- tal disease of shrimps are gas bubble disease, blister or dropsy, inflamed gills, red gill disease ,black gills disease, acidosis/alkaosis, asphyxia and cramped body and tail.

Gas Bubble Disease

The supersaturation at atmospheric gases an oxygen in pond water causes gas bubble disease. The respiration in juveniles and adult shrimps be- comes difficult feed in take is reduced , less growth si found resulting in weak- ness and eventually may lead to death. If new waters are pumped in the super- saturation of gases decrease and restores normal health of the shrimp.

Blisters or dropsy

Sudden change of pond water by pumped waters causes blisters in the shrimp . The blister are mainly situated at the inner wall of the gill chamber. Respiration becomes difficult shrimp become sluggish and slowly swim at the inner edges of the pond waters. The uropods are swollen at thier ends, which gradually become normal in a day or two. If the blister are swollen tails are ruptured and a thick liquid comes out.

Inflamed gills

The change of water in the pond cause turbidity due to highly dissolved clay particles any phyto and zooplankton which cause inflammation ofgills. They heavy metal toxicity also cause inflammation in gills. Respiration become diffi- cult to control measurers are reserted to an shrimps die in large numbers.

Red/ Orange gill disease

If a prolonged dissolved oxygen depletion prevails in pond water causes red/orange gill disease. The gills look orange red in colour. The growth is stunted, shrimps move in the surface waters and finally death occurs. Red gill disease is also caused due to excess of iron and pond soil and waters. Confirmation agents can only be made after analyzing the waters. Dissolved oxygen level in pond water can be increased by arranging aerators paddle wheeler etc.

Black gill disease

The black gill disease in shrimp is caused due to high organic content, debris ammonia and H2S in the pond soil waters. As such black gill disease is also caused duet o vitamin C deficiency and bacterial fungal infections . By reducing the organic load. Ammonia and H2S the black gill disease in shrimp can be controlled.

Acidosis / Alkalosis

The acid or highly alkaline nature and soil causes acidosis / alkalosis respectively. Poor growth soft shell , incomplete moulting, decreased moulting frequency discolouration of shell are the clinical signs of acidosis/alkalosis. The acid and alkaline nature of pond water and soil can be corrected by adding required quantities of lime of gypsum respectively.

Cramped Tail

The shrimp right form its abdomen and tail are cramped, and if they are body and tried to be made normal they die. The reason for such nature of the shrimp is suspected to be sudden change in the environmental temperature.

8.5 Good Health Management

Fish health management is a term used in aquaculture to describe management practices which are designed to prevent fish disease. Once fish get sick it can be difficult to salvage them. Successful fish health management begins with prevention of disease rather than treatment.Prevention of fish disease is accomplished through good water quality management, nutrition, and sanitation. Without this foundation it is impossible to prevent outbreaks of opportunistic diseases. The fish is constantly bathed in potentialpathogens, including bacteria, fungi, and parasites. Even use of sterilization technology(i.e., ultraviolet sterilizers, ozonation) does not eliminate all potential pathogens from the environment. Suboptimalwater quality, poor nutrition, or immune system suppression generally associated with stressful conditions allow these potential pathogens to cause disease. Medications used to treat these diseases provide a means of buying time for fish and enabling them to overcome opportunistic infections, but are no substitute for proper animal husbandry. Daily observation of fish behavior and feeding activity allows early detection of problems when they do occur so that a diagnosis can be made before the majority of the population becomes sick. If treatment is indicated, it will be most successful if it is implemented early in the course of the disease while the fish are still in good shape.

Determining if your fish are sick : The most obvious sign of sick fish is the presence of dead or dying animals. However, the careful observer can usually tell that fish are sick before they start dying because sick fish often stop feeding and may appear lethargic. Healthy fish should eat aggressively if fed at regularly scheduled times. Pond fish should not be visible except at feeding time. Fish that are observed hanging listlesslyin shallow water, gasping at the surface, or rubbing against objects indicate something may be wrong. These behavioral abnormalities indicate that the fish are not feeling well or that something is irritating them.

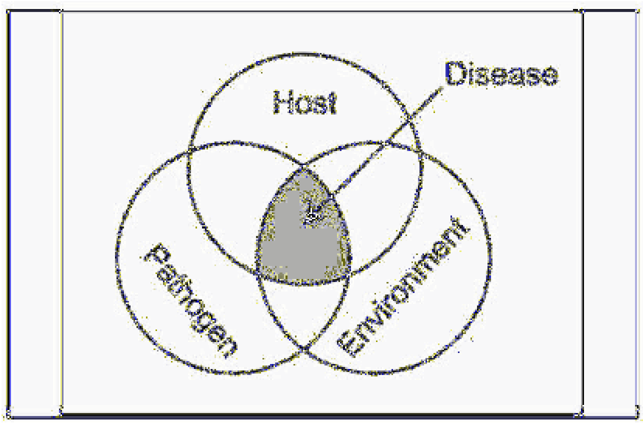


Fig 7.3 Disease rarely results from contact between the fish and a potential pathogen.

In addition to behavioral changes, there are physical signs that should alert producers to potential disease problems in their fish. These include the presence of sores (ulcers or hemorrhages), ragged fins, or abnormal body confirmation (i.e., a distended abdomen or “dropsy” and exopthalmia or “popeye”). When these abnormalities are observed, the fish should be evaluated for parasitic or bacterial infections.

Short Answer Type Questions

1. What are ectoparasites of fish? Give example .
2. Write the types of endoparasites .
3. Name any two common viral disease of fish.
4. Mention any two bacterial diseases and their causative agents.
5. Write any tow general preventive measures of fish disease. .
6. Name any two common shrimp diseases.
7. Write any two nutritional deficiency disease of shrimp
8. What is gas bubble disease in shrimps..
9. How black gill disease is caused in shrimps.
10. Define Acidisis and alkalosis.
11. Define ‘Eutrophication’.

Long Answer Type Questions

1. Describe any three viral disease of fish.
2. Explain common viral diseases of shrimp.
3. Write the symptoms and control measures of bacterial disease of fish.
4. Describe the diagnosis causes of environmental disease in aquaculture.

UNIT 9

Water Quality Management in Ponds

Structure

9.1 Introduction

Fresh water fish farming is being taken up on large scale the production of fisherman small farmers, and entrepreneurs.

Out of which water quality management is one of the fundamental for fish farming. The water quality may depend upon physio-chemical parameters and other dissolved constituents of water and these are as follows.

(a) Some Physical Factors

1. Depth

1. Temperature
2. Turbidity
3. Light

(b) Some chemicals

1. PH
2. Dissolved Oxygen

3. Free carbondioxide

4. TotalAlkalinity.

(c) Biological factors

1. Plankton

2. Weed

3. Disease causingagents

If the water is existing within the limitations the above cited parameters and other are called the quality water, and management is called water quality management inaquafarms.

9.2 Physical Factors

Depth

Depth ofa pond influences the physical and chemical properties of water.

A shallow pond allows the sunlight to penetrate up to the by bottom and in- creases productivity by photosynthesis but if the pond is too shallow water gets heated up during summer months affecting the survival of the fish, generally two meter deep ponds are considered good for maximumproductivity.

Temperature

Temperature is one of the most important factor in water quality. Tem- perature varies at different times of day and also during different seasons of the year, from place to place.

All organisms including fish possess a defined limits of temperature with the optimum lying some where in between. All metabolic and physiological ac- tivities and life process with as feeding reproduction movements and distribution of aquatic organisms are greatly influenced by water temperature.

Water temperature plays vital role and directly influence all the stages of fish suchas

1. Induced breeding (spawning)

2. Hatching (egg to spawn)

3. Nursery (spawn to fry)

4. Culture (fryto table size)

The temperature is measured bymeans or mercurythermometer alco hole thermometer.

Turbidity (Suspended Solids)

The turbidity of natural water may with due to suspended inorganic substances such as silt, and clay due to plankton. Natural becomes turbid dur- ing rains and floods and bypublic sewages suspended solids are bits of particu- late matter larger than 0.45 microns found in the water column.

Ponds with clay bottoms are likely to have high turbidity, rock basins and ponds in which sand, gravel and humus pre temporary or perennial, based on the nature of the basin and is an indication of ponds a limit, is harmful to fish and fish food organism and these are as follows

(i) Effect light reduction Suspended solids obstructs light penetration into water column and effects as following.

(a) Afavorable effect is it appears in protection and excess light for light sensitive species.

(b) Unfavorable effect, it reduces the photosynthesis activity and also the primaryproduction.

(ii) In influence the temperature directly and the fish movement in water in which solids are suspended and also results in fish kill and summer and winter, and reduces growth resistances to diseases.

(iii) Prevents the successful development of fish eggs.

(iv) Modifies the normal movements and migration of fish.

(v) Reduces the abundance of food availability.

(vi) Affects the abundance of food availability.

(vii) Influences of oxygen levels.

The turbidity is measured by means of

Transparency of pond water can be measured by means of SECCHI DISC method. Its value 40 cm to 100 cms is good for culture ponds and 25-50 cms for fish seed ponds.

9.3 Chemical Factors

(P^H Potentia of hydrogenic)

Indicate the concentration of hydrogen ions and it expresses the inten- sity of an acid, depending upon its dissociation as well as the total amount that is present.

Water is a weak electrolyte hence by definition a small fraction of it dissociations into the some that compose its molecule.

H_2o <---> H^+ + oH.

It can also be define as the negative logarithm of the hydrogen ion concentration is moles per liter.

Therefore pH = - Log 10(H+).

pH ranges 0.0 to 14.0 unites ; 0.0 to 7.0 is Acidic range and 7.0 to 14.0 is Basic range (alkaline range). 7.0 is neutral

pH of the pond water changes slightly due to rainfall and drastically changes due to addition of natural source like volcano water ; manmade pollution that is So2 ; H2 So4; HCL; HNO3 etc. Occurs in natural water decreases drastically it can be controlled by addition of sufficient quantityof lime.

Sometimes PH volume increases or decreases due to (edaphic factors soil contains mines of calcium etc., and main like pyrite feS2). If pH value increases beyond the limit and it can be controlled by addition of organic ma- nures or application of mustard oil cake 800-1200 kg/ha or culture of Azolla.

Swingle. 1967 stated that water having a range of 6.5 - 9.0 as recorded day break are most suitable for pond culture and those having PH values of more than 9.5 a unsuitable because the latter C02 is not available fish dies at about PH = 11.0 . Acid water reduces the petite of the fish their growth and tolerance to toxic substance. Fish gets prone the attacks of parasites and dis- ease inacid water.

pH can be measured by means of

1. Colour comparison in LOVIBOND comparator.
2. Electromatically in PH meter.

Free Carbondi oxide

The earth atmosphere contains relatively small amount of carbondi ox- ide . The global average being approximately 0.032% by volume as of 1970 (Machta 1973). Despite the small proportion of Co2 among the gases of the air, it is relatively abundant in natural water. Owing mainly to its high co-efficient of solubility. Co2 is very much soluble in water about 200 times greater than oxy- gen solubility.

Sources of Co2 in inland water

1. Rain water (Rain water contains 0.3 to 0.6 ppm dissolved Co2).
2. Water passes through organic soil and streams.
3. Respirations of animals and plants.
4. Bacterial decomposition of organic matter.
5. From the atmosphere.

Rawson (1939) states that Co_2 “STANDS AT THE THRESHOLD OF ALL PRODUCTION”.

Photosynthesis is the process by which carbondi oxide is converted to organic compounds in presence of sunlight , chlorophyll and certain enzymes.

$$6CO_2 + 6H_20 \xrightarrow{\text{Light}} C_6H_{12}0_6 + 60_{2.}$$

Effect on fish

A high Co_2 content ofwater is lethal to fish life. It prevents the oxygen- ation of water and it might also adversely affect the extraction of dissolved oxygen from the water. Based on observation it may be equal to 7.0 ppm is the
lethal limit for healthy fish life.

Estimation of Free Co_2

Free Co_2 is estimated by titrating with dilute NaoH (N/44) is the pres- ence of Phenolphthalein indicator (APH, 1975).

Alkalinity

The capacity of natural water system to resist changes in PH can be measured in terms of the amount of bicarbonate and carbonate ions that are available in the system, this measurement is called alkalinity.

Alikunhi(1957) stated that in highlyproductive water, the alkalinitycaught to be over 100pm. In aquaculture system the alkalinity should be between 80 to 200 pm in fresh water.

Estimations of Alkalinity

Alkalinity is measured by titrating water samples with dilute sulfuric acid to an end points indicated by phenolphthalein and methyl orange .(APHA.1975).

Dissolved oxygen

Oxygen is the most fundamental parameter to all water bodies aside form water . Dissolved oxygen is essential for the metabolism of all aerobic organism. Therefore the information on the solubility and the dynamics of oxy- gen distribution in water bodies is basically important for understanding the dis- tributing behavior and physiological growth of aquatic organisms.

The determination of dissolved oxygen (DO) in the aquatic environment is among the most important factor in the water quality management in aqua farms. If sufficient level of the DO is not maintained animal will succumb to stress and becomes vulnerable to disease and parasitic outbreaks leading to their death. At the very least the animal may refuse to eat for a period during and after an oxygen depletion, thus growth rate is retarded.

Source of Oxygen

1. Atmosphere
2. Photosynthesis

Loss of Oxygen

1. Respiration
2. Decay of aerobic bacteria

3 Decomposition of dead decaying sediments.

Oxygen's depletion may be controlled by the following methods.

1. Exchange of water
2. Artificial aeration
3. Spraying water over the surface of ponds or agitation of surface water.
4. 5 ppm of potassium permanganate solution spraying over the pond surface.

Estimation the dissolved oxygen is by Winklers method of electrical analyser.

The water characteristics ideally suited for fish farming.

S.NO.	Parameter	Level
1.	Temperature Air	24-380c
2.	Temperature Water	25-350c
3.	Transparency	25-70 cm
4.	pH	6.5 - 8.5
5.	Dissolved Oxygen	4.0 - 8.0 ppm
6.	Free Carbondioxide	0.0 - 16.0 ppm
7.	TotalAlkalinity	40.00-200 pm
8.	Free Ammonia	Less than 0.5 ppm
9.	Phosphate	0.6 - 0.1 ppm
10.	Iron	Less than 0.01 ppm
11.	Zinc	Less than 0.01 ppm
12.	Mercury	Less than 0.01 ppm
13.	Copper	Less than 0.01 ppm

Vertical temperature profile showing direct stratification and the lake region defined by it.

9.4 Biological factors and their management

The biological factor like plankton, weeds and disease causing agents also play a role in water quality maintenance.

Plankton-Water quality

Plankton are free living smaller plants and animals, which move along the waves. Plankton are natural fish food organism,. Which consist of 69% easily digestable proteins. Phytoplankton produce food and O2 by photosyn- thesis . Plankton density variations depend upon the fertilizers and fish species cultured. Carbondioxide H2, P, N2, S Fe, K, Ma,Mn, Zn, B and C12 are essential for plankton production out of these N, P, K, are most important ele- ments for plankton production.

To increase plankton production organic and inorganic fertilizers should be used. Lime is also essential for plankton production. Fertilizers and lime should be regular intervals. This helps in production in sufficient quantities. Ex- cess production of plankton, especially myxophyceae members settle on the water surface and form algal bloom. This hampers photosynthesis and oxygen depletion is observed especially during nights, Co2 levels increase in the pond and affect water quality.

Disease Causing agents - WaterQuality

The most important aspect of water quality management in the culture system is to maintain fish without disease causing agents and under hygienic conditions. The disease is fishes and prawns are caused by bacteria, virus, fungi, protozoa and helminth, and crustacean parasites. These parasites enter into pond along with water, fish or pawn seed and nets from other infected ponds.

Aquaticweeds-water quality

Excess growth of aquatic water in fish pond is not good sign in aquac- ulture systems. Weeds utilize the nutrients and compete with desirable organ- ism. Weeds also compete for oxygen, especially during nights and space with fishes. They obstruct the netting operations too. Hence the weeds should be removed from ponds by mechanical, chemical or biological methods.

Applications of lime fertilizers ad feed are some of the important mea- surers to maintain the water quality. These should be applied whenever required. Excess application leads to poor condition of water quality.

9.5 Water Filtration and Aeration

Role of aerators in the water quality management

Atmosphere oxygen dissolves in the water surface. In this layer dis- solved oxygen quickly but not at the pond bottom. To get oxygen even in the bottom layer, the pond water should be disturbed. To gets this surface are very essential . Aerators produce the air bubbles , which disturb the water in the pond, so that more oxygen dissolves in the water. Aerator therefore play a vital role in aquaculture to increase fish and prawn production.

Different types of aerators are in operations to increase aeration in the ponds. Diffused air lift pumps U- tube and splashers are some of the common aerators (Fig 6.11) in operation in aquaculture.

Fig 5.1 Different type of Aerators

The mechanical biological and airlift are generally adopted in aquacul- ture practices to manage and control the water quality for intensive rearing and culture.

Fig 5.2 Pumping of filter water

Biological filter

It comprises the mineralization or organic compounds nitrification and denitrification by bacteria suspended in the water and attached to the gravel the filter bed.

Heterotrophic and autotrophic are the major groups present in culture systems. Heterotrophic species utilize organic nitrogenous compounds exerted by the animals as energy sources and convert them into simple compounds such is ammonia. The mineralization of these organics is the first stage in biological filtration. It is accomplished ion two steps; ammonification which is the chemical breakdown of proteins and nucleic acids producing amino acids, and organic nitrogen base and deamination in which a portion of organic and some of the produces of ammonification and converted to inorganic compounds.

Air lift filter : It is the most efficient water filtering device. In culture application lift pipe extends below water level and the filter chamber rests above the top water surface. The suspended or colloidal impurities up to the size of mm can be filtered out through this system. By pumping 5 cm air/sec/2 liters of water per minute can be filtered when the diameter of lift

Short Answer Type Questions

pipe is 1 cm.

1. Name some physical factor of water quality management.
2. Name any four chemical factors of water quality.
3. Write the effect of temperature on aquatic organism.
4. Define 'turbidity' and how the turbidity measured.
5. What range of transparency is suitable for fish culture ? How it is measured.
6. Define pH what is the suitable range of PH for aquaculture.
7. How can you measure the PH of water.
8. Write the equation of photosynthesis .
9. Define Alkalinity.
10. Write the source of dissolved oxygen.
11. Write any two parameters of water and their ideal levels.
12. Write any two types of aerators.

Long Answer Type Questions

1. Describe the any three important physical parameters of culture ponds.
2. Describe any three important chemical factor of culture ponds.
3. Write short note on following

(a) PH

(b) Dissolved oxygen

(c) Alkalinity

4. Write the role of aeration in water quality management.

UNIT **10**

Routine Pond Management

Structure

Learning Objectives

After the completion of this unit the student will able to

- Know the importance of routine pond management
- Understand the daily and monthly management practices
- Know the reasons for fish and prawn kills

10.1 Introduction

After the ponds are management of ponds includes

1. Feeding and fertilizing
2. Keeping the pond in good condition
3. Detecting the troubles and disease

Every pond requires supervision in the above areas. Any good man- agement requires checking of the condition of the fish and the pond regularly. It requires daily and monthly management.

10.2 Daily Management

Everyday the ponds should be checked, especially in the morning because oxygen levels in the water are lowest then and fishes are more likely to have trouble at that time. The following should be checked everyday.

1. Checking of leakage in ponds : Check all walls, gates inlets and outlets. Walls can erode, especially after heavy rains. Little leaks get larger quickly.

2.

3. Clearing of filters : The filters in the pond must be removed and cleaned of silt, leaves and other material that are deposited in them.

4. Watching fish : The fishes should be watched carefully everyday. If they are swimming quickly and easily and around the pond, they are well. If they are loitering near the surface they are like to be hungry. If they are gasping for breath at the surface of the water, there is not enough oxygen, in which case the pond should be aerated as early as possible.

5. Feeding : Good amount of natural food should be available to the fish, otherwise the supplementary food should be provided. The supplementary food is given by

- Spreading the food on the surface
- Placing the food in bags and tided to bamboo poles.
- Pressing the food into dry pellets and adding to the pond.

Always feed the fish, at the same time and in the same part of the pond. The fish will learn where to go get food. Do not overfeed the fish. Determine how much food the fish should be fed with. Inmost of the cases feeding is at the rate of 2-5% of body weight per day. For example 100 fingerlings weighing 6 gm each, will have a fish should bed fed only 6 days in a week, so that the fish get a chance to feed on whatever food remain in the pond.

Fertilization of the pond : The water should be watched carefully every day. If a healthy oxygen colour is found, it is fertile pond and fertilizers need not be added if the water is brown in colour then the fertilizer is needed.

1. Watch for predators : Check the pond area of snake hole, rat burrows and eels.. Check the screen at the inlets for predators. These are dan- gerous to fish.

All these pond management practices do not take much each day, and therefore it is absolutely necessary to check to all these items everyday so as to reap a good harvest.

10.3 Monthly Management

The ponds which are managed well day by day will require little other treatment. However the following aspects will probably require more attention on a monthly basis.

- Check the pond wall cut the grass on embankment.
- Check the pond bottom. If there si too much buildup of silt and organic matter. Scoop this material out.
- Check for the remove the aquatic weeds.
- Check the inlets and outlets. Make sure that the water can flow smoothly in and out of the pond.

- Check the fertility and turbidity of the water. If the pond is not fertile, fertilizers should be added to the water.
- Check the fish carefully for signs of disease and proper growth of the fishes.
- Add lime if needed.

10.4 Reasons for fish and prawn kills

Aquatic organism are very sensitive to anyone change of water quality. It is difficult to estimate the exact reason for fish or prawn kills. Water parameters may change due to ecological conditions of water, parasitic, non - parasitic and nutritional prob- lems prove harmful and even fatal to fish or prawn.

The following aspects are responsive for the reasons of the fish and prawn kills.

1. Due to improper management of water quality.
2. Infected by diseased pathogens.
3. Depletion of oxygen in the culture pond.
4. Excess fo carbondioxide.
5. Acclamation of Ammonia and nitrogen waste
6. Due to water contaminated pesticides or any toxicants.
7. Water contaminated by agriculture or industrial pollutants.
8. Due to high temperature
9. **Eutrophication :** Accumulation of high nutrients water body looks pea-soap green in colour due to algal blooms. Excess growth of algal blooms leading to death of fish.
10. **Algal toxicosis :** Persistence of the algal bloom will cause toxicosis for the fish or prawn stock showing symptoms like convulsions leading to death.
11. Excess of hydrogen sulphide gas-pond smells like rotten eggs. The bottom dwelling fish or prawn come up the surface and die first.
12. Very low or high levels of pH.
13. Mal nutritional problem or improper feeding
14. Due to high stocking density
15. Infection of appliances and feeding trays
16. The entry of predatory fish (like channa, murrels, clarias, Notopterus, mystes species etc.) and fish predators (Like frogs, water snakes, aquatic birds
: Pelican , fish eagles , Henons and king fishers , aquatic mammals like otter etc.) as they kill and feel up on the young fish and prawns.

Short Answer Type Question

1. What type of supervision requires for good management of
2. Write any important steps in daily management of pond.
3. Write any two important monthly management practices.
4. Write about good feeding methods.
5. Write any two reasons for fish and prawn kills.
6. Define 'Eutrophication'. Write its adverse effect on fish culture.
7. Give any examples of predatory fish and fish predators.
8. Define Alagal Toxicosis?

Long Answer Type Question

1. Describe the daily and monthly management of culture pond.
2. Explain the reason for fish and prawn kills.

FISHERIES

Paper – II

AQUA CULTURE

INDEX

UNIT 1

AQUACULTURE- AN INTRODUCTION

Structure

1.0. INTRODUCTION: Aquaculture is the farming of aquatic organisms such as fish, crustaceans, molluscs, plants, crocodiles, alligators and amphibians. It has been defined in many ways. It has been called as the rearing of aquatic under controlled or semi controlled condition-this it is underwater. The other definition of aquaculture is the art of cultivating the natural produce of water, the raising or fattening of fish in enclosed ponds. Another one is simply the large-scale husbandry or rearing of aquatic organism for commercial purposes. Aquaculture can be potential means of producing organism for commercial products; it can mean an increased number of jobs, enhanced sport and commercial fishing and a reliable of protein for the future. Fish is a rich source of animal protein and its culture is an effect protein food production system from aquatic environment. The main role in fish culture is improvement of nutritional standards of the people. Fish culture also helps in utilizing water and land resources in more effective way. It provides inducement to establish other subsidiary industries in the country. Aquaculture happens to be the only means of maintaining overall supplies, through various management disciplines, viz, management of seed farms, brood stock management, management of Hatcheries, water quantity management, nursery pond management etc. Aquaculture normally involves rearing of organisms from fry, spat or juveniles. Aquaculture may be carried out in ponds, paddy fields, lagoons, estuaries, irrigation canals or the sea, using structures such as cages and tanks.

2.0 HISTORY: Aquaculture is having a long history on fish culture in Asia, ancient Egypt and central Europe. The book "Classic of Fish Culture" written by Fan Lei around 500 BC, a Chinese Politician and a fish- culturist, is considered as a proof for the commercial fish culture practiced in China. In 2500 BC Egyptians farmed Tilapia in ponds. Earliest fish that was used for farming is Common Carp (*Cyprinus* carpio) which was introduced by Chinese immigrants into several Asian countries.
In India Kautilya, described how fish could be poisonous in tanks during war in his book "Artha Shastra" written around 300 B.C. King Someswara son of King Vikramaditya VI was the first to record the common sport fishes of India and group them into marine and freshwater forms in his book Manasoltara compiled in 1127 AD.

3.0 Types of Aquaculture Systems:

3.1. Based on type of water: Depending on the salinity, water can be classified as freshwater (0 ppt), Brackishwater (0.5 to 30 ppt) and Marine (30-35 ppt). Depending upon the type of water being used, aquaculture is of three types, namely freshwater aquaculture if the culture done in freshwater, brackishwater aquaculture if it is done in brackishwater and Mariculture if culture takes place in sea water.

3.2. Fresh water Aquaculture: The fresh water aquaculture deals with due the culture of the organism in fresh water resources (0 ppt salinity) namely rivers, streams, canals, reservoirs. anicut tanks and ponds etc. The aspects of breeding of the brood stock, rearing of seed, pond preparation, stocking, water quality management, feed management, aquatic animal health management methods and harvesting are included. The type of organism cultured include fishes, prawns, mussels, frogs, aquatic plants etc. The prominent species being cultured in India are three Indian Major Carp (IMC) - catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*), three exotic carps, viz. silver carp (*Hypophthalmichthys molitrix*) and grass carp (*Ctenopharyngodon idella*), and common carp (*Cyprinus carpio*) are extensively cultivated. Apart from these freshwater prawns like Scampi (*Macrobrachium rosenbergii*) and Godvari River Prawn (*M. malcolmsonii*) are also cultured. Air breathing fish such as magur (*Clarius* *batrachus*) murrels such as (*Channa striatus, C. punctatus* etc) are also suitable for aquaculture in freshwaters.

3.3. Brackish water aquaculture: The brackishwater are areas of confluences of freshwater and sea water and the salinity ranges from 0.5 to 30 ppt. The brackishwater aquaculture is also known as coastal aquaculture. The brackishwater fish such as mullet and other fishes were cultured off the Italian coast by Romans long ago. Later culture of mullets, lates, milk fish and shrimp were tried in the states of Kerela, Tamil Nadu and Andhra Pradesh. Estuaries back water creeks and lagoons are the main non stagnant brackish water. In these water fishes and the seed of milk fish (*Chanos chanos*) mullet (*Mugli cepahlus*), Asisan seabass (*Lates calcarifer*), Pearl spot (*Etroplus suratensis*), Tiger shrimp (*Penaeus monodon*), Indian white shrimp (*P. indicus*) *exotic shrimp Vannamei (Littopenaeus vannamei*) are being cultured in brackishwater environment. The word shrimp is used for the prawns available in the marine and brackishwater sources while the term prawn is used for them in freshwater sources.

3.4. Mariculture: The water in oceans are vast, deep and uncontrolled stocking of fish seed will not profitable. Manuring of water cannot be done. Feeding of the required fish is impossible. Hence fish culture in open oceans is not possible. However aquaculture in marine environment is possible through cage culture, raft culture etc. Species suitable for mariculture are Cobia (*Rachycentron canadum*), Silver Pompano (*Trachinotus blochii*), Asian Seabass (*Lates calcarifer*), Snappers (*Lutjanus sp.*), Groupers (*Epinephelus sp.*) and Spiny Lobster (*Panulirus sp.*). Seaweed production and pearl culture also have lot of potential in mariculture.

4.0. Based on Management Intensity: Aquaculture can be categorized into four types mainly based on level of management intensity of cultural system.

4.1 Traditional culture : It is the simplest and an age old practice with minimum inputs managements. No selection of species, fertilization and supplementary feeding. In traditional culture system the yield is very less.

4.2 Extensive Culture: It is an improved culture system over the cultivable species are selected and stocked species mostly depend on natural food organism. Fertilizers and supplementary feeds are used to limited extent in the properly prepared fields. Fish production in extensive systems is based on the use of organic and inorganic fertilizers. Fertilization of ponds promotes the growth of simple plants which form the base of the food chain in the pond. Fish stocked in these ponds feed on phytoplankton, zooplankton, bottom-dwelling invertebrates and smaller fish. At its most effective, this type of production can be integrated with other types of crop or livestock production, using animal manure and agricultural by-products as sources to stimulate primary production.The 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 fertilisation 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.

4.3 Semi intensive culture : Semi-intensive aquaculture aims to increase the production of fish from pond systems beyond the level supported by food which is naturally available through the use of supplementary feeds. Supplementary feeds range from cereals and agricultural and fishery by-products to formulated feeds. Traditionally they are incomplete and would be inadequate as a sole source of food. Their function is to provide extra nutrients to complement those obtain from natural foods. Semi-intensive fish culture system is more prevalent and involves rather small ponds (0.5 to 1 hectare in an area) with higher stocking density (10000 to 15000 fish/ha). In this system, care is taken to develop natural foods by fertilisation with/without supplemental feeding.

4.4. Intensive culture: In intensive culture systems there is a decreased dependence on the availability of natural food and greater dependency on the use of commercial feeds. Densities of fish kept within such holding areas are limited by species tolerance, ability to grow at raised stocking densities and maintenance of environmental parameters rather than the production of a natural food supply. An 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/m^3 of water). Fish are fed wholly formulated feed. Proper 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 the profit.

It is highly evolved culture system with more stocking density and provide more formulated feed and more aeration. Stoking is done more formulated feed and more aeration. Stocking is done with hatchery reared juveniles, water quality is maintained by frequent changing or by providing water circulation together with constant aeration.

5.0 Based on Stocking Organism: The following aquaculture practice are followed.

5.1 Monoculture: Rearing of a single species of fish is called Monoculture, it is called monospecies culture. E.g. Culture of Catla in a pond. This is the culture of single species of fish in a pond or tank. The culture of Clarias only or *Oreochromisniloticus* or Heterotis or Gymnarchus are typical examples of monoculture.

The advantage of this method of culture is that it enables the farmer to make the feed that will meet the requirement of a specific fish, especially in the intensive culture system. Fish of different ages can be stocked thereby enhancing selective harvesting.

Common practices around the world

- Common carp in East Germany
- Common carp in Japan

- *Tilapia nilotica* in several countries of Africa
- Rainbow trout (*Salmon gairdneri*) culture in several countries.
- Channel catfish (*Ictalurus punctatus*) in U.S.A.
- Catfish, *Clariasgariepinus* in Africa.

5.2. Monosex culture: Rearing of only sex of species is called Monosex culture E.g. Tilapia. Mono-sex culture is based on the culture of fish by producing all males or all females depending upon the sex which have better food conversion ratio and growth rate. Sex of fish genetically is determined by the sex chromosomes (X, Y, Z, or W). The male determining gene M is present on any of the three X, Y and W. in XY mechanism, the females are XX and males are XO. Some species have ZZ female and ZW male. In platy fish there are 3 sex chromosomes – X, Y and W; XX, WX and WY are some combinations.

5.3. Polyculture: Rearing of different species in a water body is called polyculture. It is also called composite culture, E.g. culturing of catla ,Rohu, Mrigal in a water body.Polyculture is the practice of culturing more than one species of aquatic organism in the same pond.The motivating principle is that fish production in ponds may be maximised by raising a combination of species having different food habits. The mixture of fish gives better utilisation of available natural food produced in a pond. Polyculture began in China more than 1000 years ago. The practice has spread throughout Southeast Asia, and into other parts of the world.Ponds that have been enriched through chemical fertilisation, manuring or feeding practices contain abundant natural fish food organisms living at different depths and locations in the water column. Most fish feed predominantly on selected groups of these organisms. Polyculture should combine fish having different feeding habits in proportions that efficiently utilise these natural foods. As a result, higher yields are obtained. Efficient polyculture systems in tropical climates may produce up to 8000 kg of fish/ ha/year.

5.4. Fishes used in polyculture Combinations of three Chinese carps (bighead, silver and grass carp) and the common carp are most common in polyculture. Other species may also be used. While fish may be grouped into broad categories based on their feeding habits, some overlap does occur. Descriptions of the feeding habit categories and examples of fish from each category are as follows.

- **Plankton Feeders -** Plankton is usually the most plentiful food in a pond, so it is essential to include a plankton-feeding fish in a polyculture system. This group of fish feeds on the tiny, free-floating plants (phytoplankton) and animals (zooplankton) which multiply abundantly in fertilised ponds. Two fish typical of this group are the silver carp, *Hypophthalmichthysmoliirix*, and the bighead carp, *Aristichthysnobilis*.
- **Herbivores -** This group of fish feeds on aquatic vegetation. The grass carp, *Ctenophanjngodonidella*, is most noted for this behaviour and is stocked in ponds for weed control.
- **Bottom Feeders -** Fish in this group feed primarily at the pond bottom. They consume a variety of decaying organic matter, aquatic organisms such as clams, insects, worms, snails, and bacteria living in or on the

sediments. The common carp, *Cyprinuscarpio*, is well noted for this behaviour.

- **Piscivorous Fish -** These predatory fish feed on other fish and must consume about 5 to 7 g of prey to grow 1 g. They are frequently stocked in ponds to control unwanted reproduction, particularly in tilapia, and other fish that enter the pond with the water supply and compete for food with the stocked fish. Commonly used predator fish include the sea bass, *Lates* spp.; catfish, *Clarius* spp. and *Silurus* spp.; snakeheads, *Ophicephalus* spp.;
  cichlids, *Cichla* spp.; *Hemichrotnisfasciatus* and *Cichlasomamanaguense*; knife fish, *Notopierus* spp.; and largemouth bass *Micropierussaimoides*.

6.0. Integrated fish culture: Culturing fishes along with paddy, poultry, piggery and dairy is called integrated fish culture. E.g. Indian major carps.
6.1 Paddy cum fish culture: Rearing of fish in paddy fields is called paddy cum fish culture. E.g. Catla, Rohu.Rice fish farming can contribute to household income, contribute to food security and nutrition and contribute to improved sustainability of rice production.
6.2 Poultry cum fish culture: Rearing of fishes along with poultry is called poultry cum fish culture. E.g. India major carps. In this system, the fish crop is integrated using only poultry droppings or dip litter by rearing the poultry either directly over the pond or on the pond embankment. By adopting this technology, production of 3500 to 4000 kg fish, more than 20000 eggs and about 1250 kg (live weight) chicken meat can be obtained from a hectare of pond area in one year.
6.3 Cattle cum fish culture: Rearing of fishes along with dairy farm is called dairy cum fish culture. E.g, Indian major carps. Integrated cattle and fish farming is an ideal method for assured fish production in small ponds (<0.1 ha). In this technology, the fish crop is raised using the cattle on the pond embankment or any other suitable site of the farm.
6.4 Duck cum fish culture: Integrated fish farming has received attention in recent years in the North East India. Among the different livestock based system, fish duck integration is one of the most popular farming practices among woman fishers. Ducks are stocked @200-300 ducklings/ha of fish pond. From duck excreta annual manure production is 45-55 kg/duck/yr, which besides fertilizing the fishponds and can be directly utilized as fish food. Apart from this, 10-20% feed/day/duck is wasted which is utilized in ponds. Duck dropping contains 81% moisture and 0.91% N and 0.38% P2O5.

6.5 Pig cum fish culture: Rearing of fishes along with pig farm is called pig cum fish culture. E.g. Indian major carps. Integrated pig- fish farming is a highly profitable fish culture system, where pigs are reared adjacent to the fish ponds, preferably on the pond embankment from where pig urine, excreta and spilled pig feeds are introduced into the pond water. In one harvest cycle of fish (one year), 2 batches of pigs are grown, 6 months each. This is direct integration system, which is a more efficient method than the indirect integration model, wherein pigs are raised elsewhere and the pig waste is manually applied to the pond daily at a pre-determined dose.

7.0 Economic importance of Aquaculture:

7.1. 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. Therefore, its overall conversion of pound of food to pound of protein makes it cheaper to rear fish as they use the food more efficiently.

7.2. **Income generation and Wealth creation:** Aquaculture is most profitable enterprise among all agriculture based activities. Most of the shrimp cultured in the state is exported to foreign countries and lot of foreign exchange is being earned. Lot of income can be generated from the aquaculture activities

7.3. Employment generation: 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.
Aquaculture also saves fishermen time as they do not have to spend their days at sea fishing. It allows them free time to pursue other economic activities like engaging in alternative businesses. This increase in entrepreneurship provides more hiring possibilities and more jobs.

7.4. Alternative fuel source: Algae produce lipids that if harvested can be burn as an alternative fuel source whose only by products would be water when burnt. Such a breakthrough could ease the dependency of the world on drilled fossil fuels as well as reduce the price of energy by having it grown instead of drilling petroleum. Moreover, algae fuel is cleaner and farmable source of energy, which means it can revolutionize the energy sector and create a more stable economy that avoids the boom-bust nature of oil and replaces it with a more abundant fuel source.

Short Answer Questions:

1. Poly culture systems
2. Mono culture
3. Plankton feeders
4.Extensive cultures
5. Semi intensive culture
6. Intensive culture
7. Fresh water aqua culture
8. Brackish water aqua culture

Long Answer Questions:

1. Types of aqua culture systems
2. Integrated fish culture types with examples.

UNIT 2

POLYCULTURE

Structure

1.0. Introduction: 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. Polyculture practices give higher yield than monoculture under the same conditions for freshwater carp farming.

Fish pond is a complex ecosystem. It harbors phytoplankton and zoo plankton on its surface (Epilimnion); various types of aquatic organism and the carcass of the dead in the column water (metalimnion); detritus and decaying organic material in the bottom (hypolimnion). Different types of aquatic plants are seen all along the margin of the pond. Maximum exploitation of the food and aquatic resources available in such a pond through the introduction of selected varieties of compatible fish having different feeding habits to achieve high productivity is called composite fish culture or poly culture or mixed fish culture or Balanced fish population.

Polyculture is the production of two or more fish species within a particular aquaculture environment. Most polyculture occurs in ponds. When considering pond polyculture, certain issues such as feeding, harvest and marketing should be considered first.

2.0 Concept of Polyculture: The concept of polyculture of fish is based on the concept of total utilization of different trophic and spatial niches of a pond in order to obtain maximum fish production per unit area. Different compatible species of fish of different trophic and spatial niches are raised together in the same pond to utilize all sorts of natural food available in the pond.

In general, undrainable pond is characterized by its diversified spatio-trophic environment comprising of various natural fish food organisms (Phytoplankton, Zooplankton, Periphyton, Macrophytes, Benthos and detritus) at different strata of pond water column as well as in the bottom. Selection of species in polyculture is thus very important. There should be a compatible combination of species with diversified feeding habit that should include planktivorous surface/column feeders to benthic/detritivorous bottom feeders as well as omnivorous to macrovegetation feeding fish species.

The possibilities of increasing fish production per unit area, through polyculture, is considerable, when compared with monoculture system of fish. Different species combination in polyculture system effectively contribute also to improve the pond environment. Algal blooming is common in most tropical manure fed ponds. By stocking phytoplanktophagus Silver carp in appropriate density certain algal blooming can be controlled. Grass carp on the other hand keeps the macrophyte abundance under control due to its macrovegetation feeding habit and it adds increased amount of partially digested excreta which becomes the feed for the bottom dweller coprofagous common carp. The bottom dwelling mrigal, common/mirror carp help re-suspension of bottom nutrients to water while stirring the bottom mud in search of food. Such an exercise of bottom dwellers also aerates the bottom sediment. All these facts suggest that polyculture is the most suitable proposition for fish culture in undrainable tropical ponds.

3.0. Biological basis of Polyculture: Common fish species in Indian polyculture are catla, rohu, mrigal, silver carp, grass carp and common carp, and this system is sometimes called as composite fish culture. The biological basis of polyculture is different fish species grow together in a pond with difference in feeding and living behavour.

The principal requirements of the different species in combination for polyculture 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

4.0. Advantages of Polyculture:

- Maximum utilization of the resources available.
- Different stages of the same fish sp. Can be introduced and cultured when the natural feed available and its density are in plenty. This facilities high productivity.
- As the productivity and yield are more, profitability from such a culture us highly encouraging.

5.0. Management principles for Polyculture:

- Fishes selected must be highly compatible with different feeding habits.
- Market demand and nutritional values are also to be taken into consideration during the fish selection.

- •Tolerance with the other living and non-living organism of the pond by the fish to be selected for composite fish culture should never be over looked.
- •Selected fish should be able to live at different depths of the pond besides the variation in their feeding habits. This prevent competition among the organisms inhabiting the same ecologicalniche.
- •Stocking density of the fish fry and fingerlings to be introduced into a pond of one hectare must be carefully decided. Generally 5000- 10,000 fingerlings are introduced into a pond of one hectare water area. Factors like fertility capacity, feeding level, availability of the fingerlings, maintenance capacity of the pond, knowledge about fish culture etc. play an important role. Accordingly, the stocking density is to be calculated.
- • Knowledge about the availability of natural feed and supplementary feed to be provided for achieving high yield is very much essential.
- • Information about the physio-chemical factors influencing the growth of fish should be known to the concerned farmer. He should prepare the pond for fish culture well before the introduction of the selected species for achieving increased productivity
- • By knowing the initial and final densities of the fish (by weight), one can estimate the yield. This facilitates the farmer to analyse the pitfalls and steps to be adopted for increasing the yield in subsequent crops.

6.0. Ratios to be maintained between the organisms in Polyculture:

Composite fish culture has been in practice in our country since ancient times. It has become a regular traditional practice to out farmers. Still following ratios are suggested by the scientists of this field to achieve enhanced productivity.

Alikunhi proposed the ratio of 3:3:4 between *Catla* (surface feeder), *Labeo* (column feeder) and mrigal (botton dweller), Hora and Pillai (1962) proposed a ratio of 3:6:1: or 3:5:1 for the above fishes in poly culture technique. They also suggested the introduction of *Labeo calbasu* a bottom dweller in addition to *Mrigal* as their feeding habits are total different.

Researchers conducted at Cuttack held the ratio to be 5:3; 3:6, 8:2:3 for the fishes like grass carp, silver carp, Catla, Rohu, Scale fish, mirror carp and Tilapia. Combined efforts of CIFRI (Central Inland Fisheries Research Institute) and ICAR (Indian Council for Agricultural Research) resulted in the proposal of following ratios to achieve high yield in short time.

a. 5:3:8:2 – Grass carp, silver carp, Catla, Rohu, Scale carp and mirror carp.
b. 5:3:6:8:2- Gras carp, silver carp, Catla, Rohu, scale fish & mirror carp.
c. 5:3:3:6:8:2 -Grass carp, silver carp, Catla,Rohu, Scale fish & mirror Carp.

Fresh water prawn feeding on detritus and cat fishes, murrels of predatory nature can also be introduced after attaining a specified growth by the main food fishes. These organisms also grow along with the food fishes by feeding upon organic detritus and trash fish of the pond. These can also be collected and sent to the market for disposal as they are also relished as food by some people of the society. They provide additional income to the farmer.

7.0. Species suitable for Ploycultures

a. Fishes inhabiting surface waters (Epilimnion):

i. *Catla catla*(Botche) feeds on zooplankton and organic materials.
ii. *Hypophthalmichtys molitrix* (Silver Carp) feeds on phytoplankton.

b. Fishes inhabiting the bottom waters (Hypolimnion)

i. *Cirrhinus mrigala* (mrigal) and *Labeo calbasu* (calbasu) feed on the plankton living over submerged vegetation.
ii. *Ctenopharyngodon* (grass carp) lives in waters where no other fish can live and feeds on the available feed of its surroundings. Excretory materials of these fish form feed for carpio and also promotes the growth and development of other planktonic organisms.
iii. In countries like Europe and U.S.S.R., Tench fish are cultured along with carps. By feeding on the detritus, carcass of the dead and plankton of the submerged vegetation, they promote the growth of main carps.
iv. Trout fish and tilapia feeds quickly upon trash fish and promote the productivity of food carps.
v. In china, fish selected for composite fish culture are black carp (*Myelopharyngodon sp*. feeding on the snails of the bottom), grass carp (*Ctenopharyngodon* feeding on plant materials), silver carp (*Hypophthalmichthys* feeding on phyto and zooplankton), large beaded fish (*Aristichthys nobilis* feeding on macro plankton), common carp (*Cyprinus carpio* feeding on the leftovers of mrigal)etc.
vi. In Taiwan, *Mugil cephalus* is cultured in association with main carps.

8.0. Supplementary Feed in polyculture

As the main carps feed upon available food, density of the natural feed decreases slowly thus demanding the introduction of supplementary feed. Fish feed is prepared from ground nut cake and rice barn (or) cake barn, kitchen waste, vegetable waste (or) protein rich pupae of the silk worms or soya bean or notonectid insects or prawn wastes or trash fish along with required quantities of 'B'- complex-vitamins. Yeast, cobalt chloride sufficient nutrients to the main carps to grow quick and yield high. Hydrilla, Najasm, Ceratophyllum, Chara, Napier Grass, Tapioca leaves, Kitchen Vegetables refuge etc. can be given as supplementary feed to grass carps.

9.0. Yield from Polyculture:

8-9 fold increase in the yield is achieved from composite fish culture as supported by the following data. According to the research by CIFRI (1968) annual yield from a pond was recorded at

a. With main carps alone – 2088 kg/ha
b. With exotic carps alone – 2900 kg/ha

c. With main and exotic carps through composite fish culture 3085 kg/ha.

• CIFRI (Cuttack) recorded an annual yield of 9000, kg/ha/year from large tanks under composite culture.

• Data obtained in 1971 by ICAR units in Andhra Pradesh, Haryana, Maharashtra, Tamilnadu, Uttar Pradesh and West Bengal revealed the half-yearly productivity under composite fish culture at 2692kg – 3210 kg/ha

• Productivity recorded in the tanks of Karnal in Haryana Yield for 6 months – 3448-5894 kg/ha. Yield for 8 months - 6191 – 7332 kg/ha.

Grass carp gains a weight of 3 kg in one year under composite culture method and contributed 30 % of the total yield.

Short Answer Questions:

1. Supplementary feeding in poly culture.
2. Species suitable for poly culture.
3. Yields from poly culture.
4. Biological basis of poly culture.

Long Answer Questions:

1. Concept of poly culture and advantages.
2. Ratios to be maintained in poly culture

UNIT 3

INTEGRATED FISH FARMING SYSTEMS

Structure

6.0 Definition
7.0 Historical Overview
3.3 Fish cum Paddy Culture
4.0 Fish cum Poultry Farming
5.0 Fish cum Duck Culture
6.0 Fish-Horticulture Farming
7.0 Fish – Pig Farming

1.0 **Definition**: Integrated fish farming systems refer to the production, integrated management and comprehensive use of aquaculture, agriculture and livestock, with an emphasis on aquaculture or integrated aquaculture is the concurrent or sequential linkage between two or more farm activities, of which at least one is aquaculture. (FAO)

2.0 **Historical overview**: First integrated aquaculture systems originated in China, 2000 years ago. In India it is about 1500 years ago. In the fifties of the 19th century integrated fish farming practices were transferred from China to Japan. Integrated aquaculture systems have been practiced in Russia since 1850 and in Madagascar since 1914.

3.0 Fish Cum Paddy Culture:

In this system of farming fish is farmed in paddy fields. Rice and Fish go together as food particularly in South East Asian countries and there are also age old systems prevalent for their combined cultivation in India. The fish species such as Common carp, Tilapia and Murrells are most suitable for culture in rice fields.

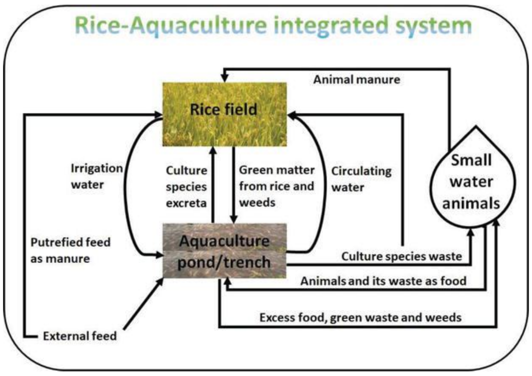


Fig-1: Interaction of different components in integrated rice-aquaculture systems

3.1. **Site Selection:** While selecting the site for integrated rice-aquaculture certain should be followed. The site selection for rice cum aquaculture farming is low laying area where water flows easily and is available at any time in needs. The Selected place should have an optimum rainfall of 80cm in a year.

3.2. **Layout of paddy plot:** Layout of the paddy plot can be done suiting the land contours.

a) Perimeter type trench: In this the paddy growing area may be placed at the middle with moderate elevation and ground sloping on all sides to facilitate easy drainage.

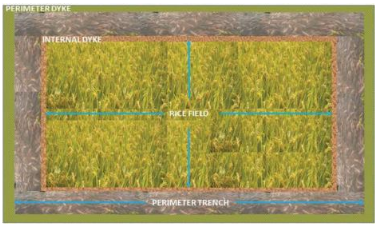


Fig-2: Perimeter type Trench

b) Central pond type: Paddy growing area is on the fringes with slopes towards the middle

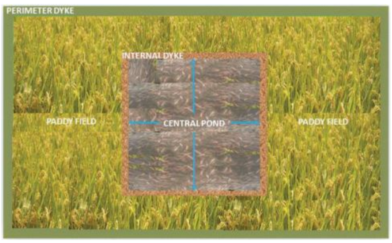


Fig-3: Central Pond Type

c) **Lateral type trench:** Trenches are prepared on one or both lateral sides of the moderately sloping paddy filed.

Fig-4: Lateral type Trench

3.3 Types of Paddy-Field Aquaculture:

Three major types of paddy-field aquaculture are generally practiced:

I. Simultaneous or combined or synchronous farming.
II. Alternate or sequential farming or paddy- fish rotation.
III. Relay farming.

I. Simultaneous or Combined or Synchronous Farms: In this system paddy and fish are grown together and harvesting the paddy and fish at the end of the rice-growing season. The methods of culture adopted are for production of either fingerlings or fish for consumption. Farmers generally cultivate local varieties of paddy which takes up to 6 months to be harvested, so that more than one crop per year can be grown. Generally organic manures are preferred over the use of fertilizers in the preparation of the paddy-fields.

II. Alternate or sequential farming or paddy- fish rotation: It is the simplest form, where flooded paddy-fields after harvest are used to raise one or more crops of fish or shrimp. In rotation system the paddy-field has to be prepared for raising fishes after the harvest of rice. To maintain the required depth of water the bunds surrounding the field have to be raised. After harvesting the rice, the stubbles are not removed.

III. Relay Farming: In this system in which two crops (kharif & rabi) paddy and one crop of fish + prawn is taken up, in this p[rolonged fish culture upto 8-9 months. This system provides letter growth rate than one paddy crop system.

3.4. Fish Culture: Since the water column in the perimeter type of renovation done at Rahara farm was suitable for rearing carps, three Indian major carps, i.e.. Rohu, Catla, Mrigal and exotic carps like Silver carp and Common carp were stocked in the integrated system. Before fingerlings are released in the waterway, it is essential to clear it from aquatic vegetation and predatory fishes. The floating and emergent weeds may be removed manually. Since the waterway will dry up during summer, removal of predatory fishes like *Murrels, Wallago attu* etc. may not pose a problem. It is better to use Mahua oil cake @ 250 ppm at the onset of monsoon during June when rain water starts accumulating in the waterway.

(i) **Stocking:** In the month of July when the rain water starts accumulating in the paddy plot and the depth of water in the waterway becomes sufficient, the fishes like rohu, catla, mrigal, common carp or minor carps may be stocked ranging from 3,000-6000/ha. Freshwater prawn *Macrobrachium rosenbergii* has also been found to grow well. Species ratio may be 25% surface feeders preferably catla which is readily available 30% column feeders i.e., rohu and 45% bottom feeders i.e., mrigal or omnivores like common carp .

(ii) **Fertilization:** Due to the presence of deep water paddy whose nutrient uptake is very high such ecosystem is generally poor as an environment for fish culture. To increase the fertility, both organic and inorganic fertilization is necessary particularly from December to March when the fishes remain only in the perimeter canal. Cow dung(5,000 kg/ha), ammonia sulphate (70 kg/ha) and single super phosphate (50 kg/ha) may be applied in three equal instalments during four months rearing period.

(iii) **Feeding:** To augment growth, supplementary feed comprising mustard oil cake and rice bran in 1:1 ratio may be given to fishes daily @ 2.5% of their body weight particularly after the harvest of kharif paddy.

(iv) **Harvesting**: In this culture system the fishes will grow for a period of 5-6 months in the entire area and 4-5 months in the confined area of the waterway. After harvesting deep water paddy when the paddy plot is gradually drying the fishes will instinctively take shelter in the waterway. Partial harvesting by drag netting may be started soon after the kharif season and fishes attaining 400-500 g may be taken out at fortnightly interval. At the end of operation when the water in the waterway is used up for irrigating the paddy plot the fishes still remaining may be handpicked. Production may range from 500-700 kg/ha/year.

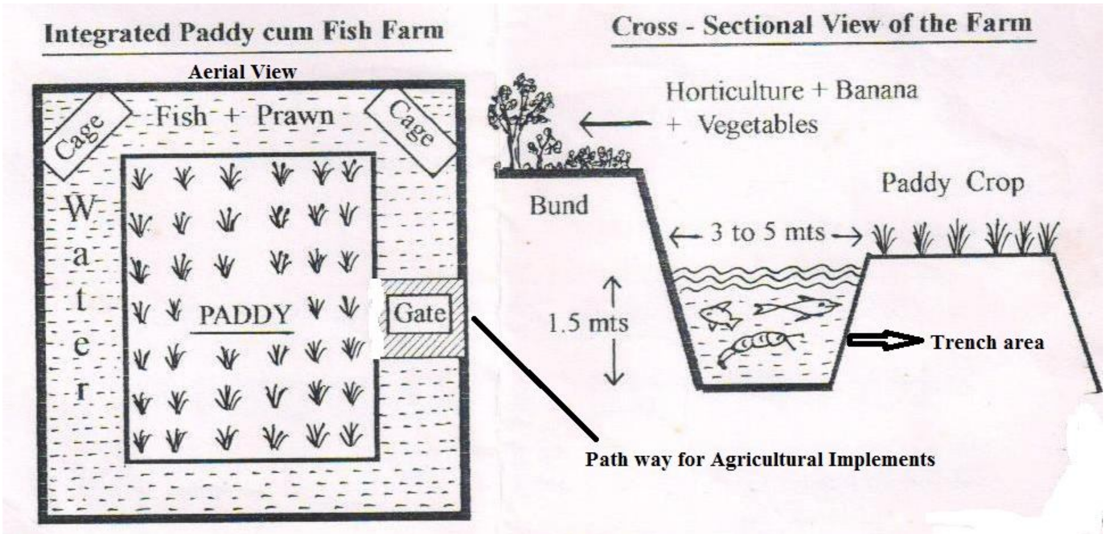
3.5. Scope of Paddy-Cum-Fish Culture:

(i) This integrated bicommodity paddy-cum-fish culture can be adopted in 2.3 million ha paddy fields of the country, where deep water rice is presently under cultivation Renovation of paddy plot can be done based on land contours, fish to be reared and depth available for water retention.

(ii) Areas where irrigation facilities are not available and 'Rabi' paddy is not normally possible, this system can be introduced for a second crop of paddy as well as a sizeable crop of fish to fetch better revenue to the farmer.

(iii) Areas, where irrigation is assured and paddy fields flooded at will, can be put to use for raising of carp seed along with paddy.

Most adoptable integrated paddy cum fish culture unit details with diagram:



Land utilisation: In a given unit 70% paddy area, 25% trench area for fish and 5% area alloted to bunds, where horticultural crops are grown.

1. Paddy cum fish culture system is a ecofriendly, the farmer will get income throughout the year by producing paddy, fish & prawn, horticulture crops & vegetables.

2. In this system optimum utilisation of land by producing paddy & fish.

3.Better paddy yields are achieved without using any chemicals and fertilisers.

4. Due to integretion of fish weeds will be controlled in the paddy field.

5. Rat damage will be limited in the paddy field.

6. Pest and disease problems are nill in the paddy fields.

7. Fish and prawn yields are much better without any diseases.

4.0. Fish cum Poultry Farming: In most of the agricultural farms, extensive fish culture and extensive poultry raising is practiced, but the two systems are not interlinked. To develop an integrated system of poultry production and fish culture, the first thing a farmer has to reorganize is the poultry raising and the stocking structure of fish. Although fish production is the more profitable component, in a integrated system the profitability of poultry sub-system (even if it is minimal) must also required to be a self sustaining activity be ensured, or, at least, the poultry sub-system must pay for itself.

The modern methods of poultry raising require sophisticated management which seems to be beyond the capacity of most of the rural fish farmers. It may be easier for a proven poultry farmer to integrated fish culture with his poultry rearing rather than a fish farmer integrating poultry raising in his fish farming system.

The Management of fish sub-system - as second consumer level - seems to be easier, as it is mainly “served” by the poultry sub-system.

Considering consumer's preference and local price structure, only three types of poultry farming is economically viable.

a. Chicken egg production
b. Duck egg production
c. Chicken meat (broiler) production in selected places (FAO)

4.1. Fish culture practice:

Considerations for selection: The selected species should be compatible with each other. The species and their combination ratio should be adjusted according to the amount of feed stuff and manure that are expected to be made available by the other sub-system. As far as possible the species should fast growing. Selected fish should be hardy and resistant to common diseases and parasites. The species should be able to tolerate low oxygen levels and high organic content in the water.

Stocking density of fish: Fish culture practice followed in the integration of poultry-cum-fish farming is the “Composite fish culture system”. It is very popular in India. More than one species of fish are reared in the same pond.

- The application of poultry manuring in the pond provides a nutrient base for dense bloom of phytoplankton, particularly nanoplankton which helps in intense zooplankton development.
- The zooplankton has an additional food source in the form of bacteria which thrive on the organic fraction of the added poultry dung. Thus, indicates the need for stocking phytoplanktophagous and zooplanktophagous fishes in the pond.
- In addition to phytoplankton and zooplankton, there is a high production of detritus at the pond bottom, which provides the substrate for colonization of micro-organisms and other benthic fauna especially the chironomid larvae.
- Another addition will be macro-vegetation feeder grass carp, which, in the absence of macrophytes, can be fed on green cattle fodder grown on the pond embankments.
- The semi digested excreta of this fish forms the food of bottom feeders.
- For exploitation of the above food resources, polyculture of three Indian major carps and three exotic carps is taken up in fish cum poultry ponds.
- The pond is stocked after the pond water gets properly detoxified.
- Stock 600-1000 fingerlings of Indian carps, catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*) and Chinese carps, silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*). Species stocking rate could be 40 percent surface feeders (catla and silver carp), 20 percent

column feeders (rohu), 30 percent bottom feeders (mrigal and common carp) and 10 percent grass carp.

- Mixed culture of only Indian major carps can be taken up with a species ratio of 40 % surface, 30 % column and 30 % bottom feeders.
- In the northern and north - western states of India, the ponds should be stocked in the month of March and harvested in the month of October - November, due to severe winter, which affect the growth of fishes.
- In the south, coastal and north - eastern states of India, where the winter season is mild, the ponds should be stocked in June - September months and harvested after rearing the fish for 12 months.

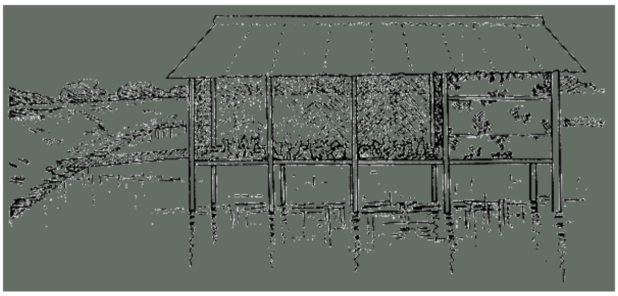
4.2. Poultry husbandry practice:

Useful considerations while constructing a chicken pen:

- Rectangular house has been found to be suitable from overall management point of view.
- **Location:**
  The house should be built at the most wind protected side of the pond. Storms can cause serious damages to the structure. If the house is constructed above the pond, it has to be carefully considered that the gap between the house floor and the pond water surface should be at least 1 foot at highest water level in monsoon period.

4.3. Construction:

Tin is the long lasting and perfect roof material. The tin roof should rest over a bamboo mat rice or rice straw mat to cut down heat inside the chicken house during the summer months. Wall material can be bamboo mat, bamboo sticks or wire mesh. Optimal height of the wall should be 120–160 cm. If bamboo mat is used, the upper 1/3 of the walls should be left free and fitted with wire mesh for light and ventilation (Fig. 3.3.a).If the walls are built with wire mesh and supporting bamboo stick, the lower one third of the walls should be covered with bamboo mat to give protection for the chicken and nests against bad weather (Fig. 3.3.b). The floor of a chicken house over the pond should be constructed with bamboo splits. The gap between the bamboo splits should be wide enough (1.5 – 3 cm) to let the chicken faeces drop into the pond water below, but should not be too wide so as to cause injury to the legs of the birds. Should be movable in order to avoid pouching and predation. Three or four linked bamboo sticks serve well as a movable bridge for the caretaker and the chickens.



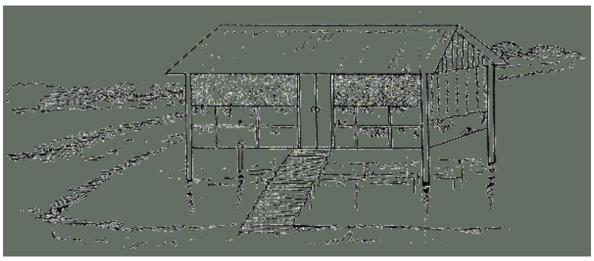


Fig. 3. Chicken houses on fish pond

4.4.Selection of poultry birds:

In the integration of fish and poultry farming both egg type and meat type are farmed. In the cage and deep litter system both egg type and meat type are grown.

4.5. Housing of birds:

- In integrated fish-cum-poultry farming the birds are kept under intensive system. The birds are confined to the house entirely.
- The intensive system is further of two types - cage and deep litter system.
- The deep litter system is preferred over the cage system due to higher manurial values of the built up deep litter.
- In deep litter system 250 birds are kept and the floor is covered with litter. Dry organic material like chopped straw, dry leaves, hay, groundnut shells, broken maize stalk, saw dust, etc. is used to cover the floor up to a depth of about 6 inches.
- The birds are then kept over this litter and a space of about 0.3 - 0.4 square meters per bird is provided.
- The litter is regularly stirred for aeration and lime used to keep it dry and hygienic.
- In about 2 month's time it becomes deep litter, and in about 10 months time it becomes fully built up litter. This can be used as fertilizer in the fish pond.
- The fowls which are proven for their ability to produce more and large eggs as in the case of layers, or rapid body weight gains is in the case of broilers are selected along with fish.
- The poultry birds under deep litter system should be fed regularly with balanced feed according to their age.
- Grower mash is provided to the birds during the age of 9-20 weeks at a rate of 50-70 gm/bird/day, whereas layer mash is provided to the birds above 20 weeks at a rate of 80-120 gm/bird/day.
- The feed is provided to the birds in feed hoppers to avoid wastage and keeping the house in proper hygienic conditions.

4.6. Egg laying

- Each pen of laying birds is provided with nest boxes for laying eggs.
- Empty kerosene tins make excellent nest boxes.
- One nest should be provided for 5-6 birds.
- Egg production commences at the age of weeks and then gradually decline.
- The birds are usually kept as layers up to the age of 18 months. Each bird lays about 200 eggs/yr.

4.7. Feeding of birds:

Under litter system the poultry birds are fed according to their age. The normal feeding practices followed-

a. **Chick mash**– 40- 45 gm/ day in 3- 4 times a day up to the age of 8 week of birds.
b. **Grower mash**– 50- 70 gm/ day in 5- 6 times a day from 8- 18 weeks age of birds.

c. **Layers mash**– 80- 120 gm/ day in 3- 4 times a day from 18 weeks age of birds.

4.8. Production: In this poultry-cum- fish farming from a hector of water spread area pond in 1 year 3500- 4000 kg fish, 650 kg chicken meat and 120000 nos. of chicken eggs can be produced.

4.9. Harvesting:

- Some fish attain marketable size within a few months.
- Keeping in view the size of the fish, prevailing rate and demand of the fish in the local markets, partial harvesting of table size fish is done.
- After harvesting partially, the pond should be restocked with the same species and the same number of fingerlings depending upon the availability of the fish seed.
- Final harvesting is done after 12 months of rearing. Fish yield ranging from 3500-4000 Kg/ha/yr and 2000-2600 Kg/ha/yr are generally obtained with 6 species and 3 species stocking respectively.
- Eggs are collected daily in the morning and evening. Every bird lays about 200 eggs/year.
- The birds are sold after 18 months of rearing as the egg laying capacity of these birds decreases after that period.
- Pigs can be used along with fish and poultry in integrated culture in a two-tier system. Chick droppings form direct food source for the pigs, which finally fertilise the fish pond.
- Depending on the size of the fish ponds and their manure requirements, such a system can either be built on the bund dividing two fish ponds or on the dry-side of the bund.
- The upper panel is occupied by chicks and the lower by pigs.

5.0 Fish cum Duck Culture:

In South East Asian countries fish-cum-duck integration is most common practice of integrated fish farming. Ducks are habituated to consume juvenile frogs, tadpoles and dragonfly etc. and there by make a safe environment for fish. Duck droppings provide essential nutrients go directly into the pond; droppings are good sources of carbon, nitrogen and phosphorus, which in turn stimulate growth of natural food organisms

For fish-cum-duck integration Khaki Campbell species of duck is recommended. Local indigenous variety of duck from disease-free population a farmer can rear. Fishpond being a semi-closed biological system with several aquatic animals and plants provides an excellent disease-free environment for the ducks. Pond bottom racking and swimming activity by ducks help in aerating the
pond water. Duck dropping contains 0.9 % nitrogen and 0.4% phosphorous. Duck dropping act as good organic manure which helps in production of different variety of phytoplankton & zooplankton in pond. About 250 - 300 ducks are enough to fertilize a one hectare water spread. The fish-cum-duck integration system provides meat, eggs in addition to fish. It

generates production of additional food and income to the farmer. Approximately 40-50 kg of organic wastes is converted into one kg of fish.

5.1. Benefits of fish cum duck farming:

- Water surface of ponds can be put into full utilization by duck raising.
- Fish ponds provide an excellent environment to ducks which prevent them from infection of parasites.
- Ducks feed on predators and help the fingerlings to grow.
- Duck raising in fish ponds reduces the demand for protein to 2 – 3 % in duck feeds.
- Duck droppings go directly into water providing essential nutrients to increase the biomass of natural food organisms.
- The daily waste of duck feed (about 20 - 30 gm/duck) serves as fish feed in ponds or as manure, resulting in higher fish yield.
- Manuring is conducted by ducks and homogeneously distributed without any heaping of duck droppings.
- By virtue of the digging action of ducks in search of benthos, the nutritional elements of soil get diffused in water and promote plankton production.
- Ducks serve as bio aerators as they swim, play and chase in the pond. This disturbance to the surface of the pond facilitates aeration.
- The feed efficiency and body weight of ducks increase and the spilt feeds could be utilized by fish.
- Survival of ducks raised in fish ponds increases by 3.5 % due to the clean environment of fish ponds.
- Duck droppings and the left over feed of each duck can increase the output of fish to 37.5 Kg/ha.
- Ducks keep aquatic plants in check.
- No additional land is required for ducky activities.
- It results in high production of fish, duck eggs and duck meat in unit time and water area.
- It ensures high profit through less investment.

5.2. Selection and stocking of fish species

While selecting fish species following point are to be considered:

- The species combination ratio should be adjusted according to the amount of feed stuff and manure that are expected to be made available
- The species should be able to tolerate low oxygen levels and high organic content in the water.
- Selected fish should be hardy and resistant to common diseases and parasites

5.3. Use of duck dropping as manure:

- The ducks are given a free range over the pond surface from 9 to 5 PM, when they distribute their droppings in the whole pond, automatically manuring the pond.
- The droppings voided at night are collected from the duck house and applied to the pond every morning.
- Each duck voids between 125 - 150 gm of dropping per day.

- The stocking density of 200-300 ducks/ha gives 10,000-15,000kg of droppings and are recycled in one hectare ponds every year.
- The droppings contain 81% moisture, 0.91% nitrogen and 0.38% phosphate on dry matter basis.

5.4. Preparation of pond: A productive pond is preferred for integrated fish culture. Considering rural conditions in our country, the smaller ponds can be used for integrated fish culture. Homestead ponds are suitable for this purpose. A pond of 0.5–1.5 ha size is easily manageable by small farmers. Any ponds that retain 1.5 to 2 m water depth in dry season are considered as suitable. If water depth goes below 1.5m the operation may face the danger of organic over-loading which may cause fish kills in the summer months. At first pond selected for integrated fish culture is drained out and dried, then for basal fertilization cattle dung is used @ 500 kg/1000m². After application of cattle dung to eliminate unwanted weed fish and other creatures poisoning done with application of mahua oil cake. Then lime is applied @ 250-300 kg/ha for correction of pH and to make the pond favourable for fish culture. After a gap of ten to fifteen days fingerlings can be released after filling up the pond with water.

5.5. Selection of duck and their rearing: Indian Runner, Khaki Campbell or their cross with indigenous local ducks are preferred for fish duck integration. To get a disease-free and good stock of duck, it is better to collect Khaki Campbell or Indian Runner duck from a Government Farm. Under intensive rearing system Khaki Campbell is able to lay above 300 eggs per year, weight of the eggs varies between 60 and 70g. The female start to lay at the age of 24 - 28 weeks and able to continue laying until 360–380 days old. Two fifty to three hundred ducklings are stocked per hector area of water body. Annual manure production from duck excreta will be around 45-55 kg/duck/year, apart from that about 10-20% of feed offered to ducks is wasted which is directly utilized as fish food. Duck dropping contains 81% moisture and 0.91% N and 0.38% P_2O_5 which is good for fertilization of pond. A pond receives 10,000 – 15,000 kg duck excreta per year when 250- 300 ducklings stocked per hector.

Ducks are allowed free range in the pond in sunny part of day – 9.00 am to 5.00 pm; swimming and dabbling activities of ducks will mix voided excreta with pond water and it will sufficiently fertilize the water body. Duck droppings avoided in night at the night shelter can be collected and applied directly in different corner of fish pond in the morning hours. If phytoplanktonic bloom is observed due to overloading of organic manure then application of duck droppings to the pond have to be suspended immediately. Ducks get its required quantity of water from the fish pond and it keeps water plants in check. Ducks act as a self manuring machine which helps in saving the expenditure involved in labour for applying manure in the pond. Ducks get 50- 75% of their total feed requirement from the pond itself in the form of aquatic weeds, insects, mollusks, etc.

5.6. Duck Feed: Ducks in the open water are able to find natural food from the pond but that is not sufficient for their proper growth. A mixture of any standard balanced poultry feed and rice bran in the ratio of 1:2 by weight can be fed to the ducks as supplementary feed at the rate of 100 gm/ bird/day. The feed is given twice in a day, first in the morning and second in the evening. The feed is given either on the pond embankment or in the duck house and the spilled feed is then drained into the pond. Water must be provided in the containers deep enough for the ducks to submerge their bills, along with feed. The ducks are not able to eat without water

5.7. Fish feed: In integration of fish culture with duck, supplementary feeding to the cultured fish is not required as duck excreta helps in fertilizing the pond water to produce fish food organism - phytoplankton and zooplankton. Sixty percent of operational cost of farming goes for feed alone. Therefore, local availability of fed ingredients as well as their cost is important. Apart from that some fish like- common carp take duck dropping directly as their feed.

5.8. Egg laying: The ducks start laying the eggs after attaining the age of 24 weeks and continue to lay eggs for two years. The ducks lay eggs only at night. It is always better to keep some straw or hay in the corners of the duck house for egg laying. The eggs are collected every morning after the ducks are let out of the duck house.

5.9. Production of fish, egg and meat: Through this type integration a production of 3500-4000 kg of fish, 17000-18000 eggs and 450-600 kg duck meat from a hector of pond area in one year without any supplementary feed and chemical fertilizers can be obtained and the cost is turned down to 60% lesser than traditional practices. The system results in a net handsome amount of income in a year per hectare. But due to some sort of difficulty in marketing of eggs and duck meat, the system is not very common and popular in our country. Developing a market channel with some effort will definitely make is enterprise lucrative.

5.10. Health care:

- Ducks are subjected to relatively few diseases when compared to poultry.
- The local variety of ducks is more resistant to diseases than other varieties.
- Proper sanitation and health care are as important for ducks as for poultry.
- The transmissible diseases of ducks are duck virus, hepatitis, duck cholera, keel disease, etc.
- Ducks should be vaccinated for diseases like duck plague. Sick birds can be isolated by listening to the sounds of the birds and by observing any reduction in the daily feed consumption, watery discharges from the eyes and nostrils, sneezing and coughing.
- The sick birds should be immediately isolated, not allowed to go to the pond and treated with medicines.

5.11. Harvesting:

- Keeping in view the demand of the fish in the local market, partial harvesting of the table size fish is done.
- After harvesting partially, the pond should be restocked with the same species and the same number of fingerlings.
- Final harvesting is done after 12 months of rearing.
- Fish yield ranging from 3500 - 4000 Kg/ha/yr and 2000 - 3000 Kg/ha/yr are generally obtained with 6 - species and 3 - species stocking respectively.
- The eggs are collected every morning. After two years, ducks can be sold out for flesh in the market. About 18,000 - 18,500 eggs and 500 - 600 Kg duck meat are obtained.

6.0 Fish-Horticulture Farming:

Integration of fruit and vegetable farming on the fishpond embankment has been tested in India, and has several advantages:

- The farmer gets additional income from growing fruits and vegetables on the pond embankment that normally lies fallow.
- The nutrient-rich pond mud is used as fertilizer for growing crops, eliminating the cost of organic manures.
- Manured pond water is used for irrigation of plants.
- Fruit and vegetable residues are used as feed for the fish.
- The plants on the embankment strengthen the dikes.

6.1 Horticulture: The dikes are strengthened, terraced, prepared and fertilized by application of pond silt. Bananas, papayas, pumpkins, gourds, spinach, brinjals, tomatoes, cucumbers and leafy vegetables are grown on the dikes. Inorganic fertilizer is also applied to the plants in addition to pond silt at 10 kg/year divided into installments. Water the crops with manure pond water. Planting of papaya is done in June/July and banana in October/November and harvesting starts after 6 and 8 months following planting, respectively. The farmer consumes a portion of the harvested fruits and the rest are sold in the market. The vegetable crops are grown and harvested twice in a year--once during August/September and another in March/April. After meeting the requirements of the farm family, the vegetables are sold.

6.2. Pond preparation: Manure the pond with the compost (made out of aquatic weeds). Apply 500 kg basally; the rest (500 kg) may be applied in two equal installments at 4 months interval but more frequent doses (e.g. fortnightly) are better. Stock the pond with fingerlings 7 days after poisoning as the toxicity of bleaching powder lasts for about 1 week.

6.3. Harvesting: The fish that attain marketable size should be harvested and the rest allowed growing further. Final harvesting may be done 10-12 months after stocking.

7.0 Integrated Fish-Pig Farming:

7.1 Fish-pig farming material flow:

The raising of pigs can fruit-fully be combined with fish culture by constructing animal housing units on the pond embankment or over the pond in such a way that the wastes are directly drained into the pond. The system has obvious advantages:

- The pig dung acts as excellent pond fertilizer and raises the biological productivity of the pond and consequently increases fish production.
- Some of the fishes feed directly on the pig excrete which contains 70 percent digestible food for the fish.
- No supplementary feed is required for the fish culture, which normally accounts for 60 percent of the total input cost in conventional fish culture.
- The pond dikes provide space for erection of animal housing units.
- Pond water is used for cleaning the pigsties and for bathing the pigs.
- The system cannot be adopted in all parts of India due to religious consideration but it has special significance in certain areas as it can improve the socioeconomic status of weaker rural communities, especially the tribals who traditionally raise pigs and can take up fish-pig farming easily.
- Pigs are brought to the pond before stocking the fish, so no basal application of manure is required.

7.2. Selection of Pigs:

- Four types of pigs are available in our country - wild pigs, domesticated pigs or indigenous pigs, exotic pigs and upgraded stock of exotic pigs.
- The Indian varieties are small sized with a slow growth rate and produce small litters. Its meat is of inferior quality.
- Two exotic upgraded stock of pigs such as large - White Yorkshire, Middle - White Yorkshire, Berkshire, Hampshire and Hand Race are most suitable for raising with fish culture. These are well known for their quick growth and prolific breeding.
- They attain slaughter maturity size of 60 - 70 Kg within six months. They give 6 - 12 piglets in every litter.
- The age at first maturity ranges from 6 - 8 months. Thus, two crops of exotic and upgraded pigs of six months each are raised along with one crop of fish which are cultured for one year.
- 30 - 40 pigs are raised per hectare of water area. About two months old weaned piglets are brought to the pig-sties and fattened for 6 months when they attain slaughter maturity are harvested.

7.3. Feeding:

- The dietary requirements are similar to the ruminants.
- The pigs are not allowed to go out of the pig house where they are fed on balanced pig mash of 1.4 Kg / pig / day.
- Grasses and green cattle fodder are also provided as food to pigs.
- To minimize food spoilage and to facilitate proper feeding without scrambling and fighting, it is better to provide feeding troughs. Similar separate troughs are also provided for drinking water.
- The composition of pig mash is a mixture of 30 Kg rice bran, 15 Kg polished rice, 27 Kg wheat bran, 10 Kg broken rice, 10 Kg groundnut cake, 4 Kg fish meal, 3 Kg mineral mixture and 1 Kg common salt.
-

7.4. Use of Pig Waste as Manure:

- Pig - sty washings including pig dung, urine and spilled feed are channelled into the pond.
- Pig dung is applied to the pond every morning. Each pig voids between 500-600 Kg dung / year, which is equivalent to 250-300 Kg / pig / 6 months.
- The excreta voided by 30 – 40 pigs is adequate to fertilize one hectare pond.
- When the first lot of pigs is disposed off after 6 months, the quantity of excreta going to the pond decreases. This does not affect the fish growth as the organic load in the pond is sufficient to tide over for next 2 months when new piglets grow to give more excreta.
- If the pig dung is not sufficient, pig dung can be collected from other sources and applied to the pond. Pig dung consists 69 - 71 % moisture, 1.3 - 2 % nitrogen and 0.36 - 0.39 phosphate.
- The quality and quantity of excreta depends upon the feed provided and the age of the pigs.
- The application of pig dung is deferred on the days when algal blooms appear.

7.5. Stocking:

- Stock the pond with fingerlings 7 days after poisoning with bleaching powder. The recommended rate of stocking is:
- Alterations can be made on stocking density and species ratio, depending on the local conditions.
- Grass carp should be fed regularly with aquatic or terrestrial vegetation. Liming of the pond is done at regular intervals. It helps in stabilization of organic matter. About 25 kg lime shall be required for one year.

7.6. Harvesting: Due to abundance of natural food in the fish-pig pond, the fish attains marketable size within a few months. Partial harvesting, therefore, should be done three times, depending upon the growth of fish. Final harvesting may be done after 10-12 months.

Short Answer Questions:

1. Scope of paddy cum fish culture
2. Types of trenchs in paddy cum fish culture.
3. Fish and horticulture farming.
4. Fish cum duck culture.
5. Fish pig farming material flow.
6. Health care of ducks.
7. Benefits of fish cum duck farming.
8. Housing of birds (chicken)
9. Use of pig waste as manure.

Long Answer Questions:

1. Describe paddy cum fish culture with daigram.
2. Types of paddy field in aqua culture.

UNIT 4

SEWAGE FED FISH CULTURE, CAGE CULTURE, PEN CULTURE

Structure:

I. Sewage Fed Fish Culture

1.0. Introduction: Fish production in ponds fertilized with waste water is a common practice in some parts of Asia. Sewage fed fish culture is now well established since it is perceived to be more attractive than intensive farming. The concept of using aquaculture as a tool for waste water treatment has been evaluated through a systematic research programme carried out over a 5 year period by the CIFA, Bhubaneshwar. In collaboration with the Public Health Engineering Department, Govt. of Orissa, the Indian Aquaculture Sewage Treatment Plant was designed comprising of duckweed and fish culture. Three species of Indian major carps and three species of exotic carps were stocked in treated water. Production levels of 3-4 metric tons/ha/yr were realized. In spite of the development of the Aquaculture Sewage Treatment plant, West Bengal, the only state in India where sewage fed fish culture is practiced, uses raw sewage for fish culture. Fish is grown in Bheries using raw sewage from Kolkata city in about 10,000 ha area.

2.0 Sewage and its characteristics: The term sewage is used loosely to include the combined liquid waste discharges of domestic and Industrial sources within a given area. It is a cloudy liquid having minerals and organic matter in solution, colloidal form and solids floating as suspension. It contains about 90-99% water. It also contains bacteria and protozoa. It is rich in phosphorus (1-14 mg/l) and nitrogen (18-120%). It contains traces of heavy metals such as zinc, copper, chromium, Manganese, nickel and lead. The BOD and COD of the sewage are very high. The direct use of raw sewage is detrimental to fish because of its high BOD, low DO, High CO_2, high levels of ammonia, hydrogen sulphide and bacterial and organic load.

3.0. Problems related to sewage fed culture system

- Accumulation of silt and high organic matter at the pond bottom.
- Incidence of parasites and fish diseases.
- Possibilities of pathogens being transferred to humans.
- Accumulation of heavy metals in the system.

4.0 Solutions

- Regulation of treated sewage intake into ponds.
- Dilution with freshwater and use of prophylactics.
- Depuration of fish in freshwater before marketing.

5.0 Treatment of sewage: Sewage in raw form can't be used directly for fish culture. It needs prior treatment, which is carried out in the following ways-

(a) Mechanical (b) Chemical (c) Biological

(a) Mechanical or Physical Treatment: Mechanical treatment includes screening, filtration skimming and sedimentation. This step is required to remove suspended and floating solids from the raw sewage. The solids are removed first by using screens and then by skimming. Finally they are removed by sedimentation.

(b) **Chemical treatment:** Chemical treatment of raw sewage involves steps such as coagulation/chemical precipitation, deodorization, disinfection and sterilization. Chemical treatment is meant to make sewage chemically fit for culture of fish. This can be achieved by adding certain chemicals in the sewage to neutralize its harmful effects. De-odorisation of sewage can be achieved by adding chlorine and ferric chloride. Sterlization can be done by using chlorine and copper sulphate and coagulation (precipitaion) by adding coagulates like ferric chloride, lime, alum and organic polymers.

(c) **Biological treatment:** Biological treatment includes oxidation of organic substances present in the sewage into carbon dioxide, water, nitrogen, sulphates and other inorganic substances by using bacteria. Bacteria decompose the substances either aerobically or anaerobically.

6.0. Stocking: All the species of Indian major carps e.g. *Labeo rohita* (Rohu), *Catla catla, Cirrhinus mrigala* (Mrigal) and Exotic carps e.g. *Hypophthalamichthys molitrix* (Silver carp), *Ctenopharyngodon idella* (Grass carp), *Cyprinus carpio* (Common carps) are preferred to be stocked but the percentage of Mrigal is kept greater and that of exotic carps is lesser. The popularity of *Tilapia* and fresh water prawn, *Macrobrachium rosenbergii* is increasing these days. *Pangasius hypophthalmus*is also stocked by some farmers to get rid of molluscs.

Sewage-fed ponds are used for raising seeds of Carps and Tilapia and also culturing them to table size The stocking density in such pond varies from

70000 to 150000 per ha. The density is depended mostly on the size of the spawn or fry.

7.0. Fish Harvesting: The Bheri farmers have evolved rotational cropping system to maintain the supply to the market. Fishes are stocked and harvested throughout the culture period leading to periodical stocking and regular harvesting. Generally, drag nets are used for harvesting by encircling technique.

8.0. Health Care: The sewage-fed cultured fishes are most vulnerable to bacterial diseases, but surprisingly the occurrence of bacterial or any other disease is not common in sewage-fed fish farms. Even when EUS was prevailing in recent years in other areas, the sewage-fed ponds were uninfected. According to the farmer the diseases is vulnerable only in hygienic water. When the diseased fish released in sewage pond, the disease is automatically cured.

9.0. Feeding of Fish: Generally the feeding of fish is not practiced in extensive type of sewage-fed fish culture system. But in semi intensive type culture system, feeding is practiced with Mastered oil cake, Rice bran with 1:1 ratio. Nut oil cake, Coconut oil cake are also used. The nursery pond fishes are fed with wheat flour.

10.0. Advantages:

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

11.0. Disadvantages:

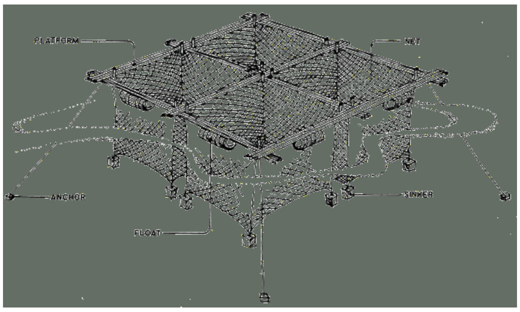
- The sewage contain high load of organic and in organic matters and toxic gases which may harm fish consumers.
- As the raw sewage is used in fish ponds, there is a chance of infection and pollution to enter into human body through food chain. But this risk can be minimized if good managerial practice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

II. Cage culture:

1.0. Introduction: Cage culture is an aquaculture production system where fish are held in floating net pens. Cage culture of fish utilizes existing water resources but encloses the fish in a cage or basket which allows water to pass freely between the fish and the pond permitting water exchange and waste removal into the surrounding water. Cages are used to culture several types of shell fish and finfish species in fresh, brackish and marine waters. Cages in freshwaters are used for food fish culture and for fry to fingerling rearing.

The first cages which were used for producing fish were developed in Southeast Asia around the end of the 19th century. Wood or bamboos were used to construct these ancient cages and the fish were fed by trash fish and food scraps. In 1950s modern cage culture began with the initiation of production of synthetic materials for cage construction. Fish production in cages became highly popular among the small or limited resource farmers who are looking for alternatives to traditional agricultural crops and it is highly adoptable to the land by poor fisherman.

2.0. Design and construction: Cage range in size from one to several hundred cubic meters and can be any shape but rectangular, square or cylindrical shapes are typical. Cage shape does not appear to affect production with most freshwater species. Cage size depends on the size of the pond, the availability of aeration, and the method of harvesting. Small cages are more easily managed than large cages and usually provide a higher economic return per unit volume.



3.0 Components of Cage:

3.1 Frame: Cage frame can be constructed from wood, iron, steel.

3.2 Flotation: Floating cages require a flotation device to stay at the surface. Flotation can be provided by metal or plastic drums, sealed PVC pipe, or Styrofoam. Floats should be placed around the cage so that it floats evenly with the lid about 30 cm out of the water.

3.3 Mesh or netting: it is made from wire mesh or nylon netting. Plastic netting is durable, semi-rigid, light weight and less expensive than wire mesh. Nylon mesh is inexpensive, moderately durable, lightweight and easy to handle. Mesh size has a significant impact on production. Mesh sizes for tilapia cages should be at least 1.5 cm, but 2.0 cm is preferred. These mesh sizes provide adequate open space for good water circulation through the cage to renew the oxygen supply and remove waste. The use of large mesh size requires a larger fingerling size to prevent escape. For example, a 1.0 cm plastic mesh will retain 9-gram tilapia fingerlings while a 2.0 cm mesh requires a fingerling weighing at least 25 grams with plastic or nylon netting. Larger mesh size facilitates the entry of wild fish into the cage.

3.4 Cage cover: Cages should be equipped with covers to prevent fish losses from jumping or bird predation. Covers are often eliminated on large nylon cages if the top edges of the cage walls are supported 30 to 60 cm above the water surface.

4.0 Site selection and placement of cages: Different criteria must be addressed before site selection for cage culture. The physio-chemical parameters like temperature, salinity, oxygen, wave action, pollution, algal blooms, water exchange, etc**.** Before attempting cage culture in an existing water body, the following criteria should be considered:

- At least 4.5 meter should separate each cage to optimize water quality.
- The surface area should be at least one half acre and preferably an acre (One acre is 4.046,9 m2) or larger.
- There should be at least 30 to 60 cm of water column below the bottom of the cage to allow waste materials to be flushed away from the cage.
- The water level should not fluctuate greatly (0.5-1.0 m).
- Locate cage in water body where the maximum natural circulation of water presents to provide natural feed and remove the waste away from the cage. In a place with good water quality where runoff is not contaminated with high levels of pesticides or large amounts of livestock wastes.
- Problems with aquatic weeds, over populations of wild fish, surface oxygen depletion problems should not be present.
- Cages may be mooved individually or linked in groups to piers, rafts, or lines of heavy rope suspended across the water surface.
- Large bodies of water tend to be better suited for cage culture than small ponds because the water quality is generally more stable and
- Small ponds (1 to 5 acre) can be used for cage culture, but emergency aeration may be required.

5.0. Production management:

5.1. Fingerling Cages may be used for fingerling production. One gram fry may be reared in 0.6cm mesh cage and stocked 3000/cubic meter. Ten gram fish may be reared in 1.2cm mesh cage and stocked 2500/cubic metre. 25-30gm fish may be stocked 1000-1500/cubic meter.

5.2. Final grow-out cages the optimum fingerling size for stocking in final grow-out cages is determined by the length of the growing season and the desired market size. The shorter the growing season, the larger the fingerlings must be at stocking. The use of male populations which grow at twice the rate of female populations will result in larger fish, greater production and a reduction in the grow-out period. Recommended stocking rate of tilapia fingerlings depends on cage volume, desired harvest size and production level, and the length of the culture period.

5.3. Aeration: Aeration can enhance water quality, reduce stress, improve feed conversion efficiency, and increase growth and production rates. Research has shown that aeration can improve cage production by 20 percent or more. Aeration is most commonly needed at night or during still, overcast days. Aeration for cages can be provided by several types of mechanical aerators.

5.4. Feeding Fresh or frozen trash fish, moist pellet (MP) and floating dry pellets are the commonly utilized feed for growing fish in cages. Feeding in cages is quite easy compared to that in ponds. The ration can be divided into equal portions and supplied at regular intervals. Feeding can be done either by broadcasting or using feeding trays. Feeds must be nutritionally complete and provide the necessary proteins, carbohydrates, fats, vitamins and minerals needed for growth and health.

5.5. Stocking in fry to fingerling rearing cages: Recommended stocking density for cages located in tanks are 225-285 fry/cm3 and for the cages in the ponds are 114 fry/cm^3. Recommended size of the fry is 2.5–3.0 cm for tilapia and carp species.

5.6. Fouling of cage net: Fouling of cage nets and other structures has been observed at many instances of cage farming. Nets get covered with biofoulers. Fouling by molluscs, especially edible oyster and sand barnacles have to be checked before its growth advancement. Algal mats and other periphyton can be removed by introduction of omnivorous grazers in cages. A fouled net will be heavier, thereby increasing drag thus resulting loss of nets and fish. To avoid/ reduce fouling, net should be changed when required, which may vary from 2 to 4 weeks depending on the intensity of fouling.

6.0. Harvest: Harvest of fish in cages is less labor intensive when compared to that in ponds. Floating cages can be towed to a convenient place and full or partial harvest can be carried out based on demand. Marketing of fishes in live conditions as a value addition can also be done.

7.0. Advantages: Following are the advantages of cage culture when compared to the other fish farming systems:

- Installation is easy, flexibility of management.
- Eeffective use of fish feeds.
- Less manpower requirement.
- Better control of fish population.
- In emergencies it can be removed from one place to another.

- Treatment of disease is much simple than that of pond culture.
- It requires less investment, because it use existing water bodies, and simple technology and swift return of investment
- Close observation and sampling of fish is simple and therefore only minimum supervision is needed.
- Many types of water resources can be used, including lakes, reservoirs, ponds and rivers.
- Since the cage is meshed, fish inside have less chances of being attacked by predators.
- They can be used to clean up eutrophicated waters through culture of caged planktivorous species such as silver carp.

8.0. Disadvantages:

- Feed must be nutritionally complete and kept fresh.
- Stocked fish simply affected by the external water quality problems eg. low oxygen levels.
- Diseases are a common problem in cage culture. The crowding in cages promotes stress and allows disease organisms spread rapidly. Also, wild fish around the cage can transmit diseases to the caged fish.
- Caged fish are unable to get the natural food of their choice, whereas it is readily available to the free fish.
- During feeding a significant amounts of fish feed passes out through the mesh, therefore, fish require feeding many times a day.
- The high fish density with the high feeding rates, often reduce dissolved oxygen and increase ammonia concentration in and around the cage, especially if there is no water movement through the cage.
- In public waters, cage culture faces many competing interests and its legal status is not well defined.
- It is difficult to over winter warm-water fish in cages. There is usually a high mortality rate because of bacterial and fungal diseases.

III. Pen Culture:

1.0. Introduction: In fish farming, there is some confusion concerning the terms cage culture and ‘pen culture’. Both terms are often used interchangeably, particularly in N. America, where ‘sea pens’ and ‘sea cages’ describe the same method of culture, or a general term ‘enclosure culture’ is used to describe what more precisely could be defined as cage or pen culture. Both cage and pen cultures are types of enclosure culture, and involve holding culturable aquatic organisms captive within an enclosed space whilst maintaining a free exchange of water. A cage is totally enclosed on all, or all but the top, sides by mesh or netting, whereas in pen culture the bottom of the enclosure is formed by the lake or sea bottom.

2.0. History: The origin of pen culture is more obscure, but it also seems to have begun in Asia. It was adopted by the People’s Republic of China in the early 1950s for rearing carps in freshwater lakes, and was introduced to Laguna de

Bay and San Pablo Lakes in Philippines by the Bureau of Fisheries and Aquatic Resources (BFAR) and Laguna Lake Development Authority (LLDA) between 1968 and 1970 in order to rear milk fish (*Chanos chanos*). Pens are still constructed at old pattern except that nylon or polyethylene mesh nets have replaced the traditional split bamboo fences. The nets are attached to ports set every few meters, and the bottom of the net is pinned to the substrate with long wooden pegs.

3.0. Location: Pens are usually built in shallow (< 10 m) waters, are 3-5 deep, and 2-7 ha in size. Although there are much larger enclosures in N. America measuring up to 50ha and in Japan up to 120ha. The areas with too much silt and decomposing organic matter should be avoided. The bottom soil should be muddy, clayey, clay-loam or sandy mud with detritus. Flow of water should be 0.2-0.5 m/sec.

4.0. Barriers in Pen Culture: There may be one or one series of barriers when the blind end of the aquatic body is to be enclosed. In the enclosures, where continuous flow of water takes place, there may be two barriers-one being upstream and another being downstream.

5.0. Species Suitable: The development and adoption of inland water pen culture has been much less dramatic than that of cage culture, and at present it is only practiced on a commercial scale in Philippines, Indonesia and China. Fishes and prawns or both can be cultured in the pens. The principal fish species cultured in these countries are milk fish (*Chanos chanos*) and carps viz., grass carp (*Ctenopharyngodon idella*); Silver carp (*Hypophthalmichthys molitrix*); bighead carp (*Aristichthys nobilis*). The production of tilapias in net pens is also being evaluated in Philippines. Generally, the fish species which are herbivores or detritovores, fast growing and tolerant to salinity changes in coastal areas are preferred the most. *Chanos chanos* (milkfish), Mugil species and *Etroplus suratensis* are highly suitable fish-species for mono or polyculture. Some carnivorous fish species, viz., *Lates calcarifer*, *Polynemus tetradactylum*, *Elops sps*. *Megalops* etc. may also be stocked in separate pens. Apart from fishes, certain species of prawns and edible clams may also be cultured in pens.

6.0. Stocking Density in Pens: The stocking density of fish or shell fish for pens may range from 10-100 individuals/m^2.

7.0. Advantages:

- More than arrange production is assured in a limited space with rich food and oxygen supply.
- It is a non-stop process because of continuous water supply.
- Maximum growth is possible in pens as energy is saved towards locomotion and feeding.
- No danger for mass mortality of fishes, since the toxic wastes like ammonia are flushed regularly.
- It generates employment opportunities for the coastal fisher-folk.

- It reduces over-exploitation of the fry.
- It requires comparatively low capital outlay.
- It requires simple technology of operation.

8.0. Disadvantages of Pen Culture:

- Nylon—webbing enclosures may be cut or damaged by some species of crabs.
- Predator fishes, if not eradicated periodically, may cause considerable damage to cultured individuals viz., fry, fishes and prawns.
- The abundance of weeds in the surroundings of pens may disturb the environment by lowering the oxygen level through release of H_2S upon death and decay.
- Unfavourable climatic conditions may damage the pen.
- Pen culture may be adversely affected with the occasional abundance of red-tide causing organisms such as dianoflagellates, especially during summer or southwest monsoon.
- Pen culture may not be suitable for all fish species.
- The major drawback of pen culture seems to be in harvesting i.e., fish stocked in the pens reveal less percentage of recovery.
- Fishes culture in pens are bounded to bear toxic industrial pollution, if happens.
- Pens are largely restricted to lentic water bodies.
- There may not be largely intensive culture in pens i.e., it is only used for extensive and semi-intensive culture.
- At present, pen culture is of much less importance and is largely restricted to a few countries in Southeast Asia.

Short Answer Questions:

1. Problems and solutions related to sewage fed culture.
2. Treatment of sewage.
3. Cage culture.
4. Components of cage culture.
5. Advantages of cage culture.
6. Advantages of pen culture.
7. Species suitable for pen culture.
8. Sewage and its characters.

Long Answer Questions:

1. Site selection and productionn management of cage culture.
2. Sewage fish culture.

UNIT 5

CRUSTACEAN FISHERIES

Unit-5

Structure

1.0. Introduction: Crustacean, any member of the subphylum Crustacea (phylum Arthropoda), a group of invertebrate animals consisting of some 52,000 species distributed worldwide. Crabs, lobsters, shrimps, and wood lice are among the best-known crustaceans, but the group also includes an enormous variety of other forms without popular names. Crustaceans are generally aquatic and differ from other arthropods in having two pairs of appendages (antennules and antennae) in front of the mouth and paired appendages near the mouth that function as jaws. Because there are many exceptions to the basic features, however, a satisfactory inclusive definition of all the Crustacea is extraordinarily hard to frame.

India has ever remained as one of the major contributors of marine crustaceans to the world production. Apart from freshwater shrimps and mud crabs, majority of the crustacean capture fishery of India is exclusively consisting of marine species. Crustaceans are landed in all the maritime states of India , but the volume of landings varies from state to state. The landings from east coast of India form only about 19% of the total crustacean landings, whereas the balance is landed on the west coast of India. In our country Maharashtra stands first in crustacean production by contributing about 29% of the total crustacean landings followed by Gujarat which contributes 23%. The major penaeid shrimp producing states of India are Maharashtra and Kerala that are contributing 28% and 27%, respectively, and Karnataka stands first in stomatopod landings(30%).

2.0. General Features:

2.1. Size range and diversity of structure: The largest crustaceans belong to the, a large order (about 10,000 species) that includes the American lobster, which can reach a weight of 20 kilograms, and the giant Japanese spider crab, which has legs that can span up to 3.7 metres. At the other end of the scale, some of the water fleas (class Branchiopoda), such as Alonella, reach lengths of less than 0.25 millimetre, and many members of the subclass Copepoda are less than one millimetre in length. The range of structure is reflected in the complex classification of the group. Some of the parasitic forms are so modified and specialized as adults that they can only be recognized as crustaceans by features of their life histories.

2.2 Distribution and abundance: Crustaceans are found mainly in water. Different species are found in freshwater, seawater, and even inland brines, which may have several times the salt concentration of seawater. Various species have occupied almost every conceivable niche within the aquatic environment. An enormous abundance of free-swimming (planktonic) species occupies the open waters of lakes and oceans. Other species live at the bottom of the sea, where they may crawl over the sediment or burrow into it. Different species are found in rocky, sandy, and muddy areas. Some species are so small that they live in the spaces between sand grains. Others tunnel in the fronds of seaweeds or into man-made wooden structures. Some members of the orders Isopodaand Amphipoda extend down to the greatest depths in the sea and have been found in oceanic trenches at depths of up to 10,000 meters. Crustaceans colonize lakes and rivers throughout the world, even high mountain lakes at altitudes of 5,000 meters. They range widely in latitude as well: in the high Arctic some crustaceans use the short summer to develop quickly through a generation, leaving dormant stages to overwinter.

2.3. Reproduction and life cycles: In many of the more advanced decapods, such as crabs and lobsters, the males are larger than the females and may have much larger pincers. Another example of sexualdimorphism is the possession by the male of clasping organs, which are used to hold the female during mating. Almost any appendage can be found modified for this purpose. Male appendages also can be modified to aid directly in transferring sperm to the female. Frequently the sperm are enclosed in a case, or spermatophore. The first and second abdominal appendages of male decapods are used to transfer spermatophores, as are the highly modified fifth legs of male copepods of the order Calanoida. These copepods can accurately place spermatophores near the openings of the female ducts. The contents of the spermatophores are extruded by a swelling of special sperm, which force out the sperm that soon fertilize the eggs.

The most widespread and typical crustacean larva to emerge from the egg is called a nauplius. The main features of a nauplius are a simple, unsegmented body, three pairs of appendages (antennules, antennae, and mandibles), and a single, simple, "naupliar" eye. Nauplius larvae are found in the life cycles of cirripedes, ostracods, branchiopods, copepods, euphausiids, the decapod peneid prawns, and members of the subclass Thecostraca. Many of the other groups pass through embryonic stages like the nauplius, or they have larvae with some similarities to the nauplius.

The nauplius of the peneid prawns is followed by a sequence of larval forms characterized by their methods of locomotion: the advanced nauplius still swims with its antennae, the protozoea also uses its antennae but has developed a small carapace and some thoracic limbs, the zoea uses its thoracic limbs for swimming, and the postlarval stages use the abdominal appendages. Most decapods omit the nauplius stage and hatch as zoeae, which may be heavily ornamented with spines. The crab zoea eventually changes into a megalops, which resembles a small crab with its tail extended behind it.

2.4. Ecology: Crustaceans play many roles in aquatic ecosystems. The planktonic forms—such as the copepod Calanus and the krill Euphausia—graze on the microscopic plants floating in the sea and in turn are eaten by fishes, seabirds, and whales. Benthic (bottom-dwelling) crustaceans are a food source for fish, and some whales feed extensively on benthic amphipods. Crabs are important predators, and the continuing struggle between them and their prey prompts the evolution of newer adaptations: the massive and often highly ornamented shells of many marine mollusks are thought to be a protective response to the predatory activities of crabs; in turn the crabs develop larger and more powerful pincers.

3.0. **Cultivable Crustaceans:**

3.1. Freshwater Prawns: Giant freshwater prawn (*Macrobrachium rosenbergii*)**,** Indian freshwater prawn (*Macrobrachium malcolmsoni*) and Ganga river prawn *(Macrobrachium choprai*) are important freshwater prawns from the aquaculture point of view. Among these, *M. rosenbergii* is the most important one and hence, brief description is given as follows:

3.2. Giant fresh water prawn

Common Name	:	Freshwater prawn
Kingdom	:	Animalia
Phylum	:	Arthropoda
Sub Phylum	:	Crustacca
Class	:	Malacostraca
Order	:	Dacapoda
Family	:	Palaemonidae
Genus	:	Macrobrachium
Species	:	rosenbergii
Scientific Name	:	*Macrobrachium rosenbergii*

Specific characters

a. **Distribution:** It is distributed in the Indo-west pacific countries, Pakistan, India and Bangladesh. In India, the most common in the river Godavari, Cauvery and their estuaries and lakhs of Chennai and Andhra Pradesh and also in Chilka Lake.

b. **Physical appearance:** Rostrum is long, slender, slightly upturned. Extend antennal scale. The dorsal margin is armed with 11-14 teeth.

c. **Habitation in pond:** Bottom of the pond

d. **Feeding behavior:** Accepts artificial feeds. Omnivorous, Cannibalism observed during moulting.

e. **Stage of Maturity:** The minimum size of maturity for & and % prawns is 153 mm and 175 mm respectively.

f. **Fecundity:** Fecundity 150,000 – 5,00,000.

g. **Growth:** Growth is in inverse exponential pattern. Made attains a length of 108 mm, 146 mm and 233 mm at the ends of 1st, 2nd and 3rd year respectively. Females attain a length of 82,5 mm, 130 mm, 168.5 mm in the corresponding year.

h. **Breeding season:** Mating prawn migrates to the estuarine region for spawning; and the breeding season coincides with the monsoon. Breeding period December to July. It can be cultured in ponds as poly monoculture. Cultured prawns can be harvested after 6 months of growth. Culture period is between 180-240 days. Survival rate about 75% upto 97%.

3.3. Marine Shrimps:

Black Tiger Shrimp (*Penaeus monodon*)
Indian White Shrimp (*Penaeus indicus*)
Green tiger shrimp (*Penaeus semisulcatus*)
Kurume shrimp (*Penaeus japonicas*)
Banana shrimp (*Penaens merguiensis*)
Jinga shrimp (*Metapenaeus affinis*)
Kadal shrimp (*Metapenaeus dobsoni*)
Yellow shrimp (*Metapenaeus bolevicoruis*)
Speckled shrimp (*Metapenaeus monoceros*)
Pacific White Leg Shrimp (*Litopenaeus vannamei*)

3.4. Black Tiger Shrimp (*Penaeus monodon*)

Common name	:	Black Tiger Prawn

Kingdom	:	Animalia
Phylum	:	Arthropoda
Sub phylum	:	Crustaceans
Class	:	Malacostraca
Order	:	Decapoda
Family	:	Penaeidae
Genus	:	*Penaeus*
Species	:	*monodon*
Scientific name	:	*Penaeus monodon*

Specific characters

- **a. Distribution**: In India, it is distributed in the east and west coasts. It forms a large scale fishery in the theries of West Bengal, Chilka Lake in Orissa and the coastal A.P.
- **b. Physical appearance**: The rostrum of this species is armed with 7-8 teeth on the dorsal side and 3 or 4 teeth on the ventral margin Rostral ridge lacks a distinct groove behind it. Telson has a groove but is without lateral spines. Carapace and abdomen have black bands. Periopods may be red.
- **c. Special features:** It is known as giant tiger shrimp because of the greatest size it grows among shrimps and the transverse markings on its abdominal segments.
- **d. Feeding behaviour**: Omnivorous with preference for animal matters like polychaetes, crustaceans, insects and small mollusks than plant matter.
- **e. Stage of maturity**: Attain maturity at 60 gms.
- **f. Fecundity:** Its fecundity ranges from 68,000 to 7,31,000.
- **g. Growth**: Its maximum growth recorded is 336 mm in length and 130 g in weight. The rate of growth varies from 18 to 55 mm/month. Under short-term culture conditions, 40-50 mm juveniles attain a size of 130-140 mm in 2 months period in well-prepared ponds. It grows to a length of about 180-250 mm.
- **h. Breeding:** It breeds in the sea close to the river mouth. After breeding Post larvae of 10-20 mm size migrate into the estuaries, lakes, backwaters and mangroves and among these the mangroves serve as the best natural nursery.

3.5. Indian White Shrimp (*Penaeus indicus*)

Common name	:	Indian white shrimp
Kingdom	:	Animalia
Phylum	:	Arthropoda
Sub phylum	:	Crustaceans
Class	:	Malacostraca
Order	:	Decapoda
Family	:	Penaeidae
Genus	:	*Penaeus*
Species	:	*indicus*
Scientific name	:	*Penaeus indicus*

Specific characters:

- **a. Distribution:** In India, it is available both in the east and west coasts. It is abundant in the coastal zones of Karnataka, Kerala, TamilNadu, Andhra Pradesh, Orissa and West Bengal. It forms a considerable fishery in the estuaries and backwaters.

b. **Physical appearance**: The rostrum of this species is slender and long with 7-8 teeth on the dorsal side and 4-6 teeth on the ventral margin. Overall creamy white. Legs may be red and the rostrum region brown. Gastro orbital ridge is well defined and hepatic ridge is absent.

c. **Special features:** Comparatively, this is the best species for culture due to its abundant seed availability. Again this is the most suited and first ranking species due to the tolerance of salinity, which will normally be high in the tropical region. Its disease resistance character is again a more desirable quality.

d. **Feeding behaviour**: Omnivorous, feeding mainly on detritus, small crustaceans, polychaets etc.

e. **Stage of maturity**: Does not attain maturity in ponds. Attains maturity when it reaches a size of about 130 mm.

f. **Fecundity**: Its fecundity ranges from 68,000 to 7,31,000.

g. **Growth**: Maximum recorded size 230 mm. Attains marketable size of 80-120 mm in 90-100 days under culture condition. However, the normal culture period of a ‘crog’ is about 4 months.

h. **Breeding**: Migrates into the inshore waters for breeding. Unlike other prawn species, the juveniles of P.indicus can be collected throughout the year. Controlled breeding has also been successfully carried out.

3.6. Pacific White Leg Shrimp (*Litopenaeus Vannamei*)

Common name	:	Pacific White leg shrimp
Kingdom	:	Animalia
Phylum	:	Arthropoda
Sub phylum	:	Crustaceans
Class	:	Malacostraca
Order	:	Decapoda
Family	:	Penaeidae
Genus	:	*Litopenaeus*
Species	:	*vannamei*
Scientific name	:	*Litopenaeus vannamei*

Specific characters:

a. **Distribution:** Ecuador, Mexico, Panama, Columbia.

b. **Physical appearance:** Rostrum curves down slightly and has 8-9 dorsal teeth and 1-3 ventral teeth. Overall white, with white legs.

c. **Special features:** Instead of crawling, it swims in the water.

d. **Feeding behavior:** Natural feeds available in the pond.

e. **Stage of maturity:** Six nauplii, three protozoeal and three mysis stage.

f. **Fecundity**: 1 lakhs – 2.5 lakhs

g. **Growth:** Maximum size 23 cm, with maximum carapace length of 9cm.

h. **Breeding:** Breed throughout year Breed in deep sea. Breeding is effected by temperature and salinity. Open thelycum is present.

Short Answer Questions:

1. Fresh water prawns (scampy).
2. Black tiger shrimp (monodon).
3. White prawn (Indicus).
4. White leg prawn (vennamei).

Long Answer Questions:

1. Cultivable crustaceans and its characters.

UNIT 6

MOLLUSCAN FISHERIES

Unit-6

Structure

1.0 Introduction:

In the past five decades, global fisheries and aquaculture have grown steadily, and seafood consumption per capita has increased from an average of 9.9 kg in the 1960s to 19.2 kg in 2012 (FAO 2012). This development is impressive, and probably driven by multiple factors, such as population growth, rising income and urbanization (Delgado *et al.* 2003; Diana 2009). Molluscan shellfish has traditionally been a major component of world aquaculture. For example, the molluscan shellfish production in 2012 (15.2 million metric tons; 1 metric ton equals to 1000 kilograms or 2204 pounds, here in after the same below) accounted for about 22.8% of the total (inland and marine) aquaculture production and 60.3% of the world marine aquaculture production (FAO 2014).

1.1 Molluscan Shellfish Habitats and Aquaculture:

Most cultured molluscan species are bivalves; only a few gastropods, such as abalones are cultured. Feeding and reproductive modes may account for the relative ease of culturing bivalves over gastropods. Bivalve molluscs are typically filter feeders of phytoplankton and are primarily free spawning with external fertilization. Due to the very large and diversified taxonomic class of gastropods, their reproduction, feeding, and habitat types vary greatly. Gastropod molluscs may be herbivores, carnivores, parasites, or omnivores, and exhibit complex mating behaviors (courtship) with either internal or external fertilization.

In general, bivalves for aquaculture typically have one of three habitat lifestyles:

1) endobenthic burrowing (bivalves that live within the sediments),

2) epibenthic cemented (bivalves that live on the surface of sediments), or

3) epibenthic free-living (non-attached) or attached with byssal thread (a keratin and protein filament secreted from the muscular foot).

Most clams have an endobenthic burrowing lifestyle. The muscular, hatchet-shaped foot and round or elongated shell shape of most species of clam’s aid them in burrowing. Depending on the species, the preferred benthic substrate may be sand, mud, or a mixture, and burrowing depth may be from centimeters to meters. Successful aquaculture of these species requires suitable substrates for growout in open water environments.

Oysters exhibit an epibenthic cemented lifestyle. When ready to metamorphose, free-swimming oyster larvae seek a suitable hard substrate, such as calcareous shell, and cement themselves down with a glue-like protein; they will remain attached for life and lose their foot after metamorphosis. Oysters can close tightly, providing protection from predators, desiccation, and other harsh environmental conditions.

Scallops and mussels have an epibenthic free or byssal attached lifestyle. They are capable of abandoning their byssal threads temporarily and swimming to avoid predators or to move to a more suitable location. Scallops usually have two light - weight and curved symmetric valves, shell ears (the extended part of shell near the hinge) with a byssus orifice, and a ventrally flattened shape to enable them to create a directed water flow and ensure a firm contact with the substrate.

2. EDIBLE OYSTER FARMING

2.1 Introduction:

The oysters are highly esteemed sea food and considered a delicacy in USA, Europe, Japan etc. In India there is a growing demand for oyster meat in some parts of the country. It is said that 'oyster' is scientifically the best known marine animal. It is one of the most widely cultivated species. As early as the first century BC the Romans were the first to develop simple methods of collecting oyster seeds and growing them for food. The Japanese developed farming methods that yielded good results. The awareness about the vast potentialities for development of oyster farming in tropics is recent. Serious efforts are now being directed in its development under tropical conditions. Main areas/ locations having rich oyster beds / suitable areas for farming in Kerala are: Ashtamudi and Vembanad lakes, Cochin backwaters, Munambam estuary & nearby areas of Sathar Island, Estuaries and the creeks of Dharmadam, Valapatnam, Nileswaram and Chandragiri.

2.2 Scope for oyster farming in India:

In India pioneering attempts were made by James Hornell in 1910 in developing Oyster Culture in erstwhile Madras state. Central Marine Fisheries Research Institute undertook scientific investigations at Tuticorin from early 70's and as a result, complete package of the technology is now available in the country. Vast stretches of backwaters, estuaries and bays spread over several lakh ha. are present along Indian coast harbouring natural population of the oyster suggesting suitability of the habitat for oyster culture. Being filter feeders, the oyster converts primary production in the water into nutritious sea food.

The four species has high commercial value. *C.madrasensis* is more widely distributed, is euryhaline and inhabits backwaters, creeks, bays and lagoons and occurs in the coastal areas of the States of Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka and Andamans. *C.gryphoides* is also euryhaline and occurs along north Karnataka, Goa and Maharashtra coast. *C.rivularis* is found along Gujarat and Maharashtra coast while *Saccostrea cucullata* is found all along the main land coast and Andamans and

Lakshadweep islands. Culture of these species is possible at places where the seed is easily available.

EDIBLE OYSTER

2.3 Oysters & their Biology:

The shape of the oyster is extremely variable depending on the environment in which it is grown. Smooth and elongated when grown individually on soft substrata. Corrugated and circular shell with lower valve deep when grown individually on hard substratum. Irregular shape when grown with other oysters. Circular/ elongated with reduced cupped nature when grown fixed to a firm substratum.

2.4 Reproduction:

In the genus *Crassostrea* sexes are separate but occasionally hermaphrodites occur. During spawning, ripe eggs and sperms are discharged into the exterior where fertilization takes place. Temperature food availability and salinity are considered as important exogenous factors, in influencing the maturation of gonads. A single female measuring 80-90 mm spawns 10 to 15 million eggs at a time.

2.5 Farming methods:

Farming methods are normally grouped as bottom culture and off bottom culture. Raft, rack, long-life and stake are used in various off-bottom culture practices. The off bottom culture methods are advantageous over the bottom culture in the following respects:

(i) The growth and meat yield is relatively better.

(ii) It facilitates three dimensional utilization of the culture area.

(iii) Biological functions like filtration, feeding etc. become independent of tidal flow.

(iv) Silting and predatory problems are minimum.

The bottom culture method is yet to be experimented in India. Various off bottom culture methods are as follows:

a. Rack and string method:

It is also called ren method. The racks are constructed at 1 to 1.25 m. depth. Rack is a fixed structure, comprising several wooden poles vertically driven into the substratum over which a wooden frame is made at a height of 0.5 m, above the water level. The shell rings are suspended from racks. A rack covering 80 sq.m. area holds

90 strings and 125 racks in a ha. At the end of 12 months, each string may weigh 7 to 7.5 kg. and the production of oyster is estimated at 80 t / ha. The mortality is about 45 per cent.

b. Rack and tray method:

The nursery reared single spat (cultch-free) measuring about 25 mm. are transferred to trays of size 40 x 40 x 10 cm. at a density of 150 to 200 oysterlings/ tray. The tray is knitted with 2 mm. synthetic twine of appropriate mesh and is suspended from rack. Once the oyster reaches 50 mm. length they are segregated and transferred to rectangular tray of size 90 x 60 x 15 cm. and these trays are placed on the rack which occupies 25 sq.m. area and holds 150-200 oysters. The average growth rate of oyster is 7 mm/ month and at the end of 12 months, the oyster attains an average length of 85 mm. The production estimated is 120 t/ ha/ year which compared to string method is higher, but the production cost is high.

c. Stake culture:

In this culture, a stake is driven into the substratum and one nail on the top end and two nails on the sides are fixed, which hold a shell with spat attached. The stakes are placed 60 cm. apart. In this method, the nursery rearing of spat is carried on the same stake. Initially for 2 months, the spat is covered with velon screen till a size of 25-30 mm. is attained and in another 10 months they reach marketable size. The production is estimated to be 20/ t/ ha/ year.

d. Raft culture:

Raft is the most suitable farm structure in sheltered bays where the depth is 5 m. and above. It is made of wooden poles placed parallelly and tied across with coir rope to make a rigid frame. Four empty airtight barrels of about 200 litre capacity are tied to the underside of the raft at corners. It is moored by two anchors and a chain. The size of the raft varies and the rafts of 6 x 5 m. size are found to be quite suitable. PVC pipes instead of wooden poles and styrofoam floats in place of barrels may be used. However, this method has not been tried in India so far.

RAFT CULTURE

e. Long line culture:

In this system long ropes or cables are anchored at each end and are supported at intervals by floats. Long lines of 50-100 m. length are easy to manage. Double long lines comprising of one line on either side of the floats are also used.

LONG LINE CULTURE

2.6 Farm management and Harvesting:

Farm management practices involve periodic cleaning of the oyster, oyster rearing trays, farm structure like racks and manual removal of predators and foulers. Oysters are harvested when the condition of the meat reaches high value which in case of *C.madrasensis* is found to be good during March-April and August-September. Harvesting is done manually and oysters are transported to shore in dinghies.

2.7 Harvest of oysters:

The oysters are harvested when the condition is high. Along Kerala harvest is ideal during May in Vembanad and Chettuva estuary and during August – October in Ashtamudi Lake. Generally high condition index is obtained when the gonad is ripe prior to spawning. Harvesting is done manually.

2.8 Transport and storage:

Oysters kept under moist and cool conditions survive for several days. However it is desirable that they reach the consumer within three days of harvest. Studies indicate that oysters packed in wet gunny bags are safely transported for 25-30 hours without mortality and in good condition.

2.9 Processing & Bi-products:

Oysters are eaten in fresh condition in the half shell in many countries. The oysters are processed in several ways, such as frozen, canning and smoking. The two shell valves constitute about 85% of the total weight of oyster and contain 52-55% calcium oxide. They are used in the manufacture of calcium carbide, lime, fertilizers and cement. They are useful spat collectors in oyster culture. The shells are broken to pieces and used as poultry grit.

3. PEARL OYSTER FARMING

3.1 Introduction:

Pearl culture presents a significant potential for economic development in coastal village communities throughout the range of the more valuable species. The industry requires minimal capital input, yet has wide ranging benefits to farmers, coastal communities and national economies. Pearls are the ideal export commodity; they are nonperishable, shipping costs are negligible, and lucrative markets are already established. The biology of pearl oysters is poorly understood, considering the importance of pearl culture and shell fisheries. Research and development priorities.

3.2 History of Pearls and Pearl Culture:

The major producers of cultured pearls have traditionally been Japan and Australia. Indonesia, India, Sri Lanka, Malaysia, Thailand, Mexico, Sudan, the Philippines, French Polynesia, Burma, the Cook Islands, Korea, Taiwan and China also have industries based on the culture of pearl oysters. Pearls and pearl shell have long been highly prized. The shell has been used for a wide range of decorative and practical purposes Chinese were producing pearl images of Buddha by the 12^{th} century.

3.3 Species Descriptions:

***a. Pinctada maxima*:**

P. maxima is distinguished externally by its light fawn color and by having no trace of radial markings. However, in some specimens the umbonal region is colored green, dark brown or purple. The nacre has a clear, rich luster which at the distal border can have a golden or silver band of varying width. This gives the species its common name of goldlip or silverlip. It is the largest species of the genus, a pair of valves attaining a weight of up to 6.3 kg.

***b. Pinctada margaritifera*:**

P. margaritifera is distinguished by black coloration to the outer surface of the shell and non nacreous border. The external shell often shows lighter striations. The shell valves are moderately convex. Maximum sizes of 30 cm "diameter" and 9 kg shell weight have been recorded, with individuals living for up to 30 years.

c. Pinctada fucata:

P. fucata exhibits a variety of color morphs ranging from the commoner reds and browns to greens, bronzes and creams. Three varieties of external patterns are seen.

3.4 Pearl oyster farming

Farming of pearl oyster is essentially for meeting two demands ie., 1) to grow the wild collected/hatchery produced spats to implantable sized oyster, 2) to grow the nucleated oysters for pearl production.

3.5 Oyster sources:

The basic stock for the farming operations is either collected from the natural beds or from the hatchery. There are about 65 pearl beds have been identified in the Gulf of Mannar area off Tuticorin at a distance of 12-20 km at depths ranging from 15-20 m.

3.6 Farming Systems

In India, the farming practices of pearl oyster is very much limited to the two Gulf zones ie., Gulf of Kutch in Gujarat and Gulf of Mannar in Tamil Nadu. The method of farming varies to the prevailing farm site conditions. Accordingly the following methods are developed and practiced.

1. Rack culture system

Rack culture system is very much suitable for areas of shallow depths ranging from 2-5 m. In such shallow areas either casuarinas or teak poles of 4-5" thickness are driven vertically on the sea bottom. These vertical poles are interconnected with similar poles horizontally and lashed with coir ropes. The horizontal poles are so arranged in a way that they are just above the highest high tide level. Driving GI pipes of 4" dia on the periphery of the rack can provide reinforcement to the racks. Generally the racks are rectangular in shape. A working plat farm at few places of the rack can also be provided by 6-8" wooden planks. A rack of 30 sqm can hold about 100 cages. Similarly there are two other types, Raft culture system and Longline culture system.

2. Raft culture system:

Rafts are generally almost square in shape. Such constructed rafts are floated with the help of 4 buoys and moored by 2 anchors of 30-40kg weight. Appropriate anchor chains are provided after considering the depth of the area. Empty oil drums coated with fiberglass, mild steel barrels and FRP/Styrofoam floatation buoys are few alternates to serve as floats for a raft.

3. Long line culture system

Long line culture system is practiced in the open sea where the depth is more. This is more suitable to withstand the high wind and wave action. Long line is primarily constructed with a long synthetic rope (15-20mm) with two main floats on both the ends. Depending on the length of the long line smaller floats is also attached to the mainline at 5m interval. Vertical lines are arranged in 1- 2 m apart from the horizontal main line.

4. On shore culture system

This system is of recent origin. Seeds of pearl oysters are reared in cement tanks of size ranging from 250-500 sqm. A water level of 1 m is maintained. Oysters are held above the bottom, through a grid system constructed using PVC pipes. A stocking density of 125nos/sqm is maintained. Raw seawater is pumped into the settlement tank and then to the rearing tanks. Stocked oysters are supplemented with mixed culture of *Chaetoceros sp*. Cell concentration in the rearing medium is maintained at 75,000 cells/l in the tank. Daily 25% water exchange is required. By this method an average growth of 50 mm in 6-7 months from a stocking size of 5.0 mm is achieved.

4. MUSSEL CULTURE

4.1 Introduction:

The green mussel (*Perna viridis*) is also referred as the green lipped mussel or the Asian green mussel. The shell of *P.viridis* tapers to a sharp, down turned beak and has a periostracum that is dark green to dark brownish green. The ventral margin of the shell is straight or weakly concave. The beak has interlocking teeth, one in the right valve and two in the left. The wavy posterior end of the pallial line and the large kidney-shaped adductor muscle are diagnostic features of this species. The native range of the green mussel is along the Indian coast and throughout the Indo- Pacific. It occurs naturally and is widely distributed along the intertidal coasts of India.

4.2 Growth:

Green mussel shows a rapid growth rate by length of 8mm-13.5mm per month. Under average culture conditions, green mussel and brown mussel attain a length of 80-88mm with 36.5-40g weight and 65mm with 25-40g in 5 months respectively. The farmed mussels give a better meat yield compared to mussels from the natural bed. The average edible portion of the meat yield is 27.2%- 33.3% of the total weight. Growth by length and weight are probably the most important criteria for assessing the success of the culture system. The growth of mussel is influenced by a number of environmental factors such as water quality, food availability, settling density, water current and tidal exposure.

4.3 Reproduction:

Mussels are known to be unisexual. The gonad of mature female can easily be distinguished by its bright orange-red color form that of the male, which is creamy yellow. Mussels attain sexual maturity in two months (15-28mm). Spawning period is prolonged extending from January–September with peak spawning during June–September in Kerala. The four main stages in the reproductive cycle are spent/ resting, developing, ripe and spawning. Fertilization is external. Seven to eight hours after fertilization, the zygote is completely transformed into mobile, trochophore larvae. After 16 to 19 hours the veliger larval stage is reached with the larval shell covering the internal body parts and developing a strong ciliated velum. The straight hinge D shaped larvae metamorphoses to pediveliger with a pedal organ, the functional foot and descends to the bottom. Pediveliger attaches to the settlers with the help of byssus threads and metamorphose to spat. Spat settlement takes place from July to September and attains seeding size in September.

4.4 Mussel culture Techniques

Many culture techniques are used for growing mussels worldwide. Some of these are on-bottom culture, longline culture, raft culture. In India fixed suspended culture is practiced.

I. **Fixed suspended culture**

This is the simplest of the rope method used for green mussel cultivation in India and Philippines. The main purpose of the pole is to support the structure. In between these poles, ropes are suspended either vertically or kept horizontally where the depth is a limitation.

4.5. Farming Techniques

A. Site selection: Open sea and estuarine areas free from strong wave action are suitable for farming. Clear seawater with rich plankton production (17-40µg chlorophyll/l,) is ideal for mussel culture. Moderate water current (0.17-0.25m/s at flood tide and 0.25- 0.35m/s at ebb tide) will bring the required planktonic food and will carry away the excessive build-up of pseudofaeces and silt in the culture area. The water should have a salinity of 27-35 ppt. and temperature of 26°C - 32°C. Site should be free from domestic, industrial and sewage pollution.

B. Availability of seed:

The seeds required for culture is presently collected from traditional fishing areas and these are often causing conflicts between farmers and mussel fishermen. Hence it is essential that additional spat collectors have to be established along the coast to ensure supply of seeds to the farmers.

C. Seed collection and seeding on rope:

Seeds collected from the submerged (sub tidal) areas will be healthier. After removing other organisms and weeds, the seeds were washed thoroughly in sea water. About 500- 750g of seed is required for seeding on one meter length of rope. The ideal size of the seed is 15-25mm 1ith 1-2g weight. The length of the rope is decided by considering the depth where the raft/rack is positioned. While suspending the seeded rope on rack it must be tied in such a way that the upper seeded portion of the rope should not get exposed during the low tide. Nylon rope of 12-14mm or 15-20mm coir rope can be used for seeding.

D. Grow-out phase:

The seed get attached to ropes and show faster growth in the suspended column water. The ropes also should be suspended in such a way that it will not touch the bottom as well as the seeded portion is not exposed for longer period during low tide. Seeded mussel on the upper portion of the rope shows faster growth due to the abundance of phytoplankton. For better growth the seeded ropes should be spaced at a distance of 25 cm.

In open sea – farming, growth of mussel is very rapid. They attain 80-110 mm in 5-6 months with an average growth of 13.5mm/month and an average weight of 35-45g. This growth is observed in farms at various locations.

In estuarine - farming, mussels attain 75-90mm in 5 months with an average weight of 35-40g and an average production of 10 -12 kg/m rope.

4.6 Harvesting:

Harvest will be done when the mussels reach marketable size and condition index is high, i.e., before the spawning and onset of monsoon. Normally harvest season is from April to June. Mussel rope is collected manually and brought to the shore for harvest and washed thoroughly using jet wash to remove grit and silt. The mussels separated from the ropes are maintained in re- circulating seawater for 24 hrs and washed again in fresh seawater. This method is called as depuration.

4.7 Storage facility:

If sufficient cold storage facility is provided, cultured mussels can be depurated, shucked and stored not only for export market but also for local market throughout the year. This will increase the profitability of the culture operation.

4.8 Post harvest technology:

Value added products of longer shelf life need to be developed from mussel meat to increase the revenue realization from cultured mussels. Mussel fry, mussel pickle etc. are some of the best examples for value added products. More studies are needed to develop ethnic cuisines with longer shelf life.

Short Answer Questions:

1. Edible oysters species.
2. Oysters seed collection.
3. Asian green mussel.
4. Mussel harvesting.
5. Mussel reproduction.

Long Answer Questions:

1. Mussel culture farming techniques.
2. Oyster farming methods.

UNIT 7

AIR BREATHING ORNAMENTAL FISH CULTURE

Structure

1.0 Introduction: Though culture of fishes in ponds is one of the age old professions of the world, it is gaining prominence, because of the realization that this source can supply rich and proteinaceous food for human consumption. Majority of the species selected from nature for rearing in ponds belong to the family of carps (Cyprinidae). Of late another group of fishes, collectively known as air-breathing fishes or live fishes is attracting the attention of fish culturists in the Far-East. Some of these hardy fishes have well developed accessory respiratory organs for breathing atmospheric air. This added advantage enables them to live even in foul waters deficient in dissolved oxygen which is one of the limiting factors for most of the fishes. As such, these fishes are quite suitable to be cultured in derelict and swampy waters, where carps cannot thrive well. The common live fishes are the murrels (*Channa spp*.), the catfishes (*Clarias batrachus* and *Heteropneustes fossilis*). the climbing perch (*Anabas testidineus*) and the giant gourami (*Osphronemus gourami*). These are widely distributed in many South East Asian countries, Including India, Culture of clarias spp. is practiced on a large scale in countries like Thailand, Philippines, and Indonesia, where very high average production is reported from ponds. Such large scale culture of live fish is not done in any part of India. But these fishes are marketed mostly in live condition and in some places they are reported to fetch higher prices than the popular Indian major carps. In view of these favourable factors, the need for culture of air-breathing fishes has long been felt in the country. In This view, the Indian Council of Agricultural Research initiated in 1971 an all India coordinated research project on the breeding and culture of live fishes.

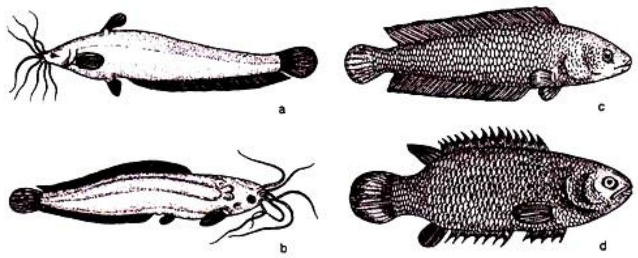


Fig. 28.1a-d : Air Breathing fishes. (a) *Clarias batrachus*, (b) *Heteropneustes fossilis*, (c) *Channa*, (d) *Anabas testudineus*.

2.0 CULTIVABLE LIVE FISHES

I. Murrels (Channa spp.): There are several species of murrels of which *Channa marulius*, *C. striatus* and *C. punctatus* are more important as food fishes. *C. marulius* grows to a maximum length of 1,200 mm. whereas *C. striatus* and *C. punctatus* reach 900 mm. and 300 mm respectively. These are freshwater river and swamp dwelling fishes, which are also suitable for culture in confined waters. They can also thrive well in wells. Murrels breed in ponds almost throughout the year, with the peak period extending from April through June. Their nest building habit with vegetation for laying eggs is well known. Fertilized eggs float on the water surface. Parental care is exhibited till the larvae attain early fingerling stage. The fry and fingerlings can be identified by their brilliant orange colour band. By virtue of having accessory respiratory organs, they can live in foul waters and can even thrive for months with very little water. Young fish are known to feed on small crustaceans and vegetable debris. Adults are highly carnivorous and piscivorous. They are also cannibalistic. Murrels are reared as part of crop in swampy rice fields in Cambodia, Malaya and Thailand. They are reared in wells, ponds and reservoirs in Pakistan and Burma. In India, they are reared in wells , and are encountered freely in ponds and reservoirs, even though no serious attempts seems to have been made to culture them,

II. CLIMBING PERCH (*Anabas testudineus*): The climbing perch is widely distributed throughout the South East Asian countries including India. It grows to a maximum length of about 230 mm and is considered to be a highly esteemed food of people in the region. It is reported that this fish breeds throughout the year and attains maturity when it is only six months old. It breeds in confined waters and is quite suitable for culture in ponds, rice fields and reservoir s. Its peak spawning season in India is from May to October. Eggs are small yellow or whitish in colour. Because of the presence of oil globule they float in water. The incubation period is about 24 hours. The climbing perch has been successfully bred by hormone treatment at the C.I.F.R.I., Barrackpore. Fifteen sets of Anabas could be bred, yielding about 46,500 hatchlings, Because of their cannibalistic nature, it is said that only 500 fingerlings survived and attained an average length of 65.5 mm and an average weight of 5.54 g in nurseries during 7 months of rearing. Depending on the length (100-164 mm) and weight (24-77 g) of the fish, the fecundity was found to vary from 10,710 to 36,477 ova. The presence of labyrinthiform organ helps the fish to retain water for breathing and to remain for long periods out of water. The climbing perch though predatory it is not piscivorous, Fry and fingerlings feed on phytoplankton and zooplankton, Advance fry and adults feed primarily on molluscs, crustaceans, insect larvae, soft plant material and dead fish.

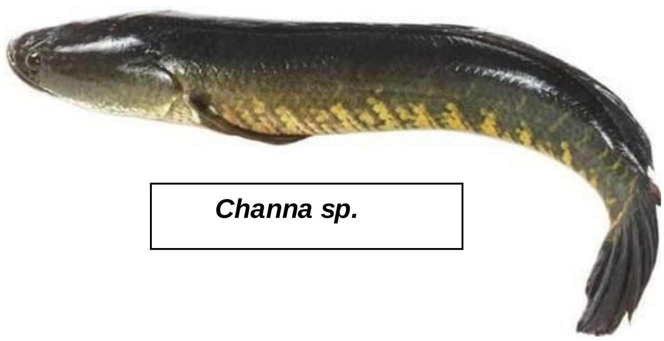
III. SINGHI (*Heteropneustes fossilis*): This is a common catfish found in freshwater swamps, ponds and tanks throughout the country. It is also suitable for pond culture. The presence of accessory respiratory organ enables it to breathe atmospheric oxygen. It reportedly attains a length of 200 mm at the end of the first year and a maximum length of about 450mm, Though this species is not a very highly priced fish like murrels and the climbing perch, it is known for its nutritive, vitalizing and medicinal qualities. The pectoral spines are very sharp and can inflict painful wounds when they are handled with less care. This fish breeds in ponds and combined waters almost throughout the year, peak season being monsoon. During rainy days, fishes move from wells to shallow inundated areas of paddy fields for breeding. The eggs are greenish in colour and are usually attached to weeds. This fish has been successfully induced to breed in India by administering in one injection 75- 100IU of human chorionic gonadotrophin. It is also possible to induce this fish to breed 8 to 10 weeks ahead of peak spawning season by administering pituitary gland injections. By hypophysation these fishes can be induced to breed several times in the same season. Even the spawning season could be prolonged by 2- 3 months when the fishes are kept exposed to light during this period for about 12 hours every day. The incubation period extends from 18- 20 hours and the newly hatched larvae measure about 2·-7 mm in length. At this stage, the larvae feed voraciously on zooplankton. Therefore, it is suggested that before stocking the larvae, the nursery ponds have to be prepared to have abundant zooplankton to get better survival of hatchlings.

IV. MAGUR (*Clarias batrachus*): This is another catfish which has several similarities with singhi and is more widely distributed in India, Sri Lanka, Pakistan, Burma, Thailand, Vietnam, Indonesia and Philippines. It has also been introduced to United States, where it is commonly known as 'walking catfish'. The accessory respiratory organs present in this fish not only help the fish to breathe atmospheric c air but may also probably be serving a hydrostatic function. Magur matures when they are one year old. Though it breeds almost throughout the year, it has a short, wall defined breeding season restricted to the monsoon. The observations made at the College of Fisheries, Mangalore on the fish collected locally from paddy fields and wells have revealed that magur breeds during the months June-July in this region. In addition to natural breeding, this fish has been successfully induced bred both through hypophysation and stripping.

3.0 CULTURE OF MURRELS

3.1 Species profile

Murrel belongs to Channidae family. They are widely distributed in tropical Africa (three species) and Southern Asia predominantly in India, Pakistan, Afghanistan, Nepal, Sri Lanka, Thailand and China. A total of 33 species are globally identified, of this 30 belong to *Channa* genera, and remaining 3 belong to *Para channa* genera. Only 13 species are stated in India. Murrel is also called as snakehead as it looks like a snake. Murrel is valued and fetches a higher market price especially in states like Andhra Pradesh, Karnataka, Tamil Nadu, West Bengal, Assam, Uttar Pradesh and Haryana due to its eminent nutrition and medicinal value. Hardy nature and ability withstand longer time out of water add greater value to Murrels in the market. Specialized trade involving live fishes is also practiced in India. Murrel is one of the indigenous air breathing fish; there is a suprabranchial accessory respiratory organ in the murrel head. Murrels can even survive in lower dissolved oxygen levels. The most important aquaculture species of murrel in India is the striped murrel (*Channa striata*), the great snakehead murrel (*Channa marulius*) and the spotted snakehead (*Channa punctata*). The culture technology is standardized only for striped murrel.



Channa sp.

3.2 Broodstock

The brood fish are reared in earthen and cement cistern. Smaller size pond (0.04 to 0.1 ha) is favoured rather than larger size pond due to its easy management. The suggested pond depth is 1.0 – 1.5 m. Pond dyke should be made strong enough to prevent fish escape during the rainy season. The earthen pond is prepared similar to that of ponds used for culture of the Indian major carp. The manure (5000 kg/ha/ yr) and the liming (300 kg/ha/yr.) are applied to produce the natural fish food organisms. A total of 2000 to 2500 kg/ha is stocked and are fed with low market value fish and rice bran at the rate of 2 – 3 percent of body weight. Typically, two year old striped murrels are used for breeding. A 100g female is expected to deliver an average 6000 eggs. The small fish is easy to handle rather than larger size fish. Inbreeding depression occurs due to the use of same blood brood fish and it can be avoided through introduction of brood fishes from outside source (including rivers, stream, other farmers) every year. To adapt to the captive condition, the new brood fish can also be reared in brood tank.

The size of pond and the stocking density depends on the size of fish and targeted growth of fish. The supplementary feed is essential at daily two rations at the rate of 3 – 4 percent of body weight when the stocking density is higher. Adding aquatic weeds in about 20% of water area stimulate the natural environment. Regular examination of maturity, proper care to brooders, implant hormone pellets and post-operative care etc need to be taken care of. Total replacement of water has to be done at least once in a week at regular interval to maintain the water quality. The sexes are distinguished by using secondary sexual characteristics during the spawning season. The female fish develops a bulging soft abdomen due to the development of ovary and the genital pore becomes reddish and oval shape. The head of the male is round shape and has the smaller genital papilla.

3.3 Breeding

In striped murrel, the spontaneous and induced breeding are practiced.

3.3.1 Natural breeding

Fish seed in natural spawning is produced by providing a natural environment through the use of aquatic weeds. The brood fish's size of 100 – 250g are stocked in a shallow water depth small size pond. The synchronized movement of brood fishes occurs after the month of March. They build a nest with the use of aquatic weed and lay eggs in the shallow water area of the pond. The eggs are collected from the pond and are reared in the hatchery. This breeding method has a poor breeding response ie. about 20 – 30 percent.

3.3.2 Induced breeding

The breeding occurs twice in a year (southwest and northeast monsoon), exclusively in the rainy season. A poor breeding response is observed when HGC is used when compared to the extract of carp pituitary. The desired dose of carp pituitary extract is 20 – 30mg/kg and 30 – 40mg/kg of body weight for male and female fish respectively. The injection is given by intramuscular method (at the base of pectoral fin).

Fishes have unusual spawning characters and chasing occurs. The spawning usually takes 16 – 18 hrs. A 1 kg female fish releases about 10000 – 15000 eggs. The eggs are free floating, spherical, non-adhesive and bright yellow colour. The fertilized eggs are transparent and unfertilized eggs are opaque.

3.4 Fry production

After hatchling at 0 hrs the digestive tract appears as a straight tube lying to the yolk sac, but with no accessory digestive organs (liver, pancreas and gall bladder). The yolk sac absorption is very fast after 1 – 2 days of hatching and the digestive tract is developed. After three days, fry starts to consume the feed such as zooplankton (protozoans, rotifers, and cladocerans). This is continued until they grow to the size of 20 – 30 mm. The expected survival rate is about 50 – 60 percent at 20 – 25 days.

3.5 Fingerlings production

The fingerlings consume the zooplankton and small crustaceans (especially insect). The live feed such as tubifex and earthworm are good food for hatchery rearing fingerling. Striped murrel are stocked with higher density, owing to the presence of additional air breathing organ. A reduction in fish growth is observed when it is more than the optimum stocking density.

The fishes are fed by combination of both low market value fish and rice bran with a ratio of 3:1 to 8:1. Fishes are fed at 6 – 8 percent of the body of the fish. If cannibalism still continues, it is advised to increase the feeding quantity to ensure higher survival. The protein requirement of fingerlings of striped murrel is about 40 – 45 percent. The anticipated survival is 30 – 40 percent.

3.6 Grow out production

The pond size of 0.1 – 0.2 ha is ideal for grow-out of striped murrel, with a water depth of 1 to 1.5 m. The dyke should be steep to prevent the fish escape from the ponds. Fishes reach the surface water due to lack of sufficient oxygen, which increase the energy loss resulting in mediocre growth. Aquatic weeds are good for striped murrel, which provides the shadow in sunny season, provide the protection against poachers and encourage the insects growth. Fish is likely to consume the aquatic insects. For grow out, the recommended stocking size is more than 10 g. Covering the ponds by the net prevents the entry of birds and thieves. The stocking density of striped murrel is about 10000/ha, at the feeding rate of 5 percent of the body. The stocking density of fish directly alter the growth of the fish, thereby stocking density is decided based on the stocking size of fish and targeted fish growth. The expected growth is 600 – 800 g in a year, fish production ranges between 2.0 – 2.5 tons/ha/yr.

4.0 CULTURE OF *CLARIAS BATRACHUS* (MAGUR)

4.1 Introduction:.

The most important aquaculture species of Catfish is the Asian catfish, *Clarias batrachus.* It belongs to Claridae family. Another important species is the *Clarias microcephalus* which is highly preferred due to its appearance and flesh quality. However, because of unavailability of seeds and poor growth performance, it has attracted least attention. Clarias species are normally found in freshwater and brackish water with lower dissolved oxygen. They have the ability to grow even in poor environmental condition. They are reared up to market size in earthen ponds, whereas, in Eastern India, it is grown in partially improved swamps. *Clarias batrachus* normally called as magur in India has greater value and high demand in India due to its therapeutic value.

Clarias batrachus

4.2 Brood stock maintenance

- A healthy brood stock is essential especially in captive condition to produce a healthy fry and attain a greater survival rate.
- The *C. batrachus* attains maturity in the first year. The brood fishes are reared in an earthen pond with a stocking density of 2 – 3/m^2.
- The brood fishes are fed with a mix of groundnut oil cake and rice bran at about 3 – 5 percent of body weight of fish.
- For better breeding performances, fishes are fed with the mixture of groundnut oilcake, soybean meal, rice bran, vitamin and mineral mixtures at 32 percent of protein concertation during gonadal development.
- 20 – 30 percent of water is exchanged to maintain good quality water in the culture system.
- The sexes can be identified through secondary sexual characteristics. The female has the round and bulging abdomen with pinkish button shaped anal papilla. The male has a pointed anal papilla.
- Magur normally breeds during June to August. The brood fishes above 100g is preferable, but 100–150g is recommended for better breeding performance.
- A female brood fish of 150g size can be expected to spawn 5000 – 6000

4.3 Artificial propagation

- The spawning can successfully be done by artificial propagation method.
- The synthetic hormone such as the ovaprim, ovatide, WOVA-FH and carp pituitary extract are used to induce the female magur. Except carp pituitary extract, other synthetic hormones are used at about 1.0 – 1.5 ml/kg. The carp pituitary gland extract is used at the rate of 30 – 40 mg/kg body weight of fish.
- Usually, no injection is given for male brooder because they do not ooze the sperm albeit. However, the synthetic hormone at 0.5ml/kg of fish is injected to male brood fish to obtain better milt quality.
- The female is stripped after 17 hrs of injection to get the ovulated eggs.
- The male fishes do not respond, and males are sacrificed to collect the testis. Hence the sperm solution (macerated testis + saline solution (0.9 percent of sodium chloride)) is prepared by using male creamy white testis to get the sperm suspension.
- The eggs are collected in a plastic tray and fertilized with sperm suspension by using feather. A little amount of water is added to activate the eggs.
- After mixing for 2 – 3 minutes, eggs are washed in running water, and it is transferred into incubation plastic container.
- Flow through hatchery system is adopted for fry production of magur. The plastic container is kept under the tap and has an outlet provision at the height of 4 – 5 cm.
- Generally, 1000 – 1500 fertilized eggs are uniformly accommodated in each plastic container, and feeble water flow is provided to maintain the optimum oxygen level.
- For hatching, it takes about 24 – 27 hrs, at 27 – 30^{O}C. A newly hatched larvae measures 4 – 6 mm length and 2 – 3 mg weight.

4.4 Fry rearing

4.4.1 Tank preparation: A small cement cistern size of 10 – 20m^2 is recommended for better management. The bottom of the tank is to be filled with about 2 – 3 cm soil and the water level is to be 0.25 to 0.30 m. The fertilizer (100g single super phosphate and 2 kg cow dung) are provided for nourishment of plankton growth. The tanks have to be prepared about a week before stocking of fry.

4.4.2 Feeding: A newly hatched larva consumes the yolk sac up to 3 dph (days of post-hatchling). After yolk sac absorption, the larvae are fed with mixed zooplankton such as the copepods, daphnia, artemia, tubifex, custard egg, etc. After 8 days the larvae are fed with starter M (a product of CIFA) to obtain better survival and growth.

4.4.3 Stocking density and others: The recommended stocking density is about 1000 – 1500/m^2. Regular cleaning of uneaten feed and debris, adequate supply of aeration, and water management have to be taken care. It is advised to replenish 50 – 60 percent of water twice daily. Aerial respiration commences after 10 – 11 days. Larvae growth measures about 10 – 20 mm length, 30 – 40 mg weight during 15 – 20 days of rearing.

4.5 Fingerling rearing: The better growth and survival are obtained with fry stocking size of 1 g (40 – 45 days) with a density of 50 – 100 m^2 in fingerling production. Feeding has to be adjusted according to the weight of the fish couple of times in a month. The fry is fed twice a day at 6 – 8 percent of body weight with 30 – 32 percent of protein. Shooting behaviour is normally found at this stage. To avoid this, the larger sized fishes have to be segregated at regular interval to get the enhanced survival rate. It reaches about 4 – 5 g during 60 – 70 days.

4.6 Grow out culture

Grow out culture is carried out in earthen or stone pitched ponds. Since magur may migrate out during rainy season, fencing is provided around the ponds. They are stocked @ 50,000 – 70,000 finger lings/ha. The ponds are fertilized in a similar manner as carp ponds.

The fish are fed mixtures of groundnut oil cake, rice bran, fish meal/trash fish. They are fed @ 3-5% biomass in the form of dough placed in baskets or in pellet form at different places in the pond. The feed should contain 30-35% protein. Magur attains marketable size of 100-120g in 7-8 months. Harvesting by netting is difficult, hence ponds needs to be drained and fish handpicked. Average production of magur from this system is 3-4 tones/ha/7-8 months.

5.0 Culture of *Heteropneustes fossilis* (Singhi)

5.1 Introduction

Heteropneustis fossilis commonly known as singhi. It also known as stinging catfish. It has a good potential as aquaculture candidates. This is an air breathing fish which can thrive well in shallow derelict water bodies with poor water quality. This is a common catfish found in freshwater swamps, ponds and tanks throughout the country. It is also suitable for pond culture. The presence of accessory respiratory organ enables it to breathe atmospheric oxygen. It reportedly attains a length of 200 mm at the end of the first year.

Heteropneustes fossilis

5.1 Larval rearing

The larvae are very delicate and require good water quality at this stage. The optimum DO is 5-6 ppm; pH 6.5-7.5 and water temperature 26-28OC. Initially the larvae are fed mixed zooplankton, Artemia nauplii and tubifex worms. Regular cleaning of debris, uneaten food and dead or weak larvae is necessary. They grow to 12-15 mm during 14-15days rearing period. After attaining fry stage they are stocked in well prepared small, cement tanks. The water depth should be shallow to allow fry to come up for breathing. The fry are stocked @ 300-500/m^2. Finely minced trash fish, molluscan meat with rice bran in equal proportion is fed to the fry. In about a month they reach fingerling size.

5.2 Grow-out culture

Singhi can be grown in monoculture or poly culture with carps and magur. It is stocked in well prepared ponds and fed with compounded diets or slaughter house waste/trash fish, silkworm pupae. Its production potential has been estimated to be 4-15 tons/ha in 4-12 months culture under AICRP.

5.3 Other species of catfish: Other species of catfish such as *Pangasius sp., Wallago attu, Ompak sp., Mystus sp., Rita rita and Bagarius bagarius* grow to large size and have good market demand. It is necessary to have greater thrust on research to develop technologies for culture of these catfish.

6.0 Culture Of Air Breathing Fishes With Carps

- With a stocking density of 5000 / ha of Indian and Chinese carps and 1,000 magur fingerlings produce 2,518 Kg / ha / yr of carps and 3,711 Kg / ha / yr of magur.
- This indicates that the polyculture is more profitable and it is useful to include magur in the carp culture system.
- The magur is found suitable for composite fish culture of carps in place of common carp.
- Magur, koi and singhi are also suitable to culture along with a highly priced carp.

Short Answer Questions:

1. Cultivable live fishes.
2. Murrels
3. Climbing perch.
4. Singhi
5. Magur

Long Answer Questions:

1. Culture of murrels.
2. Murrel brood stock and induced breeding.

UNIT 8

MODERN AQUACULTURE

Structure

MODERN AQUACULTURE SYSTEMS

1.0 Introduction:

Aquaculture is one of the most emerging sectors growing high protien food production, providing an ultimate livelihood option to a millions of peoples of India. The current aquaculture production is not able to meet the growing demand for fish due to intensification of human population. Aquaculture must have to move towards intensification to meet the rising demand, to contribute more effectively to the reduction of poverty and malnutrition, and to become ecologically more sustainable. New technologies will make it possible for sustainable aquaculture to become the new global standard. In order to improve the socioeconomic condition of the farmers, this expansion of aquaculture production needs to take place in a sustainable way through the applications of new farming interventions viz. integrated farming, Aquaponics, Recirculatory aquaculture system (RAS), Neo-female Technology, Biofloc technology (BFT), Compensatory growth Technology etc.

2.0 RECIRCULATORY AQUACULTURE SYSTEMS

2.1 INTRODUCTION:

Recirculation aquaculture is essentially a technology for farming fish or other aquatic organisms by reusing the water in the production. The technology is based on the use of mechanical and biological filters, and the method can be used for any species grown in aquaculture such as fish, shrimps, clams, etc. Recirculation is growing rapidly in many areas of the fish farming sector.

Recirculation can be carried out at different intensities depending on how much water is recirculated or re-used. The limited amount of water used in recirculation is of course beneficial as water has become a limited resource in many regions. Also, the limited use of water makes it much easier and cheaper to remove the nutrients excreted from the fish as the volume of discharged water is much lower than that discharged from a traditional fish farm.

Recirculation aquaculture can therefore be considered a most environmentally friendly way of producing fish at a commercially viable level. The nutrients from the farmed fish can be used as fertilizer on agricultural farming land or as a basis for biogas production. The term “zero-discharge” is sometimes used in connection to fish farming.

Most interesting is the fact that the limited use of water gives a huge benefit to the production inside the fish farm. In a recirculated system these external factors are eliminated either completely or partly, depending on the degree of recirculation and the construction of the plant. Recirculation enables the fish farmer to completely control all the parameters in the production, and the skills of the farmer to operate the recirculation system itself becomes just as important as his ability to take care of the fish. Controlling parameters such as water temperature, oxygen levels, or daylight for that matter, gives stable and optimal conditions for the fish, which again gives less stress and better growth.

2.2 SOME ADVANTAGES OF RAS FARMING

- This method can achieve the optimal growing environment. This creates a stable and predictable production basis 365 days a year. Little to no outside influences or pathogens can affect the fish.
- RAS addresses the growing demand for greener, cleaner, safer, transparent and more sustainable methods of growing fish.
- Low water requirement as the large majority of the water is cleaned then recirculated.
- Significant reduction in disease due to the ability of the operator to control all aspects of the fish raising.
- The fish are free from any Hormones, Antibiotics or Chemicals.
- High production of quality fish in a relatively small area with a limited supply of water and land.
- The flexibility to locate production facilities near large markets including “inland” locations and “food deserts.”

2.3 THE RAS DESIGN:

The functional parts of a RAS include a:

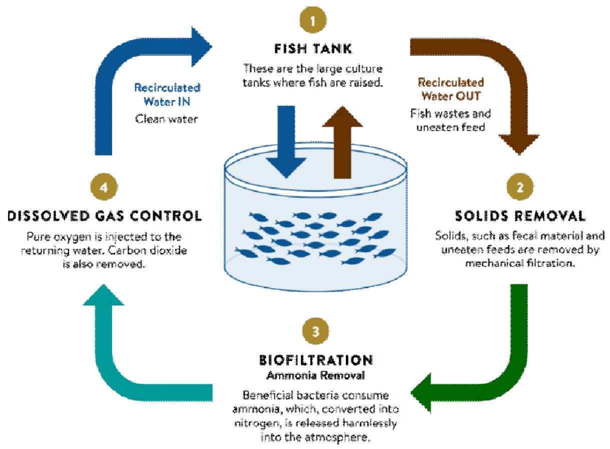
(1) Growing tank.

(2) Sump of particulate removal device.

(3) Bio-filter.

(4) Oxygen injection with U-tube aeration and

(5) Water circulation pump.



1. Fish Culture Tanks:

Fish can be grown in tanks of nearly every shape and size. Fish tanks typically are rectangular, circular, or oval in shape. Circular or oval tanks with central drains are somewhat easier to clean and circulate water through than rectangular ones. Rectangular tanks are usually built with or set upon inclined floors to facilitate cleaning and circulation. Rearing tanks range in size from 500 to 500,000 gallons capacity. The size of the tank depends on a variety of factors including: stocking rates, species selection, water supply, water quality, and economic considerations. The tank must be designed to correspond with the capacity of other components of the system, particularly size of the biofilter and sump so that all parts of the system are synchronized. Tanks can be constructed of plastic, concrete, metal, wood, glass, rubber and plastic sheeting.

2. Sump of particulate removal device

Solids removal (taking particulates, organic debris, uneaten food, and faeces out of the system) is also known as mechanical filtration. It can be accomplished in many ways.Common devices used for solids removal include bead filters, rapid sand filters, drum filters, canisters, sponges, foam pads, and even under gravel filters.

3. Biofiltration:

The biological filter (biofilter) is the heart of the RAS. As the name implies, it is a living filter composed of a media (corrugated plastic sheets or beads or sand grains) upon which a film of bacteria grows. The bacteria provide the waste treatment by removing pollutants. The two primary water pollutants that need to be removed are (1) fish waste (toxic ammonia compounds) excreted into the water and (2) uneaten fish feed particles. The biofilter is the site where beneficial bacteria remove (detoxify) fish excretory products, primarily ammonia. Ammonia and Nitrate Toxicity: Ammonia and nitrite are toxic to fish. Ammonia in water occurs in two forms: ionized ammonium (NH_4^+) and unionized (free) ammonia (NH_3). The latter, NH_3, is highly toxic to fish in small concentrations and should be kept at levels below 0.05 mg/l

.

Biofilter Design and Materials:

A bio-filter, in its simplest form, is a wheel, barrel, or box that is filled with a media that provides a large surface area on which nitrifying bacteria can grow. The bio-filter container can be constructed of a variety of materials, including plastic, wood, glass, metal, concrete, or any other nontoxic substance. In small-scale systems, some growers have used plastic garbage cans or septic tanks. The size of the bio-filter directly determines the carrying capacity of fish in the system. Larger bio-filters have a great ammonia assimilation capacity and can support greater fish production. A bio-filter must provide sufficient surface area for the colonization (attachment) of nitrifying bacteria. The ideal biofilter media has (1) high surface area for dense bacterial growth, (2) sufficient pore spaces for water movement, (3) clog resistance, (4) easy cleaning and maintenance characteristics. We use and recommend plastic because it's lightweight, flexible, and easy to clean, but it can be expensive.

(1) Submerged bed filters:

Submerged bed filters can have fixed (immobile) media in which the water flow can be upward, downward or horizontally through the media. The fluidized bed reactor (FBR) is a commonly used submerged bed filter. The FBR consists of fine particles (sand, dense plastic, glass beads, minerals, etc.) in a container through which upwelling water flows thereby "fluidizing" or suspending the media in the water column.

(**2) Emerged bed filters:** Emerged bed filters are of two basic types:

(a) Trickling filter (TF)

The trickling filter is designed to have water slowly cascade down through the media column, which is suspended above the water. Water enters the column (which is filled with bio-filter media) from an overhead spray pipe and trickles down through the bio-filter media where nitrification occurs. The waterfall action of this filter adds oxygen to (aerate) the water.

(b) Rotating Biological Contactors (RBC).

The rotating biological contractor (RBC) has a water-wheel configuration consisting of plastic media attached to a central axle which spins slowly, moving the media through the water in the RBC containment vessel. Advantages of the RBC are that it is self-aerating and self-cleaning. Once established it tends to be very stable and can operate for years without failure.

I. **Recirculation Rates (turnover times):**

The recirculation rate (turnover time) is the amount of water exchanged per unit of time. This can easily be determined by dividing the volume of water in the tank by the capacity of the pump (in gallons per minute).

Oxygen Management: Successful fish production depends on good oxygen management. The addition of oxygen in a pure form or as atmospheric air (aeration) is essential to

i. The survival (respiration) of fish held in high densities,
ii. The survival of aerobic, nitrifying bacteria on the bio-filter and,
iii. The decomposition (oxidation) of organic waste products.

Supplying sufficient oxygen to sustain healthy fish and bacterial populations and to meet the biochemical oxygen demand (BOD) for fish waste and unconsumed food is critical. Maintain oxygen levels, near saturation or even at slightly super-saturation at all times. Low oxygen levels will reduce growth, feed conversion rates, and overall fish production.

2.4 Fish Species Selection:

RAS can be used to rear nearly any species of fish, freshwater or marine or other aquatic animal. Hybrid striped bass, channel catfish, and tilapia are the most common freshwater species grown in these intensive culture systems. Red drum (redfish) and soft shell blue crabs are the main saltwater species being reared RAS. Two species dominate the U.S. aquaculture industry today: channel catfish and rainbow trout.

2.5 Feeds and Feeding:

A complete feed, containing all the essential minerals and vitamins for healthy fish growth, and formulated specifically for the fish species being reared, is necessary for fish production in RAS. We recommend feeding a commercial feed of dry, floating pellets so that the feeding activity and health of the fish can be easily observed at the water surface. The size of the pellet should correspond with the size of the fish.

2.6 Warm Temperature:

Water temperature strongly influences feeding and growth rates of cultured fish. The water temperature preferences of most cultured fish are well known and can be maintained year-round in RAS.

2.7 Species and Harvest Flexibility:

RAS are currently being used to grow catfish, striped bass, tilapia, crawfish, blue crabs, oysters, mussels, and aquarium pets. Indoor fish culture systems offer considerable flexibility to (1) grow a wide diversity of fish species, (2) rear a number of different species simultaneously in the same tank (poly culture) or different tanks (monoculture), (3) raise a variety of different sizes of one or several species to another depending on market demand and price. RAS afford growers the opportunity to manipulate production to meet demand throughout the year and to harvest at the most profitable times during the year.

3.0 BIOFLOC TECHNOLOGY

3.1 INTRODUCTION:

Biofloc technology (BFT) is as an environmentally friendly aquaculture technique based on in situ microorganism production. Fish and shrimp are grown in an intensive way (minimum of 300 g of biomass per square meter) with zero or minimum water exchange.

BFT is considered the new “blue revolution” since nutrients can be continuously recycled and reused in the culture medium, benefited by the minimum or zero-water exchange. Also, the sustainable approach of such system is based on the high production of fish/shrimp in small areas. In addition, the bioflocs is a rich protein-lipid natural source of food available in situ 24 hours per day due to a complex interaction between organic matter, physical substrate, and large range of microorganisms. This natural productivity plays an important role recycling nutrients and maintaining the water quality. The consumption of biofloc by shrimp or fish has demonstrated innumerous benefits such as improvement of growth rate, decrease of FCR, and associated costs in feed.

Regarding the applications, in the past years, BFT has been used in grow-out phase for tilapia and marine shrimp, nursery phase, fresh water prawn culture, brood stock formation and maturation in fish and shrimp, and as aqua feed ingredient also called as “biofloc meal”. In addition, recently BFT also has been applied in carp culture, catfish culture and cachama culture.

3.2 BIOFLOC SYSTEM –THE NEED

Biofloc system was developed to improve the environmental control over the aquatic animal production. In aquaculture, the strong influential factors are the feed cost (accounting to 60% of the total production cost) and most limiting factor is the water/land availability. High stocking density and rearing of aquatic animals requires wastewater treatment. Biofloc system is a wastewater treatment which has gained vital importance as an approach in aquaculture. The principle of this technique is the generation of nitrogen cycle by maintaining higher C: N ratio through stimulating heterotrophic microbial growth, which assimilates the nitrogenous waste that can be exploited by the cultured spices as a feed. The biofloc technology is not only effective in treating the waste but also grants nutrition to the aquatic animal. The higher C: N is maintained through the addition of carbohydrate source (molasses) and the water quality is improved through the production of high quality single cell microbial protein. In such condition, dense microorganisms develop and function both as bioreactor controlling water quality and protein food source.

3.3 Benefits of Biofloc culture system

- Eco-friendly culture system.
- It reduces environmental impact.
- Improves land and water use efficiency.
- Limited or zero water exchange.
- Higher productivity (It enhances survival rate, growth performance, feed conversion in the culture systems of fish).
- Higher biosecurity.
- Reduces water pollution and the risk of introduction and spread of pathogens.
- Cost-effective feed production.
- It reduces utilization of protein rich feed and cost of standard feed.
- It reduces the pressure on capture fisheries ie., use of cheaper food fish and trash fish for fish feed formulation.

3.4 Disadvantages of Biofloc Technology:

- Increased energy requirement for mixing and aeration
- Reduced response time because water respiration rates are elevated
- Start-up period required
- Alkalinity supplementation required
- Increased pollution potential from nitrate accumulation
- Inconsistent and seasonal performance for sunlight-exposed systems.

Short Answer Questions:

1. Bio filteration.
2. Recirculation system advantages.
3. Submerged bed fitters.
4. Trickling filter (TF).
5. Disadvantages biofloc technology.

Long Answer Questions:

1. Recirculatory aquaculture system and advantages.
2. Biofloc technology need and benefits.

UNIT 9

SEAWEED CULTURE

Structure

1.0 Introduction:

'Seaweed' is a general term used to describe plants and algae that grow in waterways such as the ocean, rivers, lakes and streams.

Seaweed isn't used to describe a certain species - it's a common name for a variety of types of plants and plant-like creatures, from tiny phytoplankton to enormous giant kelp. Some seaweeds are true, flowering plants (an example of these are seagrasses). Some aren't plants at all, but are algae,

Seaweed is the common name for marine algae—a group of species from the Protista kingdom, meaning they are not plants at all, even though they may look like underwater plants, growing to more than 150 feet in length. Algae are not plants, although they do use chlorophyll for photosynthesis, and they do have plant-like cell walls. However, seaweeds have no root system or internal vascular systems; nor do they have seeds or flowers.

Marine algae are divided into three groups:

- Brown Algae (Phaeophyta)
- Green Algae (Chlorophyta)
- Red Algae (Rhodophyta)

Note: There is a fourth type of algae, the tuft-forming blue green algae (*Cyanobacteria*) that is sometimes considered to be seaweed.

BROWN ALGAE RED ALGAE GREEN ALGAE SEA GRASS

2.0 Algae vs. Plants

Algae are classified into three groups: red, brown and green algae. While some algae have root like structures called holdfasts, algae do not have true roots or leaves. Like plants, they do photosynthesis, but unlike plants, they are single-celled. These single cells may exist individually or in colonies. Initially, algae were classified in the plant kingdom. Classification of algae is still under debate. Algae are often classified as protists, eukaryotic organisms that have cells with a nucleus, but other algae are classified in different kingdoms. An example is blue-green algae, which are classified as bacteria in the Kingdom Monera. Phytoplankton is tiny algae that float in the water column. These organisms lie at the foundation of the ocean food web. Not only do they produce oxygen through photosynthesis, but they provide food for countless species of other marine life. Diatoms, which are yellow - green algae, are an example of phytoplankton. These provide a food source for zooplankton, bivalves (e.g., clams) and other species. Plants are multi-cellular organisms in the kingdom Plantae. Plants have cells that are differentiated into roots, trunks/stems and leaves. They are vascular organisms that are capable of moving fluids throughout the plant. Examples of marine plants include seagrasses (sometimes referred to as seaweeds) and mangroves

2.1 Sea grasses: Like those shown here are flowering plants, called angiosperms. They live in marine or brackish environments worldwide. Seagrasses are also commonly called seaweeds. The word sea grass is a general term for about 50 species of true sea grass plants. Sea grasses need lots of light, so they are found at relatively shallow depths. Here they provide food for animals such as the dugong, shown here, along with shelter for animals such as fish and invertebrates.

3.0 Where the seaweeds found?

Seaweeds are found where there is enough light for them to grow - this is in the euphotic zone, which is within the first 656 feet (200 meters) of water. Phytoplankton floats in many areas, including the open ocean. Some seaweed, like kelp, anchor to rocks or other structures using a holdfast, which is a root-like, structure that ".

3.1 Seaweed and Conservation: Seaweeds can even help polar bears. During the process of photosynthesis, algae and plants take up carbon dioxide. This absorption means that less carbon dioxide gets released into the atmosphere, which lessens the potential impacts of global warming (although sadly, the ocean may have reached its capacity to absorb carbon dioxide).

Seaweeds play a crucial role in maintaining the health of an ecosystem. An example of this was shown in the Pacific Ocean, where sea otters control the populations of sea urchins. The otters live in kelp forests. If sea otter populations decline, urchins flourish and the urchins eat the kelp. The loss of kelp not only impacts the availability of food and shelter for a variety of organisms, but impacts our climate. Kelp absorbs carbon dioxide from the atmosphere during photosynthesis. A 2012 study found that the presence of sea otters allowed kelp to remove much more carbon from the atmosphere than scientists originally thought.

4.0 Seaweeds and Red Tides: Seaweeds can also have adverse impacts on humans and wildlife. Sometimes, environmental conditions create harmful algal blooms (also known as red tides), which can cause illness in people and wildlife.

5.0 Environmental benefits from seaweed: Sea weeds provide nursery habitats for fisheries and reduce coastal erosion. Kelp forests increase biodiversity by creating a rich habitat for a diverse range of marine life. For example, they play a vital role in the marine food web for animals feeding on kelp detritus and prey species that live among the kelp. Kelp also benefits the environment by acting as a carbon sink.

Seaweeds are a potential source of biofuel and exhibit the following advantages over terrestrial plants currently being used for bio-fuel production:

a. Seaweeds use inorganic nutrients and carbon dioxide to rapidly synthesize biomass. Many species can do so more efficiently than land-based crops, so generating larger equivalent yields and biomass than the latter.
b. Because they are already supported by seawater and have holdfasts to anchor themselves in place, seaweeds do not need to waste energy developing complicated support structures, leaving them with more energy to invest in growth.
c. Seaweeds do not compete with food crops for land, freshwater or other resources.
d. Seaweeds create cleaner seas by absorbing inorganic wastes from seawater such as ammonia and nitrates.
e. Once deployed at sea, seaweeds need relatively low maintenance and require little manual labour compared with many terrestrial crops. Nor do they require artificial fertilizers or pesticides.

6.0 Seaweed farming: Seaweed farming at sea is becoming an increasingly competitive biomass production candidate for food and related uses. With exponential growth over recent decades, farmed seaweed output reached 24 million tons by 2012.

The growth of the seaweed aquaculture industry is good for the economy and good for the ocean. The process of growing seaweed is environmentally friendly. Apart from planting the seeds and ensuring the seaweed is in a clean environment, seaweed often does not need feed or additional attention. The plants can grow naturally. Seaweed farms also create safe and healthy nursery grounds for young fish and crustaceans that can later be harvested commercially or improve wild population levels. Merely the presence of seaweed farms prevents deep sea bottom trawling in certain areas and protects the sea floor.

6.1 Pyropia / Porphyra (‘nori’ or ‘gim’):

Pyropia / *Porphyra* have been cultivated for the past several hundred years in Japan and have become one of the most successful aquaculture industries in Japan, Korea and China. Its current annual value is nearly $0.95 billion. Total 138 species of *Pyropia* and *Porphyr*a are currently accepted taxonomically, only 3 major species (*Py*. *yezoensis*, *Py*. *tenera*, and *Py*. *haitanensis*) have been commercially cultivated, mostly in China, Korea, and Japan (99.99% of total production). The culture methods of *Pyropia* / *Porphyra* in these three countries are basically similar,

6.2 Gracilaria / Gracilariopsis

The red algae *Gracilaria / Gracilariopsis* are two of the world’s most cultivated seaweeds with over 3.8 million tons of annual production and worth annually about US $1 .*Gracilaria/ Gracilariopsis* have been mostly cultivated in two Asian countries (China 70% and Indonesia 28% of global production).

Currently 185 *Gracilaria* and 24 *Gracilariopsis* species are accepted taxonomically. *Gracilaria/ Gracilariopsis* include warm temperate to subtropical eurythermal species. These species are easy to propagate (asexually and sexually), and have relatively high growth rates *Gracilaria/ Gracilariopsis* are also euryhaline species, which can tolerate a wide range of salinities, from about 10–40 ppt, though they grow best in ranges of 25–33 ppt. They can survive temperature ranges from 0–35°C but have an optimal range of 20–28°C .*Gracilaria / Gracilariopsis* have been cultivated mainly in four different ways, including open water rope cultivation, near shore bottom cultivation, pond culture and tank cultures .In any of these methods, providing sustainable seed stock is critical.

6.3 Kappaphycus and Eucheuma:

The red algae *Kappaphycus* and *Eucheuma*, major sources of carrageenan, account for over 80% of world’s carrageenan production .Approximately 10.75 million tons of these species were produced worth over US $1.9 billion in 2014 *Kappaphycus* and *Eucheuma*have been cultivated mostly in Indonesia (over 9.0

million tons, over 83% of global production, mostly *Eucheuma*), followed by the Philippines (nearly 1.4 million tons, 13% of global production, mostly *Kappaphycus*). Approximately 340,000 tons of these carrageenophytes were also cultivated in Malaysia, Cambodia / Vietnam, China, Tanzania / Madagascar, Belize and Brazil. Six species taxonomically accepted as *Kappaphycus* and 30 *Eucheuma* species, *Kappaphycusalvarezii* and *Eucheumadenticulatum* are most often cultivated.

6.4 Kelp (*Saccharina* and *Undaria*)

Over 8.0 million tons of kelp were cultivated and harvested in 2014 with a value of about US $1.4 billion annual values .Nearly all kelp production occurred in Asia: China 88.3%; Korea (south) 6.6%; and Korea (north) 4.4% .Kelp has been utilized mostly for human consumption, but recently, it also has been increasingly utilized as abalone feed due to low production costs. Since the early part of this decade, *Undaria* and *Saccharina* production have continuously increased due to demand for abalone feeds in Korea. Over 60% of total production of *Saccharina* and *Undaria* was used in the abalone industry in 2012.

6.5 Sargassum

Sargassum is the most common brown macroalgae found in temperate, tropical, and subtropical waters worldwide. These seaweeds are adapted to many different oceanic environments with a wide variety of forms and reproductive strategies. *Sargassum* species have traditionally been utilized for food and medicine in Asia. They continue to be wild harvested and cultivated in Japan, China, and Korea, for human consumption as sea vegetables and for use as a medicinal “seaweed herbs.” Locally known as the “black vegetable” in China, *Sargassum* is valued for its high nutritional content and nutty flavor. It is added to salads, soups or vegetable dishes *Sargassum* is utilized in Chinese medicine as an expectorant for bronchitis, and to treat laryngitis, hypertension, infections, fever, and goiter.

7.0 ECONOMIC IMPORTANCE:

7.1 Seaweed Salad: The most well-known use of algae is in food. It's obvious you're eating seaweed when you can see it wrapping your sushi roll or on your salad. But did you know that algae can be in desserts, dressings, sauces, and even baked goods? If you pick up a piece of seaweed, it may feel rubbery. The food industry uses gelatinous substances in algae as thickeners and gelling agents. Look at the label on a food item. If you see references to carrageenan, alginates, or agar, then that item contains algae. Vegetarians and vegans may be familiar with agar, which is a substitute for gelatin. It can also be used as a thickener for soups and puddings.

7.2 Beauty Products: Toothpaste, Masks, and Shampoos: In addition to its gelling properties, seaweed is known for its moisturizing, anti-aging and anti-inflammatory properties. Seaweed can be found in facial masks, lotions, anti-aging serum, shampoos, and even toothpaste. So, if you're looking for those "beachy waves" in your hair, try some seaweed shampoo**.**

7.3 Medicinal use: The agar found in red algae is used as a culture medium in microbiology research. Algae is also used in a variety of other ways, and research continues on the benefits of algae for medicine. Some claims about algae include the ability of red algae to improve our immune system, treat respiratory ailments and skin problems, and cure cold sores. Algae also contain abundant amounts of iodine. Iodine is an element required by humans because it is necessary for proper thyroid functioning.

7.4 Mari Fuels: Turning to the Sea for Fuel: Some scientists have turned to the sea for fuel. As mentioned above, there is the possibility to convert algae to biofuels. Scientists are researching ways to convert sea plants, particularly kelp, into fuel. These scientists would be harvesting wild kelp, which is a fast-growing species. Other reports indicate that about 35% of the U.S.'s need for liquid fuels could be provided each year by halophytes or saltwater-loving plants.

8.0 Future Directions

Seaweed aquaculture technologies have developed dramatically over the last several decades, but there are still challenges to overcome. New strain development by advanced breeding tools is the most urgent challenge. Superior strains will allow the growers to expand growing seasons and enhance production. Considering the global climate challenges, development of thermo-tolerant strains may be needed. Also the strains with disease resistance, fast growth, high concentration of desired molecules, the reduction of fouling organisms also need to be developed. Development of advanced cultivation technologies which are more robust and cost efficient farm systems is very important. This new system will be even more critical for highly exposed, off-shore environments since most seaweed aquaculture have occurred nearshore. With offshore aquaculture, new designs and approaches to macroalgae cultivation will be required, including strain development, harvesting, transport and processing. The offshore aquaculture system may leverage new material and engineering solutions, autonomous and robotic technologies, as well as advanced sensing and monitoring capabilities.

Short Answer Questions:

1. Sea weed conservation.
2. Environmental benefits from sea weeds.
3. Kappaphycus and Eucheuma.
4. Kelp (Saccharina & Undaria).
5. Sargassum.
6. Algae vs plants.

Long Answer Questions:

1. Economic importance of seaweeds.

FISHERIES

Paper – III

Resorvoir Fisheries

INDEX

UNIT – I 1

Introduction

Structure

1.1 Introduction to Reservoir Fisheries

1.2 Post harvest technology of fisheries

In uplands, mostly the reservoirs are man-made due to completion or on-going multipurpose river project aimed at to generate irrigation land electricity facilities. These reservoirs constitute richwater potential for the development of country's fisheries resources.

A reservoir maybe defined as " a natural or artificial place where water is collected and stored for use , especially for supplying a community, irrigating land, furnishing power etc " prehistoric man used to dam streams by putting sticks or bamboos across a stream or a channel to trap fish.

In modern times they are created by constructing masonary dams, weirs, barrages and anicuts. This structure can be defined as under.

(i) Dams : Amasonary concrete barriers built across, to obstruct the flow of streamor river, leading to formation of a vast impoundment upstream of the barricaded site. The water level is maintaining by discharge through sluice gates or bydiverting it to the site where power generation plant or hydro turbines are installed. The dams have been referred to as " Temples of modern india" by our first prime minister , Pt. Jawaharlal Nehru.

(ii) Weir: A small dam in a river or stream**;** or an obstruction placed across a stream to cause the water to pass though a particular opening or notch or over its crest.

(iii) Barrage: This word has its origin in French language and often applied to weirs provided with sluice opening.

(iv) Anicut: This word is of 'Tamil' origin and literally means 'dams building'. Structurally, it is a low barrage built primarily for irrigation purpose.

Fish seed committee of the government of India (1966) termed all water bodies of more than 200ha in area as reservoirs. Reservoirs are classified generally as a small (< 1,000ha), medium(1,000 to 5,000ha) and large (>5,000 ha) all man –made impoundments created by obstructing the surface flow by execting a dam any description on a river , stream or any water course, have been reckoned as reservoirs. However, water bodies less than 10ha in area, being too small to be considered lakes, are excluded.

India has 19,134 small reservoirs with a total water surface area of 14,85,557 h, 180 medium and 56 large reservoirs of the country have an area of 5,27,541,ha and 11,40,268 ha respectively. The country has 19,370 reservoirs covering 31,53,366 ha water surface area.

Fish fauna

Despite the cataclysmic faunistic change associated with the impoundment Indian reservoirs preserve a rich variety of fish species. The ichthyo fauna of a reservoir basically represent the faunaldiversity of the parent river system. On the basis of studies conducted so far, large reservoir on an average, harbor 60 species of fishes, of which at least 40 contributes to the commercial fisheries. The fast growing indo – Gangetic carps, popularly known as Indian major carps, occupy aprominent place among the commercially important fishes. More recently, number of exotic species have contributed substantially to commercial fisheries. Broad categorization of the species is as follows.

- **The Indian major carps :** Labeo rohita, L. calbasu, L. fimbriatus, Cirrhinus mrigala, Catlacatla.
- **The mahseers :** Tor tor, T. putitora, T. khudree, Acrossocheilus hexagonolepis
- **The minor carps including snow trout and peninsular carps :** Cirrhinus cimhosa, P.chagunio, Schizothorax plagiostomus, Thynnichthyes sandkhol, Osteobramavigorsii.

- **Large catfishes :** Aorishthys aor, A. seenghala, Wallago attu, Pangasius pangasius, Silonia silondia, S. childrenii.
- **Feather backs :** Notopterus notopterus, N. chitala,
- **Airbreathing catfishes :** Heteropneustes fossilis, Clartas batrachus,
- **Murrels :** Channa marulius , C. striatus, C. punctatus, C. gachua,
- **Weed fishes :** Ambassis nama, Esomus danrica, Aspidoparia morar, Amblypharyngodon mala, Puntius sophore, P. ticto, Oxygaster bacaua, laubuca, barilius barila, B. bola, Osteobrama cotio, Gadusia chapra.
- **Exotic fishes :** Oreachromis mossambicus, Hypophthalmichthys molitrix, cyprinus carpio specularis, C. carpio commun, Gambusia affinis, Ctenopharyngodon idella.

Most of the catfishes featherback air breathing fishes, murrels and the weed fishes enjoy a country – wide distribution while that of the major carps minor carps and mahseers (Tor putitora, T. tor, Acrossocheilus hexagonolepis) varies according to river basins. The Indian major carps , catla (C. catla) rohu (L. rohita) and mrigal(C. mrigala) constitute the important native Ichtho fauna of the rivers of the Gangetic system.

The three Indianmajor carps have beenstockedextensivelyinreservoirs throughout all the country for manydecades and in many instances they have established themselves in reservoir far awayfromtheir originalhabitat . Sathanur reservoir in Tamil Nadu has a naturalized population ofcatla that contributes 80 to 90% ofthe totalcatch. This Indo – Gangetic carps has eclipsed all indigenous fish fauna including laleo fimbrlatus which dominated the scene bycontributing 36% of the catch during the mid 1960s. Similarly introduction ofthe silver carp in Gobindsagar common carp in Krishnarajasagar and Tilapia (Oreochromis mosambica) in Amaravathy are example of man induced changes in fish cimmunities.

Fish populations are highly dependent upon the characteristics of their aquatic habitat whichsupport all their biologicalfunctions. Migratoryfishrequire different environments for the main phases of their life cycle which are reproduction , production of juveniles, growth and sexualmaturation . The life cycle of diadromous species take place partly in fresh water and partly in sea water the reproduction of anadromous species takes place in freshwater, where as catadromous species migrate to the sea for breeding purposes and back to fresh water for trophic purpose. The migration of potadromous species, whose entire life cycle is completed within the in land water of a river system must also be considered.

The construction of a dam on a river can block or delay upstream fish migration and thus contributes to the decline and even the extinction of species that depends on longitudinalmovement along the stream during certain phases oftheir life cycle. Mortality resulting from fish passage through hydraulic turbines or over spill way during their down stream migration can be significant. Experience gained shows that problems associated with down stream migrationcan also be a major factor affecting anadromous or catadromous fish stock, habitat loss or alteration , discharge modification changes in water quality and temperature increased predation pressure as well as delays in migration caused by dams are significant issues.

Impact of reservoir formation on the native Ichthyofauna

Formation of reservoir has affected specially the following indigenous fish stocks

1. The mahseers, snow trouts and Labeo dero and L dyocheilus of the Himalayan stream.

2. The anadromous hilsa, thecatadromous eels, and freshwater prawns of all major river system.

3. P.sarana, T. tor, Tor mahanandtcus, T. mosal, L. fimbrtatus, Lcalbasu, and Rhinomugli corsula of the Mahanadi river.

4. P. dobsoni, P. camaticus, C. dmhosa and Labeo kontius of the Cauvery River basin.

5. P. kolus, P. dubius, P. sarana, P. porcellus, L. calbasu, L. pangusia and Tor kudree of the Krishna river system, and

6. The mahseers, eels and Osteobrama balangiri of the Northeast.

1.2 Post harvest technology of fisheries

Fish is aquicklyperishable commodityat warmtemperatures in tropical areas. Theyundergo spoilage quicklydue to bacterial decomposition or due to enzymatic action. In marine capture fisheries considerable quantities of fish of low economic value are captured. Unless immediate measures for keeping the captured fishunder lowtemperaturestakeplace, the fish start undergoingspoilage. As a result, microbial spoilage and contamination bypathogenic bacteria occurs. This can have important implication for the export trade, especiallyas more stringent international qualityparameters for food items are applied world – wide.

Post harvest fisheries comprises the activities that take place from the fish is landed or harvested until it is consumed. Fisheries embraces the cultural, environmental, economic, institutional, social, technical and marketing aspects of the supply, demand, preservation, processing and distribution of fish and fish products. The focus must now switchover to reducing thewaste and enhancing the value of the fish currently being caught. Improving the efficiencyof post – harvest handling processing and marketing of fish can significantly improve the livelihood ofprimary producers and the small fish traders. Consumers also will be benefitted through the availabilityof better qualityfish and fish products for food.

For preservation and processing, the following methods are followed bythe fishermen. Some of the methods include the traditional ones followed by the fishermen for preserving the quality of fish for marketing. As demand in international markets for processed fish and shrimp products have developed in the last two to three decades, use of technological skills for better processing and manufacture of such products which command international markets has been developed in India. In this process, a number of processing units have come up in India. For export of the fish, shrimp and other products of importance. The Marine Products Development Authorityis the central organization which monitors the international marketing and production of quality products suitable for export in our country.

The lack of suitable infrastructure including transport and ice – plants increases the problems of rapid spoilage. As the fish landing sites are very remote, it is not economic to provide infrastructure needed to preserve fresh fish either after on board or immediately landing. It is often not economic to transport the catch. Because of these problems, a large part of the catcth is processed by traditional methods of sun – drying, salting and smoking.

Fish preservation is a very important aspect of the fisheries. Normally the fish farms of other fish capturing sites or located far off from the market place and there is a chance of fish decomposition and the uncertainties of their sale in market. When the fishes are caught in numbers, greater than the amount of consumption, there preservation becomes a necessity for their future use. Preservation and processing therefore become a very important part of commercial fisheries. It is done in such a manner that the fish remain fresh for a long time, with a minimum loss of flavour, taste, odour, nutritive value and the digestibility oftheirflesh.

Good Handling Practices a Harvesting and Post Harvesting Before killing

1. Stop using antibiotics in the pond preferably 14 days before harvest.
2. Stop feeding fish 1 day before harvest.

White killing

1. Fish should be killed quickly with as little stress as possible.
2. Matured or just spawned fish should not be caught if high quality is needed.
3. Good quality fish should not have damaged scale, deformities, cuts, eroded fins and tails.

Grading and sorting

1. Grade and sort the fish according to species, size, freshness, and other specification.
2. Damaged and bruised fish should be sold separately.

Boxing

1. Fish should be packed carefully to avoid twisting or squashing, normally belly up.
2. Keep the fish always in ice, even while selling.

Transportation

1. Avoid excess handling of fish.
2. Avoid unpacking and repacking during transportation.

Sorting or Grading the Catch

After harvesting, the catch is put to a sorting or grading systemso as to have a better salability. When polyculture is undertaken, fish are to be sorted species – wise and size – wise. In modern technology, mechanical graders are used whenthere is a considerable difference in size of different species. Asimple adjustable bar grader is commonly used and by adjusting the distance between the bars, different size – group canbe separated. Fromthese mechanicalgraders only a partial sorting is possible, the rest has to be done by hand.

As for any kind of food, fresh and live animals are preferred in the market and it is quite essential to sort out live fish from the dead or weak ones whichare not likelyto survive long distance transportation. In this context the air

– breathing fish like Clarias and Heterapneustes live while keeping them in water
– filled, wide – mouthed containers. In Indian markets, they can be seen being sold a live.

The live and healthyfish shouldbe stored for transport in special holding tanks with an adequate supply of clean water. If they have to be detained for longer periods, it is advisable to aerate the water and ensure a proper water temperature. If storage is to be done for unduly longer periods, it is better to refrain from feeding them.

Short Answer Type Questions:

1. Define ‘Reservoir ‘.
2. What is ‘Reservoir fisheries’?
3. What is impact of dams on fishes?
4. What are the causes for fish decompose?
5. What are the principle processes employed to check the fish spoilage
6. Which salts and acids are used in preserving the fish?
7. Write about good handling practices in fish harvest and post harvest
8. Write the most important things to look for the freshness fish.
9. Define “post harvestation fisheries “.
10. Define a ‘water’.
11. What is called ‘barrage ‘?
12. Define ‘anicut ‘?
13. What is main effect on ichtyofauna by dams?

Long Answer Type Questions:

1. Describe the reservoir fishery of India.
2. Explain the post harvest technology of fishery.

UNIT 2

Reservoir Fisheries

Structure

2.1 Introduction

A reservoir may be defined as a naturalor artificialplace where water is collected and stored for use especially for water supply, irrigation land, power generation and fisheries. Reservoir is a man – made ecosystem without a parallel in nature. Though essentially a combination of fluviatile and lacustrine systems, a close examination of the biotope reveals that it has certain characteristic features of its own.

The riverine and lacustrine characters coexist in reservoirs, depending on the temporal and spatial variations of certain habitat variable. For example, the tolic sector of the reservoir sustains a fluviatile biocoenos, where as the lentic zoneand the bays harbour lentic communities. During themonths ofheavy inflow and outflow, the whole reservoir mimics a lotic environment whereas in summer, whentheinflow and outflow fromthe reservoir dwindle, amore or less lentic condition prevails in most part of it. Another unique feature of reservoir that makes them distinctly different from their natural counterparts is the water renewa lpattern marked byswift changes in levels of inflow and outflow.

2.2 Reservoir ecology

The ecology of reservoir is radically different from that of the parent rivers. Dams alter river hydrologyboth up – and down stream of the river. The obstruction of river flow and the consequent in sudation trigger off sudden transformation oflotic environment into a lantic one. The riverine communityis subjected to changes akin to the secondry community succession. Anumber of organisms perish, some migrate to morehospitable environs, and themore hardy ones adapt them selves to the changed habitat. There is usually aninitial spurt of plankton and benthic communities due to the increased availability of nutrient released from the decayof submerged vegetation.

Constructionof dam turns the sectionof the river immediately behind it into a lake, called reservoir or dam – lake, in which the lotic water of the upper reaches becomes lentic as water approaches the dam . Reservoir ecology is thus changed from the usually riverine ecology to lacustrine ecology with passage of time. This necessitates an entirely different type of fishery, called reservoir.

The revirine ecology of the water of the upper reaches becomes increasingly changed into lacustrine ecology in the reservoir. The benthic riverine fauna disappears and it is raplaced by typical lacustrine benthic fauna. With the changed from lotic to benthic condition of the water current, riverine plankton are replaced by lacustrine plankton. The turbidity level is also reduced as reservoir act as setting besins. Fish fauna is greatly affected. The running water fish species become fewer or are completely culminated. Slow water fish species prodomine. Floating plants (pistia, salvinia, ect.) may come up, particularly in trophics where they create deoxygenation conditions to cause other serious ecologyical problems.

Some aspects of reservoir ecology

Astanding water like huge reservoir differs in some important characteristics with flowing water or a smallpond – like impoundment.

(i) The size and shape of reservoir influence the productivityand no uniform pattern is discernible.

(ii) Thedegree of siltation is dependent uponthe natureofthe catchment area. Heavy silt deposit inhibits the growth of benthic vegetation, chokes fish eggs on spawning grounds or obstructs nest building activity ect.

(iii) Transparency of water is generally high in most of the reservoir. The silt and other suspended materials form delta – like deposits in the head water and the water, below this region becomes clear. This conditional lows plankton population to develop. In reservoir where there is high level of soil erosion and rainfall is more frequent, there is great accumulation of suspended sediment and if water is discharged from close to the bottom, it is found to be muddy.

(iv) Temperature regime of reservoir is different in different situations. The reservoir in temperate regions develop a therm cline [a layer of water the temperature gradient is greater than that of the warmer layer above and colder layer below, the former being called as epilimmion, whereas the latter as hypolimnion, but in tropical water there is no thermocline.

(v) Phyto – and zooplankton abundance depends upon the season and nutrient status of the impoundment. More Chlorophyceansareindicative ofhealthy situation. Moderate growth of aquatic plants is supportive of good quality fauna, particularly fish.

Table 2.1: Physico – chemical features of Indian reservoirs

Parameters	**Overall range**	**low**	**Productivity rating** **Medium**	**High**
A. Water				
Ph	6.5-9.2	< 6.0	6. 0 – 8.5	> 8.5
Alkalinity (ppm)	40-240	< 40.0	40.90	> 90.0
Nitrates (ppm)	Tr – 0.93	Negligible	Upto 0.2	0.2-0.5
Phosphates (ppm)	Tr -0 . 36	Negligible	Upto 0.1	0.1-0.2
Specific conductivity (micro mhos)	76-474		Upto 200	>200
Temperature (^{O} c)	12-31	18	18-22	> 22
(Withminimal stratification : ie. > 50 c)				
B. Soil				
Ph	6.0-8.8	< 6.5	6.5-7.5	> 7.5
Available P (ppm)	0.47-6.2	< 3.0	3.0-6.0	> 6.0
Available N (ppm)	13-65	< 25	25-60	> 60
Organic carbon (%)	0.6-3.2	< 0.5	0.5- 1.5	1.5-2.5

2.2.2 Determinant of productivity

The objective of fisheries management in reservoirs is to regulate fish production to achieve sustainable yield of harvestable size fish. The fish yield in reservoirs is partly a function of abiotic and biotic factors influencing the productivity of the aquatic system. The degree of management that can be imposed upon these factors determines the intensity of operations.

(a) Abiotic variables

Abiotic factors are independent variable over which the fishery manager has little or no control. They relate to the geographical location and micro – climate ofthe impoundment. Included are temperature as a function of elevation and latitude, precipitation, and water and soil chemistry. Biological productive Of a biotope is influenced byclimatic, edaphic and morphometric features. The geographic location affects the metabolism of a reservoir through temperature regime, nutritionsupply shape of basinand the efficiencywithwhich the climate factors are able to act in the dynamic exchange. Theyallhave varying effects on finalproductive.

(b) Biotic communities

Biotic factors are frequentlydependent variables whichcan be managed for fishery improvement. To enhance fish yield, it is importance to understand how these factors affects aquatic production. Biotic factors include fertility of the environment; diversity of fish populationin terms of structure and functions ofaquatichabitat andpopulationmanipulationthroughplanned fishering mortality. (Aquatic weeds found in shallow water bodies also compete with beneficial plankton for nutrients interfere with harvest and can contribute to oxygen depletion. To avoid excessive weed growth, pond banks should slope rapidly 2:1 or 3:1 ratio) to a depth of 75 cm or more.

2.3 Reservoirs of India and A.P

2.3.1 Reservoirs of India

Despite the over whelmingimportance ofreservoirs inthe inland fisheries of India, areliable estimate of thearea under this resource is still elusive, causing serious constraints to the R & D(?) active. The available estimates made by various agenciesare conflicting and wide off the mark. The national commission on Agriculture (NCA) has estimated the total area under reservoir at 3 million ha during the mid – sixties and projected its growth to 6 million ha by 2000 AD (Anon. 1976). Bhukaswan (1980) put the figure at 2 million ha. Srivastava et al. (1985) compiled a list of 975 large and medium reservoirs in the country with an estimated area of 1.7 million ha. One of its major shortcomings is the exclusion of small reservoirs, especially those in Tamil Nadu, Karnataka and Maharashtra.

Enumeration of the medium and large reservoirs is relatively easy, as they are less in number and the details are readily available with the irrigation, power and public works authorities. However, compilation of data on small reservoirs is a tedious task as theyare ubiquitous and too numerous to count. The problem is further confounded byambiguities in the nomenclature adapted by some of the states. The word tanks is often loosely defined and used in common parlance to describe some of the small irrigation reservoirs.

Thus, a large number of small manmade lakes are designated as tanks, there by precluding themfrom the estimates ofreservoirs. There is no uniform definition for a tank. In the eastern states of Orissa and West Bengal, pond and tank are inter changeable expressions, including small and medium sized water bodies. In fact, some of the tanks in Tamil Nadu and Karnataka are much bigger than Aliyar and Tirumoorthyreservoirs.

Table 2.2: Distribution of small, medium and large reservoirs in India

State	Small		Medium		Large		Total	
	Number	Area(ha)	Number	Area(ha)	Number	Area(ha)	Number	Area(ha)
Tamil nadu	8895	315,941	9	19,577	2	23,222	8906	358,740
Karnataka	4,651	228,657	16	29,078	12	179,556	4,679	437,291
Madhya Pradesh	6	172,575	21	169,502	5	118,307	32	460,384
Andhra Pradesh	2,898	201,927	32	66,429	7	190,151	2,937	458,507
Maharastra	-	119,515	-	39,181	-	115,054	-	273,750
Gujarat	676	84,124	28	57,748	7	144,358	711	286,230
Bihar	112	12,461	5	12,523	8	71,711	125	96,695
Odissa	1,433	66,047	6	12,748	3	119,403	1,442	198,198
Kerala	21	7,975	8	15,500	1	6,160	30	29,635
Uttar Pradesh	40	218,651	22	44,993	4	71,196	66	334,840
Rajasthan	389	54,231	30	49,827	4	49,386	423	153,444
Himachal Pradesh	1	200	-	-	2	41,364	3	41,564
North-east	4	2,239	2	5,835	-	-	6	8,074
Haryana	4	282	-	-	-	-	4	282
West Bengal	4	732	1	4,600	1	10,400	6	15,732
Total	19, 134	1,485,557	180	527,541	56	1,140,268	19,370	3,153,366

2.3 AList of some important Reservoirs in India

State	Reservoirs	River	District	Are (ha)
1. Uttaranchal	Sardasagar Dam Nanak sagar Maneri-Bhali Asan barrage.	Chukasanda Desha Bhagirathi Asan	Nainital Nainital Uttarkashi Dehradun	7,303.800 4,662.000 - -
2. Uttar Pradesh	Matatila Rihand.	Betwa Son	Jhansi Mirzapur	20,720.000 46,620.000
3. Punjab	Beas Dam.	Beas	Kangra	26,418.000
4. Himachal Pradesh	Pong Dam Pandoh Dam.	Beas Beas	Talwara Pandoh	- -
5. Assam	Umrong (Kopili Hydroelectric project).	Bhramaputra system (Kopili River)	North Cachar	974.000
6. Assam and Meghalaya	Khandong (Kopili Hydroelectric project).	,,	North Cachar (Assam) and Jaintia hills (Meghalaya)	1,335.000
7. Meghalaya	Barapani (Umian Hydroelectric project) Kyrdemkulai (Umtru and Umian Hydro electric project) Nongmahir (Umtru Umian Hydroelectric project).	Umiamriver Umiam and Umiam ,,	East Khasi Hills, Barapani Downstream of Barapaniin East Khasi Hills Nongmahir	500.000 90.000 70.000
8. Tripura	Gumti(Gumti Hydroelectric project).	Barak River System (down stream of sarma and Raima which fromGumti)	South Tripura, bordering Bangladesh (Chittagong Hills)	4,500.000

9. West Ben gal	Kangsabati	-	-	11,396.000
10. Bihar	Panchet Naithon Konar Tilaiya.	Domodar Barakar Konar Barakar	Santhal Pargans „ ” Hazaribagh	7,511.000 11,491.830 2,792.000 6,475.000
11. Madhya Pradesh	Tawa (Multi- purpose project) Gandhisagar	Tawa Chambal	Hoshangabad Mandsaur	29,533.770 64,750.000
12. Odissa	Hirakund	Mahanadi	Sambalpur	74,592.000
13. Rajasthan	Ranapratap sagar.	-	-	20,720.000
		Krishna system		
14. Andhra Pradesh And Telangana	Wyra Musi Nagarjunasagar Srisailam.	Wyra Musi Krishna Krishna **Godavari system**	Khammam Nalgonda Guntur Kurnool	1626.000 2507.000 28,474.000 61,404.000
	Singur Lower Manair Dam (LMD) Kadam.	Manjira Manair Kadam	Medak Karimnagar Adilabad	16,534.000 8,103.000 2,474.000
		Penna system		
	Mid Penna Dam (MPD) Somasila	Penna Penna	Anantapur Nellore	1,703.000 21,349.000

15. Maharashtra	Shivajisagar Darwa.	Koyna Darwa	Satara Nasik	12,100.000 3,367.000
16. Karnataka	Tungabhadr a Krishnarajasagar Vanivilasagar Linganamakki.	Tungabhadra Cauvery Vedavathi Sharavathi	Hospet Mysore Chitradurga Shimoga	37,814.000 12,924.000 7,252.000 38,850.000
17. Tamil Nadu	Bhavanisagar Stanley Poondi.	Bhavani Cauvery Koraliyar	Coim batore Salem Chinglepet	7,861.800 15,343.000 3,263.000
18. Kerala	Periyar Barrage Neyyar Dam.	Periyar Neyyar	Kottayam Trivendrum.	606.000 9,000,000

2.3.2 Reservoirs of Andhra Pradesh

Andhra Pradesh is one of the fifth largest states in India. Both demo graphically as well as geographically. The state consists of the eastern coastal belt, and the Rayalseema area of the southwest. The state is a hot, semi – arid dryland, except the coastal districts which are very fertile and have a highly productive agriculture.

Andhra Pradesh is drained, by the three large rivers (catchment < 20 000 Km^2), including the Godavariandhe Krishna, which have anannual discharge of 105 000 and 67 675 million m^3 respectively. Penna, the third major river carriers 3 238 million m^3 annually. The medium rivers (catchment 2001 – 20 000 km^2) comprising the Nagavali, the Sarda, the Eluru, The Gumdlakamma, the Musi, the Paleru, the Muneru and the Kunleru have an annual discharge of 6 430 million m^3 .more than 33 minor rivers (catchment > 2000 km^2) of the states are smallcoastalstreams flowing into the Bayof Bengal, carrying a total of 6 764 million m^3 of water. All the rivers in the state are east – flowing and are harnessed for irrigation and power generation. People living in the dryregions of Telengana and Rayalaseema released the need for irrigation from time immemorialand learned to create reservoir on small streams, rivulets and creeks to store water for irrigation. Liked their counterparts in Karnatakaand TamilNadu, these improvised irrigation reservoirs, locallycalled tanksare oftenoverlooked while compilingthe reservoir resources data.

List of dams and reservoirs in Andhra Pradesh

The following are the dams and reservoirs located in Andhra Pradesh.

DISTRCIT WISE LIST OF RESERVOIRS IN ANDHRA PRADESH

S.No.	District	Sl. No.	Name of the Reservoir	TWSA (in ha)	EWSA (in ha)
1	Srikakulam	1	Madduvalasa Reservoir	1240	930
2	Vizianagaram	2	Peddagedda Reservoir	326	245
		3	Thotapalli Reservoir	2000	1500
		4	Gedigedda Reservior	242	182
		5	Vottigedda Reservoir	196	147
		6	Gujjuvai Reservoir	120	90
		7	Vengalarayasagaram Reservoir	1320	990
3	Visakhapatnam	8	Kothali	24	12
		9	Gambhiramgedda	70	35
		10	Konam	323	242
		11	Pedderu	148	111
		12	Tharakarama	120	90
		13	Gorrigedda	51	26
		14	Palagedda	15	8
		15	Kamugedda	40	20
		16	Addalova	14	7
		17	Jajigedda	40	20
		18	Mallavaram	8	4
		19	Ravanapalli	106	53
		20	Kongasingi	8	4
		21	Potti Pitta Vagu	20	10
		22	Tahugulagedda	28	14
		23	Ginjarthi	30	15
		24	Tajangi	32	16
		25	Kalyanapu Lova	250	125
		26	Thandava	1600	1200
		27	Raiwada	1400	1050
4	East Godavari	28	Subbareddy Sagar	25	13
		29	Pampa Reservior	24	12
		30	Chandrababu Sagar Tank	17	13
		31	Mangaligedda Reservior	20	15
		32	Lingavaram Reservoir	13	10
		33	Ginnepalli Reservoir	15	8
		34	Deyylagummi Reservoir	10	5

		35	Vattigedda Reservoir	15	8
		36	Kolagummi gedda Reservior	15	8
		37	Mangaligedda Reservior	12	6
		38	Godavari	15000	11250
		39	Yeleru	5936	4452
5	West Godavari	40	Nagireddygudem Reservoir, Chintalapudi	225	169
		41	Kolleru	5000	3750
		42	Godavari River	5000	3750
		43	Yerrakaluva Reservoir, Jr Gudem	2000	1500
		44	Kovvada Kaluva Reservoir, polavaram	260	195
		45	Jalleru Reservoir	160	120
		46	Pogonda	200	150
6	Krishna	47	Prakasam Barrage	3600	2700
7	Guntur	48	Nagarjuna Sagar	16606	12455
		49	Pulichintala	8556	6417
		50	Prakasam Barrage	3983	2987
8	Prakasam	51	Rallapadu Reservoir	350	88
		52	Gandicheruvu Reservoir	90	23
		53	Muraripalli Reservoir	5	1
		54	Peddabommalapuram Reservoir	132	33
		55	Panduvagandi Reservoir	10	3
		56	Gollapalli Reservoir	85	43
		57	Punugodu Reservoir	81	41
		58	Mopadu Reservoir	900	450
		59	Magunta subbaramiReddy Ramatheertham Reservoir	332	249
		60	Kandula Obula Reddy Gundlakamma Reservoir	2570	1928
9	Nellore	61	K.D Reservoir	6144	4608
		62	Gandipalem	945	473
		63	Kandaleru	38912	29184
		64	Alapaleru	600	300
		65	Somasila	21238	15929
		66	Nellore Tank	1901	1426
		67	Survepalli	1452	1089
10	Chittoor	68	Bahuda Reservoir	260	130

		69	Krishnapuram reservoir	60	30
		70	Kalangi Reeservoir	165	83
		71	Mallimadugu Reservoir	75	38
		72	Kalathuru Reservoir	61	30
		73	Pedderu reservoir	100	50
		74	Kalyanidam (drinking water for tirupathi municipality. Hence the fish culture not taken up in the reservoir)	260	130
		75	Araniyar reservoir	1404	1053
11	Kadapa	76	Somasila backwaters	10619	7964
		77	Brahmasagar Reservoir	2734	2051
		78	Veligallu Reservoir	1076	807
		79	Annamayya Reservoir	760	570
		80	Gandikota Reservoir	3200	2400
		81	Mylavaram Reservoir	696	522
		82	Subsidiary Reservoir-I	292	219
		83	Subsidiary Reservoir-II	214	161
		84	L.S.P.Reservoir	560	420
		85	Pincha Reservoir	372	279
		86	Ganganeru Reservoir	320	240
		87	Buggavanka Reservoir	300	225
		88	Pydipalem Reservoir	750	563
		89	Jharikona Reservoir	300	225
12	Ananthapuramu	90	Upper Pennar Project	1527	1145
		91	M.P. Dam	1646	823
		92	B.T. Project	1295	648
		93	Y.V.R. Project	457	229
		94	Chitravthi Balancing Reservoir	3546	1773
		95	Chagallu Reservoir	1452	726
		96	Jilledubanda Reservoir	80	40
		97	P.A.B.Reservoir	2700	1350
		98	Pendekallu	541	271
		99	Jeddipalli Reservoir (New)	1600	800
		100	Gollapalli Reservoir (New)	480	240
13	Kurnool	101	Alaganuru Balancing	1343	1007
		102	Gorkal	1510	1133

		103	Krishnagiri Reservoir	154	77
		104	Pandikona	485	243
		105	Owk Reservoir	1070	803
		106	Gajuladinne Project	3200	1600
		107	Sunkesula barriage	554	416
		108	Srisailam back waters	29786	22340
		109	Velugodu	4700	3525
		110	Jurreru Project	186	47
		111	Tundlavagu Reservoir	408	306
Total		**111**		**235508**	**170725**

2.4 Classification of reservoirs

Fish seed committees of the Godavari of India (1966) termed all water bodies of more than 200 ha in areas reservoir. David et al. (1974) while classifying the water bodies of Karnataka state, considered impoundment above 500 ha as reservoir and named the smaller ones. Reservoirs are classified generally as small (< 1 000 ha), medium (1 000 to 5 000 ha) and large (> 5 000 ha), especially in the records of the Government of India (Sarema, 1990, Srivastava *et al*,. 1985) Which has been followed in this study all man – made impoundments created byobstructing the surface flow, by erecting a dam of any description, on a river, stream or any water course, have been reckoned as reservoir. However, water bodies less than 10 ha in area, being too smallto be considered as lakes, are excluded. The reservoir are classified bymanyauthors in different ways mainlybased on the area of reservoirs.

Mohantry (1984) reported three types of reservoirs

- Minor reservoirs - with water spread area upto 40 ha.
- Medium reservoirs – with water spread area upto 400 ha.
- Major reservoirs with water spread area above 400 ha.

Pathak (1990) classified reservoirs of our country into three categories.

- Large reservoirs – covering area of 5000 and more hectares.
- Medium reservoirs – having impounded water area of 1000 – 5000 hectares.
- Small reservoirs – having water area less than 1000 hectares.

Agarwal (1990) classified reservoirs keeping in view the availabilities and other factors of management into four types.

- Large reservoirs – the water spread area between 1000 – 5000 ha.
- Medium reservoirs – the water spread area between 100 – 1000 ha.
- Minor reservoirs – the water spread area between 10 to 100 ha.
- Small reservoirs – the water spread area below 10 ha.

Jhingran and Sugunan (1990) classified the reservoirs into these groups.

- Large reservoirs – the water spread area more than 1000 ha.
- Medium reservoirs – the water spread area is less than 500 ha.

In modern times reservoirs are created by constructing masonary dams, weirs, barrages, and anicuts.

This structure can be defined as under

(i) Dams : Amasonary concrete barrier builts across, to obstruct the flow of streamor river, leading to formation ofa vast impoundment up streamof the barricaded sites. The water level is maintained by discharge through sluice gates or bydiverting it to thesites where power generationplant of hydroturbines are installed. The ‘ dams ’have been referred to as ‘ Temples of Modern India ’ byour first Prime Minister, Pt. Jawaharlal Nehru.

(ii) Weir : Asmall dam in a river or stream; or an obstruction placed across a streamto cause the water to pass through a particular opening or notch or over its orest.

(iii) Barrage : This word has its origin in Fresh language and often applied to weirs provided with slucise openings.

(iv) Anicut : This word is of ‘ Tamil‘ origin and literallymeans ‘ dam building ’structurally. It is a low barrage built primarilyfor irrigation purpose.

2.5 Management of reservoirs fishery

India has a large spread of fresh water resources in the form of rivers, reservoirs, lakes, ponds, etc. Indian reservoirs, being in the tropics, have high primary productivity and have the capacity to produced more fish than their present low Indian average of 20 - 25 kg/ ha/ yr in reservoirs and 49.5 kg / ha / yr inminor reservoirs. The fact that fish production from reservoirs is low and more area is added to the present extent of reservoirs, emphasizes the need for attention to shape and develop the reservoirs fisheries from the survey and planning stage to achieve high rate of production and better returns for the fishermen, who represent the weaker sectionof the society.

Reservoirs fisheries is essentially a stocking – cum – capturer system. There are 975 reservoirs in the countrywith a total area of more than 12 lakhs hectares. Majority of these water bodies are not being scientifically managed. Only a handfulhave so far been harnessed on scientific lines. While the others are either half – hardlymanaged or even not managed at all.

Fisheries Management

There are marked variations in the fisherymanagement practices which are followed in various reservoirs withinthe country. Even thoughthe reservoirs are owned bythe Government their fishing rights and exploitation system very considerably.

The fishing system can be divided into the following board categories

(a) Privatelyowned and managed reservoirs

(b) Public water bodies

(c) Community waterbodies

(d) Water bodies managed bythe Government after a scrutinyof the various managed practices followed in the country.

Which are auctioned to private individuals on an annual basis. Fish yield of small reservoirs, where the management is on the basis of culture – based fisheries is dependent on a number of parameters such as growth rate, naturalmortalityand fishingmortality. Therefore, stocking density, size at stocking, size at harvesting, rate of fishingmortality, and harvesting schedule hold the key for obtaining the optimum yield.

Enhancement

Majority of the small reservoirs and other communitywater bodies in India are essentiallyamenable to culture – based fisheries and there is a general consensus that any significant improvement in yield from them can be achieved only throughsomesort of enhancement activities. Fisheries enhancement canbe achieved through human intervention in the aquatic ecosystems with a view to increase their productivity.

Stock enhancement

Augmenting the stock of fish has been the most common management measure that is followed in the reservoirs in most countries. Ever since the reservoirs were considered as a fishery resource, it became apparent that the original fish stock of the parent river was insufficient to support a fishery. Augmentation of the stock was also necessary to prevent the unwanted fish to utilize the available food niches and flourishat the cost of economically important species. The policies and guidelines on the subject are often erratic and even arbitrary. Stocking of reservoirs with finger lings of economically important fast – growing species Despite a remarkable increase in crap seed production in India, the open water bodies of the country remain under stocked. The Government hatcheries that have the responsibility to stock the public reservoirs. The number of fish to be stocked per unit area is to be based on the natural productivity of the system, growth rate offish, natural mortality rate and escape through the irrigation canal.

Selection of species for stocking

The basic principle that should be followed in selecting a species to be stocked are.

1. The planted species should find the environment suitable for maintenance growth and reproduction.
2. It should be a quick growing form from whichhighest efficiencyof food utilization is obtained.
3. Afisherybased onhigh production of herbivorousfishes with shorter food chain is more productive and hence energy – effective.
4. The number of fish to be planted should be such that the food resources of the ecosystem are fully utilized.
5. The size of the stock should be chosen with the expectation of getting thedesired results.
6. Stocks should be readily available without major shift in the cost involved in its transportation.
7. Cost of stocking and managing the species must be less than the benefits derived from stocking and management. One of the important phases of stocking policy is to know the amount of food availableper individual in the environment.

Stocking rate

India a large country with too many water bodies to be stocked, has inadequate state machineries to meet all the stocking requirements.

1. Large reservoirs (1000 – 5000 ha) – 5000 fry/ha/yr .
2. Medium reservoirs (100 – 1000 ha) – 1000 fry/ha/yr.
3. Minor reservoirs (10 – 100 ha) – 2000 fry/ha/yr.
4. Small reservoirs (below 10 ha) – 10000 fry/ha/yr.

But the stocking fryinreservoirs has some disadvantages, like the mortality is high. This maybe due to the sensitive nature of fryand predation by carnivorus fish. It is advisable to stock fingerlings instead of fry.

Srivastava (1985) recommended the following stocking rates of fingerlings for reservoirs in India.

1. Large reservoirs (5000 – 10000 ha) – 200/ha.
2. Medium reservoirs (1000 – 5000 ha) – 400/ha.
3. Minor reservoirs (up to 1000 ha) – 1000 /ha.

Impact of stocking in small reservoirs

In sharp contrast to the large and medium reservoirs, stocking has been more effective in improving the yield from small reservoirs as success in the management of small reservoirs depends more on recapturing the stocked fish rather than on their building up a breeding population. The smaller water bodies have the advantages of easy stock monitoring and manipulation. Thus, the smaller the reservoirs better the chances of success in the stock and recapture process. In fact, animaginative stocking an harvesting schedule is the main them of fisheries management in small, shallow reservoirs.

(a) Species enhancement : Decline of indigenous fish stocks due to habitat loss, especially that caused by dam construction, is a universal phenomenon. Planting of economicallyimportant, fast growing fish from outsides with a view of colonizing all the diverse niches of the biotope for harvesting maximum sustainable crop from them is species enhancement.

Introduction of exotics : Fish in India the fish transferred on trans - basis within the geographic boundaries of the country is not considered as exotic to peninsular rivers. This is despite the fact that the peninsular rivers have habitat distinctly different from those ofthe Ganga and the Bhrahmaputra, Catla Rohu. And mrigal have been stocked in the peninsular reservoirs for many decades now, with varying results. In some of the south Indian reservoirs, they have established breeding populations. The hall mark of the Indian policy on introduction is the heavy dependence on Indian major carps. Silver carps and grass carps are not normally encouraged to be stocked in Indian reservoirs, though they are stocked regularly in a few small reservoirs. The three exotic species brought in clandestinely bythe fish farmers, bighead carp – Aristichthys nobilis, Oreochromit niloticus and Africa catfish Clarius gariepinus have not gained entry into the reservoir ecosystems. They still remain restricted to the culture systems.

(b)Environment enhancement: The improvement of the nutrients status ofwater bythe selective input of fertilizers is a verycommonmanagement options adopted in intensive aquaculture. If similar environmental enhancement is adopted in small reservoirs, stocks can be maintained at levelhigher than the natural carrying capacityof the environment.

Sreenivasan and Pillai (1979) attempted to improved the plankton productivityofvidur reservoir bythe application of super phosphatewith highly encouraging results. As soon as the canal sluice was closed, 500 kg super phosphate with $p_2 o_5$ content of 16 to 20 % was applied in the reservoir when the water spread was 50 ha with a mean depth of 1.67 m.

Short Answer Type Questions

1. Define ‘Lentic Region’ .
2. Define ‘lotic region’.
3. What are chemical characteristics of reservoir water ?
4. What is called ‘ Phyto Plankton ? Give examples ?
5. What is called ‘ Zoo Plankton ? Give examples ?
6. What are the determinants of productivity of a reservoir fisheries ?
7. Define ‘ Biotic factors ’ in reservoir fishery. Give two examples.
8. Define ‘Abiotic factors ’ in reservoir fishery. Give examples.
9. Give names of any four major reservoir in AP.
10. Gives names of any four major reservoir in India.

Long Answer Type Questions

1. Give an account on classification of reservoirs.

2. Give an account on management of reservoir fisheries.
3. Write about reservoir ecology.
4. Write about reservoir fisheryes of india.
5. Write about reservoir fisheryes of Andhra pradesh

UNIT 3

Sport Fisheries in India
Kolleru and Pulicat Lake Fisheries

Structure

3.1 Introduction to Lakes

A lake is defined as "a body of standing water occupying a basis and lacking continuitywithsea" - F.A. Foral. "Those bodies ofstanding water which are of considerable expanse and deep enough to stratify thermally" - R.A. Muttkowskii. "All large bodies ofstanding water(except ponds)" - P.S. Welch.

Types of lakes on the basis of thermal characteristics by S. Yoshimura.

Tropical Lakes : Surfacetemperature 20^0 - 30^0c, small thermal gradient at anydepth; circulation irregular during winter months.

Subtropical Lakes : Surface temperaturenever below 4^0c, large annual variations; thermal gradient large; circulation period winter.

Temperate Lakes : Surface temperature above 4^0c in summer and below 4^0c in winters; seasonal variation and thermalgradient large; circulation periods in spring and autumn.

Subpolar Lakes : Surface temperatureabove 4^0c onlyfor short duration during summer; thermal gradient small; circulation periods in early summer and earlyautumn.

Polar Lakes : Surface temperature below 4^0c; almost with ice; circulation period onlyin the summer.

Kolleru : It is located between Krishna and Godavari delta. Kolleru spans into two districts - Krishna and West Godavari. The lake serves as a natural flood-balancing reservoir for these two rivers. The lake is fed directly by water from the seasonal Budameru and Tammileru streams, and is connected to the Krishna and Godavari systems byover 68 in-flowing drains and channels.

Pulicat Lake : It is considered to be the second largest brackish lake in the Indian Subcontinent. It covers the land of around 720 sq.kms. Out of the total land covered bythe Pulicat Lake 84% of the land is found in the region of Andhra Pradesh and the 16 % is covered bythe land of **Tamil Nadu**. The lake is veryshallow and measures the depthof 1-2 meters. The lagoonof the Pulicat Lake is around 0.2 kilometers to 17.5 kilometers.

Especiallyduring the period of monsoonwhich starts fromthe monthof August or September, the lake of Pulicat is covered with the nutritious water and huge number of zooplankton and phytoplankton are found in the **Pulicat Lake**.

These in finit esimal organisms have the necessary food for the invertebrates and the fishes that helps them to survive happily in the lake.

3.2 Kolleru Lake

Kolleru Lake is the largest freshwater lake and is located in Andhra Pradesh. Kolleru is located between Krishna and Godavari delta and covers an area of 308 km². The lake serves as a natural flood-balancing reservoir for these two rivers. The lake is fed directly by water from the seasonal Budameru and Tammileru streams, and is connected to the Krishna and Godavarisystems by over 68 inflowing drains and channels. It serves as a habitat for migratory birds. It supports the livelihood of fishermen. The lake was notified as a wildlife sanctuary in November 1999 under India's Wild Life (Protection) Act, 1972, and designated a wetland of international importance in November 2002 under the international Ramsar Convention.

Thousands of fish tanks were dug up inside the wetland converting the lake into a mere drain. Apart from this the farmers had converted the land use pattern ofthe lake. This had a lot of impact in terms of pollution leading to even difficulty ingettingdrinking water for the local people. The total area of the lake converted to aquaculture ponds accounts for 99.73km2 in 2004in comparison to 29.95km2 in 1967. The area under agricultural practice in the wetland also increased from 8.40 km2 in 1967 to 16.62km2 in 2004. Sewage inflow from the towns of Eluru, Gudivada and even Vijayawada and industrial effluents, pesticides and fertilizers from the Krishna-Godavaridelta region contaminate the lake. Eleven major industries release about 7.2 million litres of effluents into the lake every day.

In 1982, the Andhra Pradesh government set up the Kolleru Lake Development Committee (KLDC), which had set up a Rs 300-crore master plan for Kolleru. It also called for the creation of a Kolleru lake development authority to check encroachments, regulate and monitor pollution, clear the lake of weeds and use it as compost and raw material to produce biogas. Dr. T. Patanjali Sastry, President, Environment Centre, Danavaipeta, Rajahmundry moved the High Court to protect the ecosystem of the Kolleru lake. Later on the fishermenassociation also filed another PIL claiming that the ecosystemwas degraded not due to the fish tanks but due to sewage coming out from the industries and the residential areas.

The court gave preference to the ecologyof the lake first. In 2006, the Central Empowered Committee (CEC), appointed by the Supreme Court directed the state to remove all sorts of encroachment including the fish tanks. This caused a huge hue and cry among the fishermen community. The government is undertaking many projects to restore back the glory of the lake.

Rich in flora and fauna, it attracts migratory birds from northern Asia and Eastern Europe between the months of October and March. During this season, the lake is visited byan estimated 20,00,000 birds. The resident birds include Greypelicans, Asian Open-billed Storks (Anastomus oscitans), Painted Storks (Mycteria leucocephala), Glossy Ibises, White Ibises, Teals, Pintails, Shovellers.

Fishing: The roads and bridges that had come up with agricultural development in the area, along with an increased demand for fish, especially from Calcutta, created a new and vast market for fish by 1978. Pisciculture suddenly became profitable. By 1984, 5,000 acres ofgovernment lakebed land were converted to fish tanks under cooperative societies.

The main issues concerning the lake are:

- It is RAMSAR site, there is an Internationalcommitment from Govt. of India to maintain ecosystem of Lake Kolleru.
- This fragile wetland/estuarial system is under threat due to human interventions both in the lake itself, in the upstream catchment area (5400 km2) as well in the downstream Upputeru River estuarysystem.
- Approximately 50% of the Lake area has been converted in fish ponds (42%) and paddy fields (8%).
- 86,000 ha of the surrounding agricultural land is prone to flooding due to the reduced storage capacity of the Lake.
- Pollutionwith pesticides, fertilizers, sewage and industrial waste, resulting in an excessive growth of

weeds and hyacinth.

- Strainght Cut: Salt water intrusion due to reduced outflowand breached distributaries in the Upputeru River.

Need for the scientific study

The Government ofAndhra Pradesh has recognized the urgent need to stop further degradation of this fragile ecosystem. For example, it has initiated a rehabilitation package that includes, among other the dismantling of fish ponds below the 5.0m contour of the Lake despite fierce oppositionof local fishermen and fishpond owners. However to develop a strategic integrated management action plan there is still an urgent need for:

Access to scientific data and scientific norms

- Better understanding of the sound ecologicalbasis for interactions among the various sectors
- Integrated Water Resources Management/IWRMApproach.
- Development of sustainable plan to conserve and maintain ecosystem and environment of the Lake

Ecology of the Lake and Limnological Aspects

The parameters analysed to assess the water quality are broadlydivided into:

Physical parameters: Colour, Temperature, Transparency, Turbidity and Odour.

Chemical parameters:

pH, Electrical Conductivity(E.C), Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Hardness, Calcium Hardness, Magnesium Hardness, Nitrates, Phosphates, Sulphates, Chlorides, Dissolved Oxygen (D.O), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Fluorides, Free Carbon-di-oxide, Potassium and Sodium. · **Heavy metals:** Lead, Copper, Nickel, Iron, Chromium, Cadmium and Zinc. · **Biological parameters:** The biological parameters involved the qualitative analyses of planktons (zooplankton and phytoplankton).

Physical parameters Color

In natural water, colour is due to the presence of humic acids, fulvic acids, metallic ions, suspended matter, plankton, weeds and industrial effluents. Colour is removed to make water suitable for generaland industrial applications and is determined byvisualcomparison of the sample withdistilled water.

Visual comparison:

About 20ml of the sample and 20ml of distilled water were taken in two separate wide mouthed test tubes. The results were tabulated (as clear, greenish, greyish, brownish, blackish, etc) bycomparing the colour of the sample with distilled water.

Temperature

Impinging solar radiation and atmospheric temperature brings about spatial and temporalchanges in temperature,setting up convection currents and thermalstratification. Temperature plays a very important role in wetland dynamism affecting the various parameters such as alkalinity, salinity, dissolved oxygen, electrical conductivity etc.

Transparency (Light Penetration)

Solar radiation is the major source of light energy in an aquatic system, governing the primaryproductivity. Transparency is a characteristic of water that varies with the combined effect ofcolour and turbidity. It measures the light penetrating through the water bodyand is determined using Secchidisc.

Turbidity

Turbidity is anexpression of optical property; whereinlight is scattered bysuspended particles present in water (Tyndalleffect) and is measured using a nephelometer. Suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter; plankton and other microscopic organisms cause turbidity in water. Turbidity affects light scattering, absorption properties and aesthetic appearance in a water body. Increase in the intensityof scattered light results in higher values of turbidity.

Chemical parameters pH

The effect of pH on the chemical and biological properties of liquids makes its determinationveryimportant. It is one ofthemost important parameter in water chemistry and is defined as -log [H^+], and measured as intensity of acidity or alkalinity on a scale ranging from 0-14. If free H^+ are more it is expressed acidic (i.e. pH<7), while more OH^- ions is expressed as alkaline (i.e. pH> 7).

In natural waters pH is governed bythe equilibrium between carbon dioxide/bicarbonate/carbonate ions and ranges between 4.5 and 8.5 although mostly basic. It tends to increase during day largely due to the photosynthetic activity (consumption of carbon-di-oxide) and decreases during night due to respiratory activity. Waste water and polluted natural waters have pH values lower or higher than 7 based on the nature of the pollutant.

The colorimetric indicator method can be used only for approximate pH values.

Total Dissolved Solids

Dissolved solids are solids that are in dissolved state in solution. Waters with highdissolved solids generallyareof inferior palatability andmayinduce an unfavourable physiological reaction in the transient consumer.

Total Suspended Solids

Suspended solids are the portions of solids that are retained on a filter of standard specified size (generally 2.0 ýÿ) under specific conditions. Water with high-suspended solids is unsatisfactory for bathing, industrial and other purposes.

Total Hardness

Hardness is predominantlycaused by divalent cations such as calcium, magnesium, alkaline earth metal such as iron, manganese, strontium, etc. The total hardness is defined as the sum of calcium and magnesium concentrations, both expressed as $CaCO_3$ in mg/L. Carbonates and bicarbonates of calcium and magnesium cause temporary hardness. Sulphates and chlorides cause permanent hardness.

Calcium Hardness

The presence of calcium (fifth most abundant) in water results from passage throughor over deposits oflimestone, dolomite, gypsumandsuchother calcium bearing rocks. Calcium contributes to the total hardness ofwater and is an important micro-nutrient in aquatic environment and is especially needed in large quantities bymolluscs and vertebrates. It is measured by EDTAtitrimetric method. Smallconcentration of calcium carbonate prevents corrosion of metal pipes by laying down a protective coating. But increased amount of calcium precipitates on heating to form harmfulscales in boilers, pipes and utensils.

Nitrates

Nitrates are the most oxidized forms of nitrogen and the end product of the aerobic decomposition of organic nitrogenous matter. The significant sources of nitrates are chemical fertilizers fromcultivated lands, drainage from livestock feeds, as well as domestic and industrial sources. The stimulation ofplant growth bynitrates mayresult in eutrophication, especially due to algae. The subsequent death and decay of plants produces secondary pollution. Nitrates are most important for biological oxidation of nitrogenous organicmatter.

Phosphates

Phosphates occur in natural or wastewaters as orthophosphates, condensed phosphates and naturally found phosphates. Their presence in water is due to detergents, used boiler waters, fertilizers and biological processes. Theyoccur in solutionin particles or as detritus. Theyareessentialfor the growth of organisms and a nutrient that limits the primary productivity of the water body. Inorganic phosphorus plays a dynamic role in aquatic ecosystems; when present in lowconcentration is one ofthe most important nutrients, but in excess along with nitrates and potassium, causes algal blooms. It is calculated bythe stannous chloride method.

Sulphates

Sulphates are found appreciably in all naturalwaters, particularly those withhighsalt content. Besides industrial pollution and domesticsewage, biological oxidation of reduced sulphur species also add to sulphate content. Soluble in water, it imparts hardness withother cations. Sulphate causes scaling in industrial water supplies, and odour and corrosion problems due to its reduction to hydrogen sulphide. It can be calculated byturbidometric method.

Chlorides

The presence of chlorides in naturalwaters can mainlybe attributed to dissolution ofsalt deposits in the formofions(Cl^-). Otherwise, highconcentrations may indicate pollution by sewage, industrial wastes, intrusion of seawater or other saline water. It is the major form of inorganic anions inwater for aquatic life. Highchloride content has adeleteriouseffect onmetallicpipes and structures, as well as agricultural plants. Theyare calculated byArgentometric method.

Dissolved Oxygen

Oxygen dissolved in water is averyimportant parameter inwater analysis as it serves as an indicator of the physical, chemicaland biological activities of the water body. The two main sources of dissolved oxygen are diffusion of oxygenfromthe air and photosynthetic activity. Diffusion of oxygen from the air into water depends on the solubility of oxygen, and is influenced bymany other factors like water movement, temperature, salinity, etc. Photosynthesis, a biological phenomenon carried out bythe autotrophs, depends on the plankton population, light condition, gases, etc. Oxygen is considered to be the major limiting factor in water bodies with organic materials. Dissolved oxygen is calculated bymany methods.

Biological Oxygen Demand

Biological Oxygen Demand (BOD) is the amount of oxygen required by microorganisms for stabilizing biologically decomposable organic matter (carbonaceous) inwater under aerobic conditions. The test is used to determine the pollution load of wastewater, the degree of pollution and the efficiency of wastewater treatment methods. 5-Day BOD test being a bioassay procedure (involving measurement of oxygen consumed by bacteria for degrading the organic matter under aerobic conditions) requires the addition of nutrients and maintaining the standard conditions of pH and temperature and absence of microbialgrowthinhibiting substances.

Chemical Oxygen Demand

Chemical oxygen demand (COD) is the measure of oxygen equivalent to the organic content of the sample that is susceptible to oxidationbya strong chemicaloxidant. Theintrinsic limitation ofthetest lies in its abilityto differentiate between the biologically oxidisable and inert material. It is measured by the open refluxmethod.

Plankton: Amicroscopic communityof plants (phytoplankton) and animals (zooplankton), found usually free floating, swimming with little or no resistance to watercurrents, suspended inwater, nonmotileor insufficiently motile to overcome transport bycurrents, are called “Plankton”.

Phytoplankton(microscopicalgae) usuallyoccurs as unicellular, colonial or filamentous forms and is mostly photosynthetic and is grazed upon by the zooplanktonandotherorganismsoccurringinthesameenvironment. Zooplankton principally comprise of microscopic protozoans, rotifers, cladocerans and copepods. The species assemblage of zooplankton also may be useful in assessing waterquality.

Plankton, particularlyphytoplankton, has long beenused as indicators of water quality. Because of their short life spans, planktons respond quickly to environmental changes. Theyflourish both in highly eutrophic waters while a few others are very sensitive to organic and/or chemicalwastes. Some species have also been associated with noxious blooms causing toxic conditions apart from the tastes and odour problems.

Culture Fisheries

Fish culture has been encouraged bythe Andhra Pradesh from 1977 as a source of additional income to the fisherman of Kolleru by organizing fishermen cooperative societies. About 133 fish tanks have been constructed having a total extend of over 2400 ha. This has encouraged the private entreprenours to develop pisciculture and more than 5000 ha were converted into fish tanks. In addition, there are several important occupation. The fishermen cooperative societies could not make any headway in fish that are used in the culture are: catla catla, cirrhinus mrigula, cabeo rohita, cyprinus carpio, ctenopharyngodon idella and Hypophthalmichthysmolitrix. The area covered byfishtanks at various (contours) of the lake bytheyear 1982 is as follows.

This area has increased to 3750ha by1984 and there after the increase has been contineous and rapid. As there is no machineryto regulate the digging of fish tanks, the lake area has been pock marked bythese tanks ina disorderly manner resulting in the obstruction to the free flow of water especiallyduring monsoon.

Exotic Species

Oreochromis mossambicu, popularly known as Java tilapia was introduced in Indianwaters during 1952 (Shettyet al. 1989). This cichlid fish is hardy and breeds in confined water. Under tropical conditions, it spawns repeatedlyat intervals of about a month throughout the year, excepting winter. The species exhibits remarkable parental care. Intially, monosexualculture was practised and the returns were good in Tamilnadu. Now, the species is going to be a menace in the Kolleru area as it has entered the naturalwaters. This prolific breeder, which is omnivorous and cannot easily be attacked bypredatory fishes like Channa sp. because of its strong dorsal spines will become a major problem. It has also entered the fish tanks in some areas and has become a source of concern to the fish farmer. The entry of this fish into the fish tanks results in reduced returns. In the wild, if it establishes firmly, maycopare with manyother species especially Anabas species which is of economic value and may even replace the later in course of time.

Other exotic species like the grass carp, Ctenopharyngodon idella and the silver carp, Hypophthalmichthys molitrix do not breed in confined waters and have not become ecologically competitive so far. Morever, there is not record to show that they have entered natural waters.

Molluscan Fauna

1. Bellamya bengalensis
2. Bellamya dissimith’s
3. Pila virens
4. Amnicola travancorica
5. Melanoide tuberculata
6. Thira Scabra

7. Lymnaea accunianta
8. Lymnaea tuteola
9. Indiplanorbis exustus
10. Gyralus convexusculus
11. Melamps singagrensis
12. Lamethidens marginalis

Tourism

The kolleru lake is a source of delight for those who admire the beauty of Nature and Love recreation activities, like boating, fishing and bird-watching. A number of colorful migratory birds from as far away as Siberia arrive here during October and depart by the middle of April. There are more than 60 species of birds and a Pelicancy sanctuaryin the area. The lake, once a heaven for colorfulmigratorybirds like storks is no longer their sanctuary. Thisis due to the occupation of the islands by man, destruction of water insulted trees on which these birds used to rest as a protection against snakes and predators. Besides pollution there is muchover-fishing by mandepriving thesebirds copious supplyof aquatic food.

Abird sanctuaryat Agadallanka, another in between Kollatikota and Prathikollanka and a third are for birds and animals at Minapaka lanka are proposed by selecting uninhabited spots. Guest houses one at Prathikollanka and another at Kolletikota and 8 cottages along Thokalapallidrainare proposed. Mechanized boats with low-power of countryboats must be used to minimise disturbance to the birds, life.

3.3 Pulicat Lake

Pulicat lake, the country's second largest brackish water ecosystem after Chilka in Orissa, is facing an ecological crisis with its area shrinking and fish dwindling due to silting and indiscriminate fishing, a studyhas found.

The lake in Tamil Nadu's Tiruvallur district is home to 160 different fish species and more than 110 varieties of terrestrial and aquatic birds and small mammals and reptiles.

About 15,000 flamingos visit the lake on their annual migration route. More than 60,000 migrant water birds feed and breed in the northern part of lake during winter. About 40,000 people living in 34 villages on the banks of the lake on the Tamil Nadu side, depend directly or indirectly on the lake.

Geography and Topography

The lagoon's boundary limits range between 13.33° to 13.66° N and 80.23° to 80.25°E, with a dried part of the lagoon extending up to 14.0°N.;

with about 84% of the lagoon inAndhra Pradesh and 16% in Tamil Nadu. The lagoon is aligned parallel to the coast line with its western and eastern parts covered with sand ridges. Area of the lake varies with the tide; 450 square kilometres (170 sq mi) in high tide and 250 square kilometres (97 sq mi) in low tide. Its length is about 60 kilometres (37 mi) with width varying from 0.2 kilometres (0.12 mi) to 17.5 kilometres (10.9 mi). Climate of the lagoon coast line is dominated by Tropical monsoons. Air temperature varies from 15 °C (59 °F) to 45 °C (113 °F). The large spindle-shaped barrier island named Sriharikota separates the lake from the Bay of Bengal. The Satish Dhawan Space Centre, located on the north end of the island. is the launch site of India's successful first lunar space mission, theChandrayaan-1.

There are a large number of fishes and the crustaceans, around 1200 tonnes those have harvested in a year. Out of the fishing activity, the prawns constituted ofthe 60% ofthetotalfishing along with the mullets. There is a huge amount of the seafood export from this region that includes the Tiger prawns, white, finfish, jellyfish, live green crabs from the lagoons. There are in all 168 species found in the Pulikat lake.

Hydrology

Three major rivers which feed the lagoon are the Arani River at the southern tip, the Kalangi River fromthe northwest and the Swarnamukhi River at thenorthernend, in addition to some smaller streams. The Buckingham Canal, a navigation channel, is part of the lagoon on its western side. The lagoon's water exchange with the Bayof Bengalis through an inlet channelat the north end of Sriharikota and out flow channelof about 200 metres (660 ft) width at its southern end, both of which carry flows only during the rainy season. The water quality of the lake varies widely during various seasons – summer, pre–monsoon, monsoon and post– monsoon – as the depth and width of the lake mouth varies causing a dynamic situation ofmixing and circulation ofwaters. The resultant salinityvariation and DO (dissolved oxygen) affects the primaryproduction, plankton, biodiversity and fisheries in this lake.

Salinity values vary from zero during the monsoon to about 52,000 ppm (hyper saline) during post and pre–monsoon seasons. Adjustment to this wide variation is difficult for sessile and sedentaryspecies in the lake. However, euryhaline species stilldwell in the lake.

Flora and Fauna

The lagoon has rich flora and fauna diversity, which supports active commercial fisheries and a large and varied bird population.

Limnology

Fishing is the major occupation in the manyvillages located around the lake peripheryand on the islands. The lake has rich fish diversity, mostly marine species, some truly brackish water and a few freshwater species. Mullets and Catfish are the major brackish water fish, which have supported sustenance fishing for the lake fishermen. The lake is a nursery for several species of fish. Two thirds of the settlements in the lake area are in Tamil Nadu and the balance inAndhra Pradesh. 12,370 fishermen live on fulltime fishery in the lake (6,000 in Andhra Pradesh and 6,370 in Tamil Nadu). An average 1200 tonnes of fish and crustaceans are harvested annually, ofwhichprawns constitute 60%, followedbymullets. Seafood exports ofwhite and Tiger prawns, jellyfish, finfish and live lagoon Green crabs are also economic benefits from the lagoon. 168 total fish species are reported.

Avifauna

The shallow lake is known for its diversity of aquatic birds and is an important stopover on migration routes and is reported to be the third most important wetland on the eastern coast of India for migratory shorebirds, particularlyduring the spring and autumnmigration seasons. In view of the rich avifauna of the lagoon, two bird sanctuaries are established in the lagoon, one in each of the two states of Andhra Pradesh and Tamil Nadu.

The Andhra Pradeshportion of Pulicat Lake Bird Sanctuary, established in September 1976, has an area of 172 square kilometres (66 sq mi) within the lagoon's total area in the state in the Tada Taluk of Nellore district. The Wildlife Divisionofthe state has listed 115 species ofwater and land birds inthe sanctuary. The Tamil Nadu part of the lagoon of 60 square kilometres (23 sq mi) area, extending over the Ponneriand GummidipunditaluksofThiruvallur district was declared a Bird Sanctuary in October 1980.

Threats to the Lake

In the Andhra Pradesh part of the lake several threats to the lagoon have been identified. These are: pollution from sewage, pesticides, agricultural chemicals and industrial effluents – fromArani and Kalangirivers draining into the lake that bring in fertilizers andpesticides with the runofffromthe agricultural field in to the drainage basin, domestic sewage, effluents and wastes from numerous fish processing units; oil spills from the mechanized boats.

Threats to the Tamil Nadu part ofthe lagoonare fromtwo major sources. These are siltation and pollution.

Pollution and Human Impacts are: the Araniand Kalangirivers carrying runoff from agricultural fields in the drainage basin cause increase in pollution load fromfertilizers and pesticides into the lake; pollution fromdomestic sewage being released to the lake; Petrochemicalcomplex, power plant and a satellite port on Ennore creek

3.4 Sport fisheries in India

Sport fishing is a source of recreation to millions of people from India and abroad and it deserves the status of family recreation. It is an important element ofenjoyment and satisfaction derived fromthe sport fishing. The medical authorities also sayit is healthy for people to go fishing. Sport fishing satisfies diverse tastes and pursuits.

Most of the well known food fishes are also some of the best known game fishes. The true definition of a game fish or a sports fish is that any fish caught or angled on rod and lines putting up some fight and not thrownback in disgust bythe angler or sports man. Apart fromthis, the classificationof fish deal withsmallandbig game fish generallyweighing over 50 kgs. Trouts, snow trout's and Mahaseers, goonch ect. Placed under big game fish category. In addition, there are different kinds of methods within the sports fishing or angling.

Principal Game Fish (Sports fishery)

Based on their occurrence and ecosystem, the game fish classified into two groups, such as (a) Fresh water game fish (b) Estuarine and marine game fish.

The fresh water game fish listed as follow, Notopterus chitala, Chela arrgentea, Raimas bola, Tor Chillinoides, Tor putitora, Tor tor, T.Khudree, Acrossocheilus hexagonolepis, Schizothoraithys esocinus, Schizothorax Planifrons, Catta catla, Labeo calbasu, Labeo rohita, Cirrhinus mrigala, Wallago attu, Clupisomagarua, Silonia silondia, Pangasiuspangasius, Eutropiichthys Echa, Mystus (Aoricthys) aor, Mystus seenghala, Bagarius bagarius, Channa striatus, Canna marulius, Anguilla bengalensis and Mastacembelus armatus etc.

Eustuarine and Marine game fish have the following species Megalops cyprinoides Lates calcarifer, Eleutheronema tetradactylus, Lutjanus argentimaculata, Scomberomorus commersoni, S. guttatus, Sparus berda and Sparus datnia etc.

Fishing equipment

Sports Fishing and Tourism

India, one of the many countries of the world, earnsconsiderable foreign exchange throught our ismin cluding fishing. Among the carps of the India, several of which give (Mahaseer, trout etc.) good sports fishing satisfies diverse tastes and persuits. It is a source of recreation for millions of tourists.

3.5 Cold water fisheries

The cold water fish adopted to live below 10^0 c to 20^0 c temperature. The upland water at high altitudes of mountains and the spring water at low altitude in temperate regions remain cooler than the rest and the cold water fish flourish in this region. Such water bodies comprising several hill streams, rapids, pools, lakes and reservoirs are abundantly found in Himalayan region. And in the. Deccan plateau region of peninsular India. These are either fed by melting snow and the springs as in north or by the rain water as in Deccan plateau.

During recent years, there has been growin grealization for development of cold water fisheries in India, since the production from cold water is negligable in comparison to total inland catch. Thetrout hatchery established in Kashmir is one of the potential sources from where the brown trout have been transplanted to theupland waters of Jammu, Kashmir, Kullu, Simla, Kangra, Nainital, Shilong and Arunachal. Other hatcheries constructed at Nilgiris and Kerala.

Indigenous cold water fishes.

Mahaseer, snow trout and India hill trout are the principal cold water fish species inhabiting the mountain water of India. Mahaseer fishery of cold water. It is one of the major game fish of Himalayas. How ever, it has not received attention as exotic fish in India. It is generally found in large sizes and abundant inquantities from mountain streams and rivers. Some of the important species of mahaseer are:

1. **Tor tor (Hamilton) :** It is characterized by short head than the depth of the body. It attains a length of 1.5m and in the river Narmada and Tapti. It is insectivorous in its juvenile stage but becomes herbivorous when adult. It has a prolonged breeding season from July to December. The eggs are laid in batches. It constitutes the major fisheries of rivers Narmada and Tapti.

2. **Tor putitor(hamiton) :** It is commonly allied as goldenor common Himalayan Mahaseer. It has head longer than the depth of the body. It occur in the Himalayas from Kashmir to Darjeeling hills. This fish breeds thrice in a year, firstly during winter months(January to February), subsequently in summer (May- June) and lastly in August - September.

3. **Tor mosal (Sykes):** Mosal Mahaseer has head more or less equal to the depth of the body. It is found in the Mountain Rivers on foot hills of the Himalayas, Kashmir, Assam and Sikkim.

4. **Tor mosal mahmnadicus:** It resembles the mosal mahaseer in all aspects except, it is found in the river Mahanadi and that its head having small eyes is often higher than the depth of the body.

5. **Tor khudree (Sykes):** It is characterized by its head being as long as thedepth of the body. It is found in Orissa and throughout peninsular India. It attains a length of about 1.3 m.

6. **Acrossocheilu hexagonolepis (Mc Cleland):** It is commonly known as copper or chocolate Mahaseer. It has an oblong and compressed body with an obtusely round and prominent mouth. The colour of the body is deep is bluish greywith darkish fins. These are mainlydistributed Upper Ondia, Assamand Cauvery river in Tamil Nadu. It attains a length over 60 cm. it differs from Tort or in having hexagonal shape of its scales and the thin lips.

Exotic cold water fishes

The exotic fishes found in the hills streams of India chiefly include the trouts, mirror carps, crucian carps and tenches.

1. Trouts: Exotic trouts in India are represented bythree species, two of them belonging to genera Salmo and one to Onchorhynchus.

Short Anser Type Questions

1) Mention any two types of lakes.
2) Name the districts surrounded to kolleru lake.
3) Write the name of brackish water lake.
4) Write the name of the rivers enter into the pulicat lake.
5) Write the largest natural fresh ater lake in India.
6) Name the lake which is present in both A.P and Tamil nadu states.
7) Write any two names of fresh water game fish.
8) Mention any two exotic trouts.
9) Classists the type of game fishes.
10) Mentionthe temperature range of cold water fishes.
11) Mention anytwo cold water hill streams in India.

Long Answer Type Questions

1) Describe the fishers of kolleru lake.
2) Describe the fishers of pulicat lake.
3) Describe the status of coldwater fisheries.
4) Give an account on the importance of sport fisheries in tourism.

UNIT 4

Over Fishing,Effect of Dams and Barriages on Fisheries and Fish Migration

Structure

4.1 Introduction.

4.2 Over fishing.

4.3 Fish migration.

4.4 Effect of dams on fish migration and fisheries.

4.1 Introduction

The collectionoffish from naturalresources more than required is called "over fishing". Over fishing results indecreaseof fish population in wild resources. Moreover, theover fishing ofberried fishstop the breeding in the naturalresource, so, we shouldn`t do over fishing of the wish fish. More over, this indeed reduces the income & a fishermen in the nearest future. It mass be effect to biodiversity.

The life cycle of diadromous species takes place partly in fresh water and partlyin sea water. The reproduction of anadromous species takes place in freshwater, whereas catadromous species migrate to the sea for breeding purposes and back to freshwater for trophic purpose. The migration of potamodromous species, whose entire life cycle is completed within the inland water of a river system, must also be considered.

Based on the migratory habits Fishes can be classified into three types

(a) Resident species which prefer to remain confined within the local territories.

Ex : Channa. Notopterus. Cyprinus. etc.

(b) Local migrants which tend to perform seasonal migration with in short distances for feeding, breeding, etc. Ex Indian major carps, mahseers, cat fishes. etc.

(c) Long distant migrants whichperform regular annualmigrations for feeding or spawning or both Ex. Hilsa ilisha, Indian shad Hilsa ilisha migration got restricted to the portion of rivers below the anicuts and barrages and the fisheries bearing onthese stock declined considerable in the stretches of the rivers above the anicuts Hilsa fishery has been rendered practically non-existent.

Another bad effect has been found in the case of Pangasius pangasius in the Ganga, the Brahmaputra, the Mahanadi and the Godavari rivers. Dams located onthe lower and middle reaches of these rivers obstructed the migration of this and adverselyaffected its population.

4.2 Over Fishing

In 1990's fishing reached the point of diminishing returns. Many population have fallen to levels at which they can no longer recover without significant reduction in catches or amoratorium on fishing. There are simplytoo manyboats catching too manyfish. The first surge in number of fishing vessels occurred during the industrialrevolution. The world's fishing fleet doubled between 1970 and 1990 with around 1.2 millioncommercialvessels scouring theworld oceans today. Russia and five other countries account for 90 percent of the high-sea catches.

India has about 47,000 Mechanised vessels, 36,500 motorised vessels and 1,50,000 artisanalvessels. Withintroduction ofmechanised bottomtrawling from the late 50's the exploitation ofdemersalfishes attained a 2.7- fold increase during 80's.but the proportion of productionwent downfrom about 32% ofthe total in 1981 to about 22% in late 80's.as a result of intensive coastal **trawling** and the introduction of '**purse-seines'** manyprominent fish resources declined in production. This was due to **recruitment over fishing** resulting from the destruction of juveniles as wellas trampling ofthe bottom habitat.

The main cause of the world's fisheries crisis is **chronic overfishing,** subsidised by governments attempting to prop-up an unsustainable industry. Further more, the **European Union**(**EU**) has around 40% more vessels than necessary to catch fish on a sustainable basis. Worldwide, there are more than 1 million large "**industrial" fishing vessels**, and **2 millon smaller fishing boats.** These fleetsmust be cut to fit the dwindlingresource, and fishpopulations allowed torecover.

4.2.1 Conservation of wild fish and fisheries

The deterioration of the marine environment through various human activities and declining fishing yields (through overfishing, oilspills or pollution loads) inthe coastal areas of India has attracted the attention of the naturalists and policymakers and prompted them to develop conservational stratiges. The International ConventiononBiodiversityConservationheld at Rio inDec. 1992 is the outcome of the globalawarenessthat it is our ethicalobligationto strive for.

A'sustainable development that meets the needs of the present without comprising the abilityof the future generation, to meet their ownneeds'. **The indiscriminate exploitation of the rich marine natural resources** has lead to denudationofmany area, destructionof habitats and disappearance of rare animals and plans. Many developing countries have formulated rules and regulations regarding exploitation of naturalmarine resources.

The Wild Life Protection Act (1972) provides legal protection of manymarineanimals and Chapter IVofthisAct dealingwithsanctuaries, National Park Game Reserves and closed areas is equally applicable to marine reserves

also. The **Ministry of Environment and Forests, the Government of India,** constituted a national Committee on Mangroves, Wetlands and Coral reefs in 1933 with a view to explore the mean for conservation ofthe said ecosystems.

(i) The National Marine Park in India

For thesake of givingprotection to marine life, followingNationalparks have been established, So far

1. The Gulf of Mannar National Park.
2. The Gulf of Manner National Park : Islands from Rameswaram to Tuticoin –TamilNadu
3. The Wandoor National Marine Park South Andamans –Andaman .
4. Proposed Marine National Park in Lakshadweep Islands.

(ii) Sanctuaries

1. Bhittarkanika –Gahirmatha sanctuary– Odissa.
2. Malvan Marine Sanctuary– west coast of Maharashtra.
3. Proposed extension of konark -Balukhand sanktury atkuiang - of strang –Odissa.
4. Proposed extension of Point Catimore Sanctuary: Tamil Nadu.

4.3 Fish Migration

Fish populations are highly dependent upon characteristics of the aquatic habitat whichsupports all their biologicalfunctions. This dependence is most by marked in migratory fish which require different environments for the main phases of their life cycle whichare reproduction, production of juveniles, growth and sexualmaturation. The species has to move from one environment in order to survive.

It has become customary to classifyfish according to their capacity to cope during certain stages of their life cycle with water of differing salinities (McDowall, 1988). The entire life cycle ofthe **Potamodromous** species occurs within fresh water of a river system (Northcote, 1998). The reproduction and feeding zones maybe separated bydistances that many vary from a few meters to hundreds of kilometers.

The life cycle of the **diadromous** species takes place partly in fresh and inmarinewaters, withdistances ofup to severalthousandsofkilometers between the reproduction zones and the feeding zones.

Two different groups can be distinguished in the categoryofdiadromous species

- **Anadromous** species (e.g. salmon), whose reproductiontakes place in freshwater withthe growing phase in the sea. Migration back to freshwater is for the purpose of breeding

- **Catadromous** species (e.g. eel) have the reverse life cycle. Migration to the sea serves the purpose ofbreeding and migration back to freshwater is a colonization for trophic purpose. Catadromous is much less common than anadromy.

4.4 Effects of dams on fish migration and fisheries

The construction of a dam on a river can block or delay upstream fish migration and thus contribute to the decline and even the extinction of species that depend on longitudinal movements along the stream continumduring certain phases oftheir life cycle. Mortality resulting from fish passage through hydrotic turbines or over spillways during their downstream migrationcan be significant. Experience gained showsthat problems associated with downstream migration can also be a major factor affecting anadromous or catadremons fish stocks. Over fishing is called as the collection of fish from natural resources more than required. It maycaps to disturb the ecosystem of water body and may effect to biodiversityoffish fauna.

With the accomplishment of **river valley projects,** the free flowing river stretches are bound to be changed into huge lacustrine habitats and the dams, wiers, anicuts, barrages etc. affect fish populationdirectlyor indirectly. In the former case, these barricading structures act as physical barriers to fish migrations, whereas in the latter case ecologicalconditions are changed.

Other changes also occur, such as inundation of spawning grounds, fluctuationinwaterlevels, alterationinthe physico-chemicalconditionofspawning area in theupper reaches, disappearance ofmarshland constituting the spawning and feeding grounds of important food fish, changes in the transparencylevels etc.

The building of a dam generally has a major impact on fish populations: migration and other fish movement can be stoppedor delayed, thequality, quantity and accessibility of their habitats, which plays an important role in population sustainability, can be affected. Fish can suffer major damage during their transit through hydraulic turbines or over spillways. Changes in discharge regime or water qualitycanalso have indirect effects uponfishspecies.

Upstream Migration

One ofthe major effects oftheconstructionof a dam on fish populations is the decline of anadromous species. The dam prevents migration between feeding and breeding zones. The effect can become severe, leading to the extinction of species, where no spawning grounds are present in the river or its tributary downstreamof the dam.

Since the nineteenth century, there has beena continuous and increasing decline in the stock of diadromous species in France: in a large majority of cases, the main causes of decline have been the construction of dams preventing free up stream migration..

Downstream Migration

In the first stages ofdam development, engineers and fisheries biologists were preoccupied with providing up stream fish passage facilities. Passage through hydraulic turbines and over spillways was not considered to be a particularly important cause ofdamage to downstreammigrating fish. Experience has shown that problems associated with downstream migration can be major factors affectingdiadromousfishstock.

Development of reservoir fisheries

Studies conducted by **Central Inland Capture Fisheries Research Institute (CICFRI),** barrack pore, over 2 decades in a number of small reservoirs, situated in different agro climatic zones of the countryhave clearly demonstrated that **a fish yield up to100-200 kg/ha** can be achieved **from small**

reservoirs by adopting extensive aquaculture techniques, if managed scientifically. In case of reservoirs created by damming activity, **the natural estimated average fish production may range from 6-7 kg/ha.**

For thesustainabledevelopment offisheries inIndianreservoirs following steps should be adopted.

1. Fish Faunal Surveys before the Impoundment

The reservoirs can be utilized as a bulk fishery with the inventory of fishermen population, fishing crafts and gears used in the area, is essentialfor the planned development, Recommendations regarding provision of fish-ways, stocking, conservation etc. should be made and followed.

2. Stocking of Reservoirs

The reservoirs can be utilized as a bulk fishery resource if dense stock of commercially important special (Indian Major Craps or Exotic carps) is maintained by stocking the reservoirs from outside source. Preference should be given to **stocking those species which are endemic** to **particularregions,** e.g., **coldwater fish in coldwater zones; peninsular sp**. **in south Indian waters, etc**. Stocking operations should also be taken up in the areas which are not deficient in fish food and where the introduced sp.

It has been suggested that fingerling of Indian Major Carps of about 100 mm in total length, should be released in equalratio, on an average of 500/ ha in the first year.

3. Establishment of fish farms at Dam Sites

To enhance the fish production in the reservoirs, fish of commercial importance have to be stocked there from outside source, whether through naturalstocksor after rearing fingerlingnear the reservoir site. Therefore, schemes have been launched at manyreservoirs to construct fish farms.

4. Locating the Breeding Sites in theReservoirs

Different fishes have different breeding habits . Some breed exclusively in flowing water, while other in flowing as well as standing waters. Therefore, investigations should be done to locate spawning groundsand spawncollections be done for stocking purposes

5. Rehabilitation offishermen

Generallythere is no fishermen communitysettled in the vicinity of the reservoir and it will be fruitful to establish fishermenpopulationat places which are close to good fishing grounds andare easilyaccessible, so that the landing of fish catching operations are taken proper care and easily disposed, all fishermen should be properlytrained and be organized in a manner as to form cooperative societies to get rid of the middle men problems.

6. Experimental Fishing

Experimental fishing is suggested to be done to judge the efficacy of the crafts and gears used there. The results of experimental fishing have led to the improvement of the local nets, designing of the new nets use of echo sounders as wellas light and electro fishing.

7. Commercial FishingOperations

(i) Fishing by Govt. Agency : In most of the states fishing by the Department of Fisheries is done to a limited extent as it is not an economic and the catches are always very poor due to the limited number of employees and desirable quantity of equipments. Thisshould, therefore belimited to experimental fishing only.

(ii) Auctioning : In states like Rajasthan, Madhya Pradesh, Uttar Pradesh, Uttaranchal and Punjab etc. the reservoirs are auctioned to private pisiculturists or cooperative societies on yearlybasics. The contractors remain alert, keep close watch on poaching by others and thus try to get better fish landing to bring themselves to profits, bytransporting iced fish to distant places.

(iii) Fishing Licences : State governments have made provision of issuing fishing licences to individuals or cooperative societies. The fish landings are supposed to be brought to destined landing centers from where they are handed over to the contractor ona prefixed rate. SometimesGovernment. gives motor boats to the society for the transportation of catches, while the society may owna refrigerated truck for the transporting fish.

(iv) Fishing Methods : The reservoir fishing is mostlyrestricted to gill or drag-netting, with the help or non-mechanised or mechanized boats. Sometimes, hook and line and trapping method are also applied, but that, too, in shallowmarginalzones.

For judicious exploitation of fishery resources various rules and regulations under the Indian Fisheries Act should be effectively enforced laying more emphasis onallowed limits of mesh-size, limits of size of fish to be caught, declarationofclosed fishing seasonfromJuneto September (to allowunhampered migrations and breeding), declaring certain areas assanctuaries, protection from heavypollutional load from the industries etc.

Short Answers Type Questions

1. Define over fishing.
2. Where does the maturation of diadromous fish take place.
3. What is called potadromous migration ?
4. What is called diadromous migration ?
5. What is called anadromous migration ?
6. What is called catadromous migration ?
7. Expand “EEZ”.
8. Give two examples for the national marine parks in India.
9. What are the main functions of the nationalmarine park ?
10. Define a “ sanctuary of fish .
11. What are the main functions of “Fish Sanctuary” ?
12. Define“Amphidromous migration”.
13. What is called a “Dam” ?
14. Define “Fish Faunal Survey”

Long Answer Type Questions

1. Give a detailed account on dams and barrages and fish migration.
2. Write an essay on “Over Fishing”.

UNIT 5

Fish Processing and Preservation

Structure

5.1 Introduction

5.2 Fish and prawn spoilage

5.3 Processing and preservation of fish.

5.1 Introduction

When the fishes are caught in numbers, greater than the amount of consumption their preservation becomes a necessity for their future use. Preservation and processing therefore become a very important part of commercialfisheries. It is done in such a manner that the fishes remain fresh for a long time, with a minimum loss of flavour, taste, odour, nutritive value and the digestibility of their flesh. The decomposition or spoilage of fish occurs mainly due to various chemical, microbial and the enzymatic action. Employing anyone of the methods like freezing, drying. Salting, smoking and canning achieve the preservation of fish.

The term fish processing refers to the process associated with fish products between the time fish are caught or harvested, and the time the final product is delivered to the customer. Although the term refers specifically to fish, in practice it is extended to cover any aquatic organisms harvested for commercial purposes, whether caught in wild fisheries or harvested from aquaculture or fish farming.

Fish is a highly perishable food which needs proper handling and preservation if it to have a long shelf life and retain a desirable quality and nutritional value. The central concern of fish processing is to prevent fish from deteriorating. The most obvious method for preserving the quality of fish is to keep them alive units they are readyfor cooking and eating. For thousands of years. China achieved this through the culture of carp. Other methods used to preserve fish and fish products include.

- The controlof temperature using ice, refrigeration or freezing
- The controlof water activity by drying, salting, smoking or freeze- drying
- The physical control of microbial loads through microwave heating or ionizing irradiation
- The chemical control of microbial loads by adding acids
- Oxygen deprivation, such as vacuum packing.

5.2 Fish and prawn spoilage

Fish is a perishable food- after a few hours of death at around 8 hours, it become useless, foul smelling and unsuitable for eating. It is called fish spoilage. Thus fish spoilage is the deterioration of fish making it foul smelling and inedible. Preservation is the storage of the fish and fish products without decay and fit for human consumption.

Fish or prawn Spoilage is caused bythe following actions.

1. Chemical action
2. Autolysis or enzymatic action.
3. Microbial action.

Freshness of fish.

Freshness is usually judged in the trade entirely by appearance, odour and texture of the raw fish. Since assessment depends upon the senses, these to look for the freshness of fish are:

i. The general appearance of the fish including that ofthe eyes, gills, sur-face slime and scales and the firmness or softness of the flesh.

ii. The odour of the gills and belly cavity;

iii. The appearance, particularly the presence and of discolouration along the underside, of the backbone.

iv. The presence or absence of rigor mortis or death stiffening.

v. The appearance of the belly walls.

causes of spoilage of fish

In the cooler regions of the world the fish preservation is not required for a few days after their capture. This is because, the temperature is low enough to discourage the bacterial growth as so the spoilage offish is minimized.

In tropical regions such as India, the hot climate favours rapid growth of bacteria and so the spoilage of fish flesh becomes inevitable. Landed fish may ordinarily remain fresh for not more than 8 hours and begin to decompose rapidly after that. The decomposition or spoilage of fish flesh occur mainly due to various chemical, microbialand the enzymatic action.

Chemical Action

The chemical action involves oxidation of fat, containedwithin the fatty tissues ofthe fish. It is more pronounced in fat fishes (e.g. oil sardine, mackerels, catla, trout, grass carp etc.) which as a result become decolourised. The oil starts getting oxidized as soon as it comes in contact with the atmospheric air, which is known as rancidity. The colour in contact with the and its viscosity changes and the fish becomes strong tasted. Methods employed to prevent rancidity include applicationof antioxidants like polyphenols or other viscous fluid and minimizing exposure of fish to atmospheric air.

Microbial action

Microbialaction involves bacterial decomposition of the fish flesh. The bacteria are found in the lower part of the gastrointestinal tract and on the general body surface of the fish. Theymay also be contributed from the surrounding insanitary a most suitable place for their growth and multiplication.

Proteins, constituting 70-90% are degraded by proteolytic organism such as pseudomonas, proteus, Chromo bacterium, Halo bacterium, and Micrococcus, etc. the Carbohydrates, present in small amount in the fish flesh are spoiled by carbohydrate fermenting organism like streptococcus, *Leuconostoc,* Micrococcus, etc. fasts constituting 3-5% ofthe flesh are digested by relatively few gram negative bacteria. Degradationprocess occurs through the processes as follows.

Proteolytic micro-organisms

Proteins ——————> Amino acids + Amines+ Ammonia + Hydrogen sulphide

Fermentive micro-organisms

Carbohydrates ——————>Acid + Alcohols + Gases

Lipolytic micro-organisms

Fats ——————————— > **Fatty acids + Glycerol.**

2.5 Autolysis or Enzymatic action

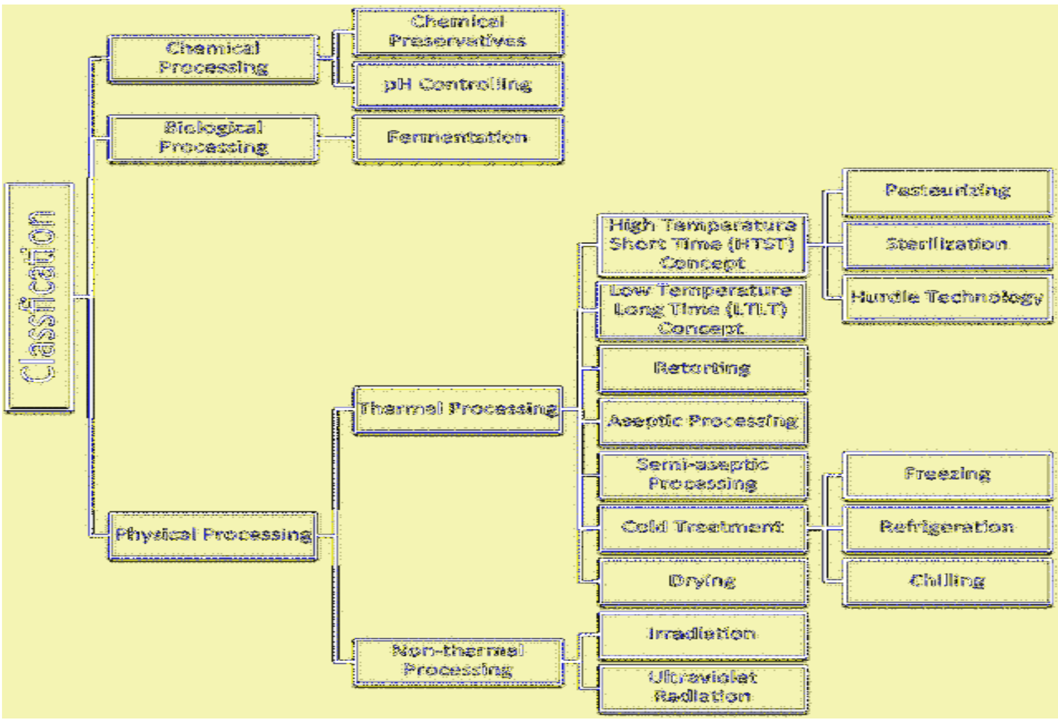
Enzymatic action is due to actionof various enzymes found in the body tissues/ cells of fishes. They spoil the tissue bythe process of autolysis and make the fish susceptible to bacterial attack. Proteinase for example can digest muscle proteins of the fish, catalase, the gillspoilage andATP ase brings about a complete disappearance of TP, from muscle tissue in 6 to 8 hours. Autolys is which on further decomposition like various amines and fatty acids, and foul smelling products like indole, skatole, etc.

5.3 Processing and preservation of fish

5.3.1 Processing of fish and prawns

Fish processing can be subdivided into fish handling, which is the preliminary processing of raw fish, andthe manufacture of fishproducts. Another natural subdivision is into primary processing involved in the filleting and freezing of fresh fish for onward distribution to fresh fish retail and catering outlets, and the secondary processing that products, or products chilled, frozen and canned products for the retail and catering trades.

Fishprocessing is also concerned with proper waste management and with adding values to fish products. There is an increasing demand for ready to eat fish products, or products that don‘t need much preparation.



Processing techniques flow chart

Handling the catch

When fish are captured or harvested for commercial purpose, they need some preprocessing so they can be delivered to the fish caught by a fishing vessel need handling so they can be stored safely until the boat lands the fish on shore. Typical handling processes are.

- Transferring the catch from the fishing gear (such as a trawl, net or fishing line) to the fishing vessel
- Holding the catch before further handling
- Sorting and grading
- Bleeding, gutting and washing
- Chilling
- Storing the chilled fish
- Unloading, or landing the fish when the fishing vessel returns to port.

The number and order in which these operations are undertaken varies with the fish species and the type of fishing gear used to catch it as wellas how large the fishing vessel is and how long it is at sea, and the naturalof the market it is supplying. Catch processing operation can be manual or automated. The equipment and procedures in modern industrial fisheries are designed to reduce the rough handling of fish, heavymanuallifting and unsuitable working positions whichmight result in injuries.

Handling livefish.

An alternative, and obvious way of keeping fish fresh is to keep them alive until they are delivered to the buyer or ready to be eaten. This is a common practice worldwide. Typically, the fish are placed in a container with cleanwater, and dead, damaged or sick fish are removed. The water temperature is then lowered and the fish are starved to reduce their metabolic rate. This decreases fouling of water with metabolic products (ammonia, nitrite and carbon dioxide) that become toxic and make it difficult for the fish to extract oxygen.

Waste Management:

Waste produced during fish processing operation can be solid or liquid.

Solid waste : Include skin, viscera, fish heads and carcasses (fish bones.)Solid waste can be recycled in fish meal plants or it can be treated as municipal waste.

Liquid waste : Includeblood water and brine fromdrained temporarily, and should be discharges from washing and cleaning. This waste may need holding temporarily, and should be disposed of without damage to the environment. How liquid waste should be disposed from fish processing operations depends on the content, and oil and grease content. It also depends on an assessment of parameters such acidity levels, temperature, odour, and biochemical oxygen demand and chemical oxygen demand. The magnitude of waste management issues depends on how much waste volume there is, the natural of the pollutants it carries, the rate at which it is discharged and the capacityofthe receiving environment to assimilate the pollutants.

Quality and Safety

The internationalorganization for standardization, ISO, is the worldwide federation of national standards bodies. ISO defines quality as “the totality of feature and characteristics of a product or service that bear on its ability to satisfy stated or implied needs. “(ISO 8402). The quality of fish and reduced if appropriate practices are followed when handling, manufacturing, refrigerating and transporting fish and fish products. Ensuring standards of qualityand safety are high also minimizes the post-harvest losses”.

“The fishing industrymust ensure that their fishhandling, processing and transportation facilities meet requisite standards. Adequate training of both industry and control authority staff must be provided bysupport institutions, for channels for feedback from consumer established. Ensuring high standards for quality and safetyis good economics, minimizing losses that result from spoilage, damage to trade and from illness among consumers”.

Fish processing highly involves very strict controls and measurements in order to ensure that all processing stage have been carried types of food safety system. One of the certifications that are commonly known is the Hazard Analysis Critical Control Points (HACCP).

5.3.6. Preservation of fish and Prawn

Preservation techniques areneeded to prevent fishspoilage and lengthen shelf life. Theyare designed to inhabit the activityof spoilage bacteria and the metabolic changes that result in the loss of fishquality. Spoilage bacteria are the specific bacteria that produce the unpleasant odours and flavours associated with spoiled fish. Fish normallyhost manybacteria that are not spoilage.

Bacteria, and most of the bacteria present on spoiled fish played no role in the spoilage. To flourish, bacteria need the right temperature, sufficient water and oxygen, and surrounding that are not too acidic. Preservation techniques work byinterrupting one or more of these needs. Preservation techniques can be classified asfollows.

Fish preservation is a very important aspect of the fisheries. Normally the fish farms or other fish capturing sites are located far off from the market places and there is chance of fish decomposition and the uncertainties of their sale in market. When the fishes are caught in numbers, greater than the amount of consumption, their preservation because a necessity for their future use. Preservation and processing, therefore becomes a very important part of commercial fisheries. It is done in such a manner that the fish remain fresh for a long time, witha minimum loss offlavour, taste, odour, nutritive values and the digestibility oftheirflesh.

5.3.7 Methods of preservation

Preservation can be done, both for short and long duration

1. Preservation forshort duration

Chilling : Thisis obtained by covering the fish with layers of ice. However, ice alone is not effective for long preservation, because melting water bring about a short of leaching of valuable flesh contents which are responsible for the flavour. But ice effective for short terms preservation suchas is needed to transport landed fish to nearbymarkets or to canning factories, etc. hereautolytic enzymatic activities are checked bylowering the temperature valuableflesh contents which are responsible for the flavon. But ice is effective for short terms.

2. Preservation forlong time

When the preservation is required for a long period of time, the fish are passed through the cleaning, gutting and conservation and storage.

3. Cleaning

During cleaning, the caught fishwashed thoroughlyincold, clean water to remove bacteria, slime, blood, faces and mud, etc from the bodysurface of this fish. It is being done under proper sanitaryconditions.

4. Gutting

After cleaning, the fish are cut along their mid ventral side, and their visceral organs are removed. Byremoving viscera, the bacteria in the gastro intestinal tract and enzymes of visceral organs are removed along with it to prevent bacterialdecompositionand enzymatic autolysis respectively.

Preservation offish in cold storageis practised on a smallscale in India. Cold storagepreservationoffish ispractised at the placeswhere storage facilities are available. The fish are preserved overnight in cold storage and marketed the next day. With the increase in availability of ice Fish is transported in ice by different modes of transport like rail, trucks, motor launches, ect. The west coast has a large number of freezing plants at place like Bombay, Mangalore, Cochin, Trivandrum where freezing of prawns, lobsters and frog legs are undertaken. At Bombay fishes like pomfrets, jew fishes , etc, are frozen and stored for several months.

Oil sardine, mackereland seer are the three commercialimportant food fish used in the application of refrigerated sea water for preservation. These fishes were stored in artificial sea waters prepared bydissolving common salt to give a sodiumchloride content 3.5% at a temperature of -1.1 to 0^0C.Ingeneral the fish stored in refrigerated seawater had firmer textureand better appearance than ice-stored one.

In general different methods of freezing are adapted through sharp freezer.

Air blast freezer, contact plate freezer, verticalplate freezer, immersion freezing, liquid Freon freezing, liquid nitrogen freezing, fluidizing bed freezer, cryogenic freezing, sub freezing etc. All the methods of freezing shall help in absorption of heat and inpreserving the initial qualities of fish. Among the various methods of freezing the best freezer is mostlyin use in India. The air blast freezer is in the form of a tunneland heat transfer is effected rapidly bythe circulation of air. The temperature used ranges from 0 to 30^0C and air velocityvaries from 30 to 1050 meters/mt.

1. Freeze drying

This is modified deep freezing, completely eliminating allchances of de- naturation. The deep frozen fish at -20^0C is then dried by direct sublimation of ice to water vapour with melting into liquid water. This is achieved byexposing the frozenfish to 140^0C in a vaccumchamber. The fish is then packed or canned in dried condition. Anyloss of flesh contents byway ofleaching during melting of ice is thus avoided. The product is quite fresh looking in appearance, flavour, colour andquality.

2. Filleting and freezing of fish.

The processing industry also adopted freezing of fish in the form of fillets at times when prawns are not available. Fillets are nothing but the strips of flesh cut parallel to the backboneofthe fish. Fisheslike milk fish, cat fish, perches, mullets, carps, eels, etc., are suitable for filleting and freezing. Filleting can be done byhand which is economicalor byusing a filleting machine. Fillets maybe or without skinand it fetches a much higher price in the luxurymarket.

Fillets are dripped in brine to enhance their appearance and to reduce the amount of drip and it also gives a saltyflavour. The freezing offillets can be an individualquick freezing of block freezing. After dropping inbrine, the fillets wrapped in polythene sheet and frozen in contact plate freezer at -35^0 C to 40^0C.in bloc freezing the fillets in known weight 500gr., 1kg., 2kg. and packed inpolythene bag'slined withwaxandsufficient quantityofglazedwater is poured to cover the fillets. The fillets are put in a freezer at -35 to 40^0C and stored at -23^0C.

5.3.8 Drying

Drying involves dehydration i.e. the removal of moisture contents of fish, so that the bacterial decomposition or enzymatic autolysis does not occur. When moisture contents reduce up to 10%, the fishers are not spoiled provided they are stored in dryconditions. Fish is achieved either naturally or byartificial means.

1. Natural drying

In natural drying the fish after being caught are washed and dried in the sunshine. They are suspended or laid out flat on the open ground. The process. However, has a number of disadvantages. It is slow and results in much loss, through putrefaction.

2. Artificial drying

In artificial drying the killed fish are cleaned, gutted and have their heads removed. They are then cut lengthwise to remove large parts of their spinal column, followedbywashing and drying them mechanically.

5.3.9 Salting

Salting is a process where the common salt. Sodium chloride is used as a preservative which penetrates the tissues. Thus bacterialgrowth and inactivates the enzymes. Salting commences as soon as the fish surface of the fish comes with common salt and the product shall have the required salinity with taste and odour.

Some of the factors involved in salting of fish which play an important role are purity of salt, quantify of salt used, method of salting and weather conditions andtemperature, etc.

During the process the small fish are directlysalted without being cleaned. In the medium and large sized fish the head and viscera are removed and longitudinal cuts are made with the help of knives in the fleshy area ofthe body. Then the fish is washed and filled with salt for uniformpenetration throughflesh. Large fish like sharks are cut into convenient sized pieces. Generally, sardines, mackerels, seer fish, cat fish. Sharks and prawns are used for salting.

The salt used should be pure common salt so as to keep the quality of the fresh fish. Traces of calciumand magnesiumcaused whiteningand stiffening of the flesh and gives bitter or acid flavour to the product. In addition it does not allow the easy penetration of common salt. Dry salting, wet salting and mixed salting are the three methods employed in salting of fish.

1. Dry salting

In this process the fish is first rubbed in salt and packed in layers in the tubs and cemented tanks. The salt is applied in betweenthe layers of fish in the proportion of 1:3 to 1:8 salt to fish. The proportionof salt to fish varies with the fish since the oily fish require more salt. At the end of 10-24hours the fish age moved from the tubs and washed in salt brine and dried in the sunfor 2or3 days. Large fish lose about on third and small fish about one half of their dressed weights.

2. Wet salting

The cleaned fish are put in the previously prepared salt solution. It is stirred daily till it is properlypicked. In some fish like seer, black pomfret, India salmon etc. the gut is removedand filled with salt in 1:3 proportion. First the salt is filled in the gut region of the fish and stacked, on the following day, further addition of salt is done since the salt settles down at the bottom. Finally the process is repeated to ensure the proper filling up of salt and left undisturbed for 7-10 days allowing the liquor to flow off. This method is mostly followed in eastern parts of our country. In western parts the gut is removed and the salt is applied in one lot and theyare arranged in bamboos baskets. The fish preserved in wet salting process are to be consumed before the rain sets in and the fishes are marketed without drying.

3. Mixed salting

In this process, simultaneous use ofsalt and brine is followed. The salting process is continued till the concentration of salt in the fish tissue. The salting process mayaffect the shape, structure and the mechanical features of music tissue.

4. Pit curing

It is another process employed in south and south east of our country. In this process the fish treated with salt are buried in pits lined withleaves. After 2-3 days they are removed and marketed directly.

5.3.10 Smoking

In this method, landed fish is cleaned and brined. It is then exposed too cold or hot smoke treatment. In cold smoking, first a temperature of 38^{0}C 1-3 raised from a smokeless fire. After this heating, cold smoke at a temperature below 28^{0}C is allowed to circulate to past the fish. In case of hot smoking, fish a strong fire produces a temperature around 130^{0}C. This is followed by smoking at a temperature of 40^0 C. The smoke has to be wet and dense. Good controls are necessary over density, temperature, humidity, speed of circulation, pattern of circulation and time of contact with fish of the smoke.

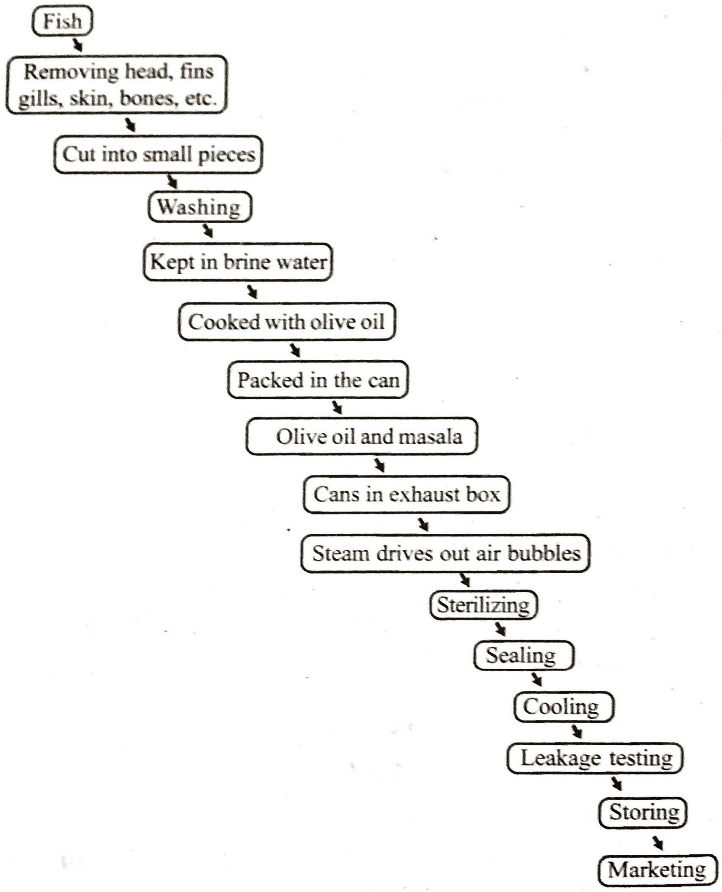
The phenol content of the smoke acts as an antiseptic and it is also imparts acharacteristic colour and flavour. Some condensationof tarsand resins also adds to the taste. Strict hygienic conditions are maintained throughout this operation. For the best results, fish are hanged on special structures in special installations called smoke houses. Some are produced by burning wood in the smoke house itself or are conducted to it through pipes from fire produced at a distance. For making fire and some only hard wood

(Conifer wood, Saw dust etc.) are used. Smoke house has a chimney at the top for exit of smoke. It also has a number of galleries for hanging fish. The smoke house is made of fire proof material and it is verywell insulated to retain heat.

5.3.11 Canning

Canning is a method of preservation in which spoilage can be averted by killing micro-organisms through heat. It is generally well known that food carries micro-organisms which cause spoilage if left unchecked. These micro- organisms are to be eliminated and the entryof other are restricted. The canning process involves pre-treatment of fish, preparationof can, filling and closure of thecan, techniqueofheating thefilled cansto killmicro-organismswithout damage to fish, finallycooling, cleaning, and storage of the product.

Canning is costly and complicated process. However fish can be stored for longer duration with flavor as follows.



Storing of processed and preserved fishes or prawns in air tight tins is called canning. In canning, heat treatment is the principal factor. The heat treatment destroys micro-organisms.

Canning involves the following steps:

1. Head, fines, gills, tail, gut and bones are removed.
2. Species are cut into small pieces.
3. The pieces are cleaned and washed.
4. The pieces are then kept in brine water. This process removes blood, slime and dirt.
5. They are cooked with olive oil / cooking oil in a pressure cooker for 5 minutes, then masala is added.
6. After cooling, they are packed in cans, and then hot oil is poured into cans.
7. The cans are sterilized for 1 ½ hours.

8. Then the cans are sealed it the prasens of hot steam equipment.

9. The cans are then cooled, dried and sent to markets.

Advantages of Canning:

1.Canned food is free from decomposing organisms.

2. It is ready to eat without any additional preparation.

3. It can be stored in ambient temperature for longer duration.

4. It has very long shelf life.

5.3.12 Demerits of fish preservation

Although the preservation and processing constitute a very important aspect of the fish industry, it has certain drawback, as well, particularly with respect to retaining quality of fish flesh, these are discussed briefly.

1) Chilling brings about denaturation offlesh. This is because of ice crystals formed during chilling and causing mechanicaldamage to the muscles. Cellwalls burst, structure gets deformed and the flesh loses muchof flavour and taste. The flesh also because dehydrated and losses texture. If proper hygienic measures are not taken during the processes like washing, guttation and evisceration, etc. more harm would be done to the preserved material, owing to increase in the bacterial population.

2) Incomplete or poor preservation leads to decaboxylation of histidine offish flesh into histamine. The latter some other related substances, collectively called saurine, are common causes of food poisoning.

3) Drying reduce weight, nutritive value and the digestibilityofthe flesh.

4) Excess salting allows growth of salt tolerant bacteria, causing pink eye spoilage of fish flesh.

5) Salting combined with smoking results in loss of protein, about 1 to 5
% due to salting and 8 to 30% due to smoking.

6) Smoking also accelerates rancidity of fat and so reduces digestibility of fat products.

7) Canning leads to muchloss of vitamin B_1,panthotenicacid, vitamin-C and pteroxylglutamicacid

Short Answer Type Questions

1. How is freshness of fish is judged.
2. What are the main causes of ‘spoilage of fish ?
3. What is fish processing ?
4. What is rancidity?
5. Define chilling.
6. What is ‘fishprocessing‘?
7. What is meant by‘filleting‘?
8. Define ‘salting ‘ in fisheries
9. Define ‘pit curing‘ in fisheries.
10. What is called ‘smoking in fish processing ?
11. Writ two demerits of fish preservation.
12. Define ‘freezing‘ in fisheries.

13. Define gutting‘.
14. Expand ‘HACCP‘.
15. Give two example of bacteria that spoil the fish flesh.
16. What is autolysis? What‘s the effect ofprotein autolysis ?

Long Answers Type Questions

1. Write an essay on fish and prawn spoilage.
2. Describe the waste management is fish processing.
3. Write about various methods of fish preservation.
4. What are the demerits of fish preservation ?

On Job Training

1. Visit to fish and prawn processing company.
2. Visit fish preservation and export company.

UNIT 6

By Products of Fish and Prawn, Value Addition to Fishery Products

Structure

6.1 Introduction

6.2 Byproducts of fish

6.3 Byproducts of prawns

6.4 Value addition to fishery products

6.5 Marketing

6.1 Introduction

A **by-product**, or **byproduct**, is a secondary product derived from a manufacturing process or chemical reaction. It is not the primary product.

While some chemists treat "by-product" and "side-product" as synonyms in the above sense of a generic secondary (untargeted) product, others find it useful to distinguish the two. When the two terms are distinguished, "by-product"

Fisheries are consumed as food in fresh condition. Some of them are also utilized after the preservation. During preservation and processing, some material of fish and prawn are discarded as waste. Similarly some trash and distasteful fishes are unsuitable for human consumption. There waste material of fish and above fishes become an important source to produce fish by-products by which in turn are used to product different useful fish by - products are described in detail.

6.2 By Products of Fish

Fish Meal

The waste obtained after the fish processing for oil extraction is called as fish meal. It is prepared either by wet or dry processing, depending on the raw material, and also from trash fish. The good quality fish meal is used for animal feeding and other is used as manure. The chemical composition of fish meal has 50-70% proteins, 5-10% fats, 10-20% minerals and 6-12% moisture. The fish meal is considered as very rich source of proteins. Calcium 5%, phosphorous 4%, a variable amount of iodine and vitamins B1, B12, A, D, K are also found In fish meal, which promotes the growth of animals. It constitutes a valuable source of feed for farm animals.

Fish oils

The oils from the fish are obtained by extracting from the entire body of the fish or only from the liver. The oil obtained from the entire body are known as body oils and are grouped into drying and semi drying oil. The drying oil comprises oils of sardine, salmon, herring, mackerel, anchovy, and white fish, while the oils of sprat and carp constitute semidrying oils are due to low iodine content. The body oil is edible and used for industrial purposes. Liver oil extracted from the live, is of medicinal importance and contains vitamin A. the flesh with rich oil content possess liver with flesh with low oil content. Freshly extracted oils are differently coloured from colour less to golden yellow, greenish yellow or even red. The oil extracted from the stale fish is darker in colour and concentration of the oil also varies from fresh to stale along with iodine content.

liver oil

Fish liver oil consists of vitaminAmainly and Din some species. These vitamins maybe formed due to metabolic activities whichmight have been made their way into the liver in 0.1 to 2.4% in cod than in other liver oils i.e., 80% in few sharks.

The livers of fishes are grouped into three classes depending upon the commercialutilityviz.

1. High oil content withlow vitamin Apotencyin cods with 60-75% of oil and 500 to 20,000 IU/g. vitamin Apotency.

2. Low oil content with high vitaminApotency in large tuna with 25- 75% of oil and 3,00,000 IU/g. vitamin Apotency.

Fish bodyOils

The whole fish is processed to obtain the fish meal and the bodyoil. Commerciallyimportant oils include sardine, herring and salmon oils. The fish with rich oil content and low oil content are processed through wet and dry processes respectively.

In the wet process the fish is crushed to a pulp and cooked with steam continuously in vertical cylindrical cooker. The cooked materialis pressed and oil alongwitha mixture offish soluble knownasstick water is drawninto settling tanks and later passed through centrifugalto separate the oil. The material after the extraction of oil is dried, powdered and marketed as fish meal.

In dry process, fishes with low oil content are processed as the oil recoveryis low. The fillet waste andshark carcasses are disintegrated in a grinder and cooked under regular stirring in a cylinder heated by steam. The oil is then pressed out.

Fish Manure

The dried and putrefied fishes are used for the preparation of fish manure. Fish manure are prepare as mentioned in fish meal. Prawn are also prepare in similar way from the leftout things like head tail, appendages and body shell. It contain 5-6% of nitrogen, 3 – 4% of phosphates and traces oflime. Fish guano is prepared from the fish materialleft after the extraction of oil. It contain 8 – 10 % of nitrogenand considered a rich nutrient for the plans.

Fish Flour

Fish meal is prepared by solvent extraction process on commercial scale. This can be blended with wheat ormaize flour and isused as enriching component in bread, biscuits, cakes, sweets and soups. It forms anidealprote in supplement to humandiets. Gruopers and seer fishes are used commonly for preparation of fish flours.

Fish Flakes/wafers

Thread fin breams and cat fishes are used in the preparation of flakes or wafers. Fish flesh is boiled, then mixed with maida, salt, etc. to prepare flakes or wafers.

Fish Sticks

Bodyshelland digestive tract are removed from prawn bodyand boiled for 15 minutes in 7% salt solution. Fishes are cleaned and cut into 10 cm length and 1 cm width pieces. These are dipped in egg, maida, salt mixture, and then added to bread power to prepare sticks.

Fish Salads

The fishes are cleaned and pieces are boiled with steam. The boiled fish or prawns are mixed withtomatoes, salt, garlic, maida, pepper andoilto prepare fish salad. This can be used in fresh condition or can be stored.

Fish Sausage

Fish flesh is ground and mixed with sugar, fats, masalaand preservatives. Smallbags are prepared with above mixture and boiled to prepare fish sausage.

Fish Cakes

Tuna and mackerels are used commomly to prepare fish cakes. Fishes are cleaned and steam boiled, the separated in layers. Potatoes are boiled with salt, pepper and citric acid. Layered fish are mixed with the above mixture and packed in vaccum to prepare fish cakes.

Fish Silage

The fish is mixed with formic acid, sulphuric acid and molasses resulting in the formation of semi stuff. This silage is preferred over fish mealsince the vitamins are do not produce fish odour.

Isinglass

Isinglass is the carefully washed and dried fish sounds or air bladders, made into specialdorms bymechanicalmeans. Russianisinglass from sturgeon, is the best, but good quality isinglass is manufacture in Iceland, Canada, India, Philippines, West Indies and USA. The fish sound is a hollow compressible sac, containing air on the specific gravityofthe fish to rise or sink. The swim bladder consists ofseveraltissues, the outer layer of which is thick and fibrous containing collagen. The inner layer has guanine, a lustrous material. The kinglass is used in wine and beer industries.

Fish Glue

The fish glue industry is one ofthe minor by- product Industry in USA, England, Norway and Japan. The great obstacle confronting this industry is obtaining a regular supplyof suitable glue stock in sufficient qualities.

The conversionofanimalskinandbones into gelatin hasbeenthe subject of many researches. The hydrolysis of fish sounds, or air bladders not merely resemble the manufacture of glue for when the tissue is heated with water. It dissolves. And upon evaporating and cooling the resultant solution forms a gel which is a gelatin of high purity. Fish skin and bones containmuch collagen and other similar proteins.

Best grade is used (i) for photo-engraving and half tone plates (ii) as flexible glue for court plaster, stamps, labels and book binding (iii) readyto use adhesive in shoe repairs, etc., (iv) as balt cement for leather cements, with hide glue (v) sizing operation and (vi) chipping of glass and for translucent glass and furniture works.

Fish Proteins

The proteins of the fish have high digestibility, biological and growth promoting value. Hence, it plays an important role in human nutrition. The available amino acids are more evenly balanced than the other proteins of animals origin. Amino acids like lysine and methionine are rich in fish protein. In general fish, protein is some what superior to egg albumen, bean protein and casein and perhaps equal; to chicken proteins. 15 – 25 % of protein is obtained from the fishmuscle whichforms the chief source.

Shark Fins

The fins of the large sharks except caudal fin are cut near the root, washed in seawater, mixed with wood ashes and lime and dried in the sun or smoked, this products which is crisp and brittle are used in soups and regarded as delicacy inchina and Philippines.

Fish Roe

Fish roe is a good source ofvitamins B,C,D and Einaddition to various aminoacids present. Viz thymine, citruline, creation, taurine, tyrosine, xanthine and hypoxanthine.. fish roe fat possesses high lecithin, (50%) and cholesterol (14%). Roe protein is colouress and tasteless with digestibility coefficient and biological value at 81 and 88 % respectively. It is used invarious food products and for the manufacture of glue and synthetic fibre.

Table utilization of fish products & by – products

Source	Products/by-product	Uses
Fat of liver and body	Fishliver oil+ vitaminA Fish bodyoil	Pharmaceutical Pharmaceutical
Protein of muscle	3. Fish flour, sausage, ham	Humanconsumption
And other tis-sue	Fishmeal Fishsilage Fishsoluble Fishmanure Fishguano	Animalfeed Animalfeed Animalfeed Agricultural Agricultural
Collage of bodytissues	9. Fish Guano	Industrial
Collagen of air bladder	10. Isin glue	Industrial
Skin	11. Fish leather	Industrial
Scales	Animalcharcoal Guanine Shagreen	Industrial(purificationofliquids). Industrial (artificialpearls). Industrial (abrasive).
Fins	15. Dried fins	Humanconsumption
Eggs	16. Fish roe	Humanconsumption
Sterols	Cholesterol Squalene Lecithin	Pharmaceutical Industrial (mordant in dyeing) Industrial (Antibloomagent in chocolate industry)
Enzymes & harmones	20. Enzymes & harmones	Pharmaceutical

Fish leather

After tanningand removing dentucles theskinof sharks andrays provide a strong and highly durable lether. In japan, the skin of puffer fish is used for preparing latrious. The viscera is removed from the bodyand the skin is dried. The candle is burnt inside the jacket, the skin useful as a transparent shade. Dried and treated skins are used for making belts, shoes, bags, suitcases and other ornamentalwears.

Shagreen

It is the skin of the sharks and rays. These are armed with sharp pointed placoid scales. It is used in polishing wood and other materials, for covering jewellery and sword covers.

Helmets

The skin of whales are used for the manufacture of helmets.

Fish soaps

The fins of various-sharks are dried and exported to other countries where theyare for the preparation of soaps.

Fish insulin

The pancreases of large fishes are removed to obtain raw material for manufacturing insulin.

Artificial pearls

The material obtained by scalping the silvery coating of the scales of certain fishes, is used for polishing the hollow glass beads. There beads are then filled with wax and marked as artificial pearls, used in jewellery.

Ambergis

This is a solid, buoyant waxyor fatty inflammable substance, grey, dull or speckled in colour and musky inodour, which occurs as a concretion, in the intestine or stomach of the sperm whale. Usually sick members vomit it. It is generallyfounds floating in sea or inthe shore, inhot latitudes, usually during the cold and wet moths. Pieces of considerable size have been found on the west coast of Sir Lanka. Ambergris is different from amber, a vegetable products of the sea. Formallyit was though to be fungoid growth, etc. It is usuallyfound in all parts of the intestines, and is mostly a concretion of undigested squids and cattle fish; with the nuclear mass being horny beaks of cephalopods. Next to pearls, ambergris is the highest priced product of fisheries.

6.3 By products of prawns

Prawn crackers : Flavored prawn crackers mainly used as fast food snacks. Its raw material are specially chose natural cereals (maize+ rice). It is non fried cereal of dietary fiber, which can stimulate intestines paristalsis and facilitate metabolismanddigestion.

Shrimp Cake: Shrimp cake, made withchunkyshrimpsfromthe finest, freshest quality health shrimps that are raised in eco-friendly farms practicing green shrimp technology, This product contains 0g Trans Fat and has no preservatives.

Prawn sauce : is an amber-colored liquid extracted from the fermentation of prawns with sea salt. It is used as a condiment in various cuisines. Prawnsauce is a staple ingredient in numerous cultures. In addition to being added to dishes during the cooking process, fish sauce is also used as a base for a dipping condiment that is prepared in many different ways bycooks in each country mentioned for fish, shrimp , pork, and chicken. In parts of southern China, it is used as an ingredient for soups and casseroles. Prawn sauce, and its derivatives, impart an unique flavor to food dueto their glutamate content.

Prawn pickle : Prawns have very limited shelf life and theyneed to be processed immediatelyto preserve them for a longer period. Making pickle is one sucheasymethod. Prawnpickle, ifmade properlyunder hygienic conditions adding requisite quantityofsalt, spice and preservatives, would have shelf life of around 8 to 10 months. Pickles can be made in any part of the country. This note concentrates on the North-East region as it has ample varieties of fish and the non-vegetarian food is fairly popular in most of the states. Manufacturing process is not very complicated and the capital investment is not much. Hence a new entrant would not find it difficult to venture into this product line.

Prawn oil : Flavored cooking oil with similar taste to shrimp paste. Made by crushing the prawn shells and boiling them in the oil. This oil is used in great range of recipies. This prawnoilalso used for medicinal purposes. This oil has properties like cholesterol decreasing in the body and also good for heart.

Prawn Chutney Powder: This is a typicalkerala food itemmade from coconut, prawns and spices. Prawns chutneypowder is a veryunique chutney. It is in powder form. Made by the finest dry prawns and coconut for making this product without adding anyharmfulchemicals which makes it very special and unparalleled in the market.

Prawn ice-cream and prawn cheese spread : Prawn flavor is also used in certain ice creams and cocktails that have a slight tough of the prawn flavor in the taste. While preparing cheese prawn products are added to make prawn cheese. As per the nutritional facts of the prawns these product have much levels of fat and have good amounts of vitamins and proteins.

Prawns- Manure : Semi-dried prawns and heads, tails and chitinous bodyshellof prawns which are separated during the preparationof prawn pulp. It contains 5-6 % of nitrogen and 3-4 % of phosphates and some line.

Prawn-meal : The chitinous shells, if died and powdered, provide the prawn-meal which is a valuable protein-rich poultry feed. Mixed with shark- meal the prawn meal can be used as a food for pigs and milking cattles.

Dhatosin : Crystal like material is extracted from prawnshells is called 'Dhatosin': It developed at (CIFT) veraval in Gujarat. It is widely used in textile industryforsizing.

Butter Sandwiched prawn : Salted and flavored butter sandwiched between two sufficient big and identical size peeled and deveined and Fan tail prawns and arranged in an asthetic shape is an attractive value added product. The product is wrapped in polythene bag and frozen in the IQF (Individual Quick Frozen).

Prawn cutlets: Prawncutlets are prepared fromcooked prawn mince. The cooked mince is mixed with cooked potato, fried onion, species etc. and formed into found shape each preferably of 40 grams size. The formed cutlets are battered and breaded and fried.

Individual Quick Frozenproducts (I.Q.F) : HighQualityraw material is used for I.Q.F. Products and the processing is done under strict hygienic conditions. The I.Q.F. marine products fetch better price then Frozen materials in the foreignmarkets. I.Q.F products suitable for export fromour country are given as follows.

Shrimp and prawns : Whole peeled and deveined cooked, headless- shell on, butterflyfan tail etc.

Prawn Products: Prawn is battered and breaded in different forms.
The most important among them are as follows.

(a) Battered and breaded peeled prawns.

(b) Battered and breaded shrimp fan tail.

(c) Battered and breaded shrimp round tail on.

6.4 Value addition to Fishery products

Landings of high value marine products throughout theworld are showing a state of stagnation as a result of unplanned exploitation of resources. At the same time, a significant amount of total catch consisting oflow cost bycatch fish remains underutilized. Ona global scale, more and more consumer are beginning to look at fishery products as health foods, since unlike redmeat, fisheryproducts are good sources oftherapeuticallyimportant polyunsaturatedfattyacids, easily digestible proteins and severalmicronutrients. Further, fisheryproducts are a major commodityof international trade and a source of foreign exchange for several countries particularlythose from Asia. Therefore, there is a need for total utilization of the catch to meet the increasing global requirement of the commodity.

Fish, however, is regarded as a smellyproduct cumbersome to bring it to a consumable from at home. In addition, lack of knowledge in preparing fish for a meal is another reason for the occasional lethargic attitude towards the consumer prefer processed food products including fish items in super markets in ready-to-serveform. Such a preference is favoured bychange in work culture andlife styledueto availabilityofadditionalincome and lesser leisure for household work.

Technology

A number of techniques are available for making novel products from marine and freshwater aquatic resource. These include individual quick freezing, sous vied, cook-chill, high pressure processing, breading and battering, developing products from fish mince, surimiand sea-food analogues, fish fillets and steaks, modified atmosphere packaging, andproducts through improvement of traditional; processing techniques such as canning, curing, smoking etc.

The IQF products allow the processor to supply the customer with frozenseafood insmall, ready-to-cook quantities. The productsmaybe prepared bycryogenic freezing of the products by directly applying carbon dioxide gas (boiling point, 790C) or liquid nitrogen (boiling point, - 196^0C) or the more common mechanicalrefrigeration..

Super marketsareturning to high'heat-n-eat' refrigerated foods, through 'cook-chill' technology, which imparts convenience, freshness and quality to the products. These foods, generally individuallypacked in a variety of retail packages,

In the emerging modified atmosphere packaging (MAP) technology, normal air in the package is replaced by a mixture of nitrogen, carbon dioxide and oxygen(usually 30, 40 and 30%, respectively) to reduce the spoilage rate. The CO^2 dissolves in the moisture ofthe food forming carbonic acid, lowering the surface pH, whichinturns retards the growthofbacteria.

Some technology for value addition of fishery products.

1. Breading and batting
2. Canning
3. Cook-chill processing
4. Extrusion cooking
5. Fermenatation
6. High pressure treatment
7. Individual quick freezing (IQF)
8. Lamination and dehydration
9. Low does irradiation

10. Marination
11. Modified atmosphere packaging
12. Smoking

13 Sous-vied processing

14. Retortable pouch packaging

A number of fish species such as tuna, mackerel, saridine etc., and mollusks like clams and oysters are ideal for canning. Canned products (in fancy packs) such as tuna-base salads, marinated items and elaborated mackerel- based preparations are becoming popular in Europe. salted and dried small fish such as anchovy are referred to as shirasu-boshi and are delicacy snack items. Bombay duck (Harpodon nehereus) is one of the low-valued seasonal fish available throughout the west cost of India. Aprocess to prepare dehydrated laminates of the fish has been developed.

The laminates have a shelf life of 6 months at ambient temperature and is a source of good quality protein. Laminates of ribbon fish have also been desveloped.

Texturised products such as sausages have been prepared by high pressure treatment of Pollack, sardine, skipjack tuna and squid bythe treatment. Severalsuch fish items have started appearing in Japanese supermarkets. Other technologies. For fish processing include accelerated freeze-drying, smoking, extrusion cooking, productionof fish sauces by fermentation, marination, etc .

Some value added products developed at the food

Technology Division, Bhabha Atomic Reseach Centre, Mumbai.

- Restructured, breaded and batterd shark gel steaks/ cutlets.
- Shark paneer for convenint use.
- Spray dried powders from low cost fish such as croaker, threadfin bream etc.
- Dehydrated Bombay duck laminates.
- Dehydrated ribbon fish laminates.
- Biodegradable film/coating from low coat fish meat for frozen high value fish items.
- Jawala protein hydrolyzate for aquafeed.
- Cook-chillprocess for extended refrigerated strage of shrimp and White pomfret steaks.

Radiation processed fresh fish for extended refrigerated shelf life Dehydro-irradiated shrimp.

6.5 Marketing

In India, the Marine Products Exports Development Authority Cochin is conducting regular workshops for entrepreneurs onproductionofvalue-added sea foods. The seafood industry should avail of the opportunities to markets. Apart from the marine resources, such products can also be developed from fresh water fish including aquacultured fish. Availability of efficient cold chain, refrigerated transport and both domestic as wellas foreign markets. Successful efforts in this direction can help in the total utilization of the fish catch for commercialpurposes as well as to meet nutrition requirements of population.

Short Answer Type Questions

13. What are by produces ?
14. Define Isin glass .
15. Mention any two byproducts of fish.
16. Which type of Vitamins are formed in fish liver oil.
17. Write any two names of prawn by products.
18. What is Shagreen ?
19. Which by products are used in agriculture field.

Long Answer Type Questions

1. What are by products? Explain various types of byproducts of fish.
2. Explain various types of byproducts of prawns.
3. Describe value added products from fish.

UNIT 7

Marketing and Marketing Intermediaries

Structure

7.1 Introduction

In earlier days, the term marketing of fish meant buying and selling of fish at the landing centre. After the second world war, the concept and function of fish marketing have taken a new role in business activities. The fisheries have now become highly industrialized in all advanced fishing national. The new marketing techniques have been adopted so as to sell more fish. The modern fish marketing system lays emphasis in meeting the existing demands for fish, besides tapping the potentialdemand in the important markets. In many advanced countries the improved methods of fish marketing are being adopted with the advancement of fisheries development. A progressive fish marketing system will also provide remunerative price to the primary producer through the interest of the consumer is also protected.

In many developing countries traditional system and fish marketing is adopted. The methods and practices have remained unchanged and unimproved over decades. The fish marketing is normally done at the collection centres which are mainly situated in the area of fish landing. Fish has peculiar feature at its own and gives a big strain and stress on the methods of its marketing. The fish marketing should have the wide scope for exploitation, production, distribution, preservation and transportation of fish in addition to actual sale of fish by reducing middle men.

7.2 Marketing

Characteristics of marketing

1. Perishability of the commodity
2. Large number of intermediaries involved.
3. Handling and treatment, icing, peering, curing, and packing
4. Seasonal concentration of landing
5. Scattered landing places
6. Small quantity produced by each fisherman, to be assembled, stored and transported.
7. Non-uniformity of landing, quantity, freshness and size.

Factors affecting fish marketing patterns

1. Concentration of landings as a result of construction of improved port and landing facilities increases maneuverability of boats in the course of fishery development.

2. Incresed size of capital requirements for fishing activities often with outside investors coming to fisheries. Increases the scale of operation resulting in economic growth. The above factors will lead top greater bargaining power of fishermenorproducers.

3. Increase of processed or frozen fish.

4. Institutional development by Government intervention, eg. Fish marketing organization, state fishing corporation, Government loanschemes and fishermen's co-operatives are very likely to affect and change fish marketing patterns.

7.3 Types of Markets

Based on the marketing place, production importance and products, the markets can be classified into the following types.

1. **Whole sale market :** More amount of fish comes to this market, then distributed to other types of markets.

These are two types

(a) Primary whole sale market : More amount of sale of fish takes place in this market. Collection ofthe fishes from surrounding places and selling the fish to wholesalers take place. This type of markets are found either in a village or a place covering a group of villages or towns or cities. These are known as shandis.

(b) Secondary whole sale market : These are also called as gunjs. The fishes are brought from the primary whole sale markets and sold to the wholesalers.

- **Terminal markets :** The fishes are sold to the retailers or consumer or to the agents.
- **Retailmarkets :** The fishes are sold to the consumer bythe retailers or whole salers.
- **Fairs :** These are found temporarilyduring festival times or in fairs the fishes are sold directly to consumers.

Functions of the fish market

Fish markets are bridges between products between producers and consumers. The following are the functionof the market.

1. All types of fishes are brought together for selling
2. Transportation of fishes
3. Storage of fishes
4. Business problems can be solved
5. Fishes can be graded here
6. Money transactions take place in markets
7. Time and distance is saved

7.4 Fish marketing intermidiaries

The reare many fish market intermediaries from fishproducers consumers to forms a complicated network whichis given below.

Fish market intermediaries	Notation
Fish farmers	FF
Fishing workers	FW
Fish farmers-cum-contractors	FFC
Fish farmers-cum contractors-cum-whole	FFCW
Fish farmers-cum-whole sellers	FFW
Fish farmers-cum-retailers	FFR
Fish farmers-cum-fishing workers	FFFW
Commission agents	CA
Commission agent-cum-whole seller	CAW
Whole seller	W
Whole seller-cum-retailers	WR
Fishing worker-cum-retailers	FWR
Fish Farmers-cum-vendor	FFV
Fishing worker-cum-vendor	FWV
Fish contractor	FC
Retailers	R
Vendor	V
Consumer	CUM

7.5 Marketing system flow channels

The marketing system of fishes can be analysed in terms of use flows, physical flows and channelflows.

Use flows

The production frominland resources is largelyconsumed in fresh from. A negligible quantity is dried bytraditional method and used for non-edible purposes. Ice is used to preserve the freshness of fish. Very rarely the facilities of coldstorage are used. Whenfishis sent to outstation, it ispacked withice but processing is done.

Physical flows

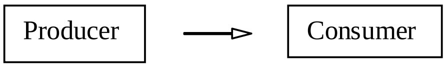
Due to food habits and economic conditions of the people in and surrounding the fish production centers, fish flow to other stations, mainly to urban centres. In India, Calcutta alone consumes more than 10%

of fresh water fish of production and about 30% of reservoir fish especially of major carps. A major share of production from pond and riverine resources is consumed locally or nearby production centers. Unlike pond and riverine fishes, the catch from the reservoir is mainly consumed in urban centres, away from the production centres. This is mainly because of poor local consumption and due to high price and bulk production from reservoirs. As the fish marketing is controlled by powerful marketing intermediaries, they prefer to send the fish to outstation and distant places, where the demand and price of the fish are very high.

Channel flows

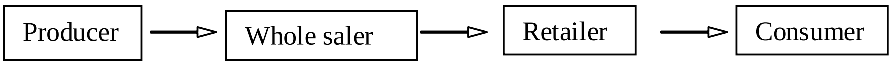
The fishes are distributed in different marketing channels. Srivastava (1985) identified 16 marketing channels and also stated that all the channels are not in operation in fish markets. Some channels are more popular than other. Four popular channels identified are.

Channel I: Fish farmer (producer) sells fish directly to the consumer.

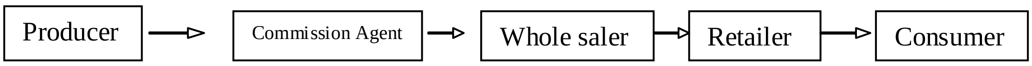


Channel II: The fish farmer sell fish to retailer, who sells to consumer.

Channel III: Fish farmer sells fish to wholesaler, who sell to retailer, then to consumer.



Channel IV : The fish farmer sells fish to commission agent, who again sells to wholesaler, he sell fish to consumer through the retailers.



Channel V : The fish farmer sells fish to commission agent, who again sells to wholesaler, it goes to processing unit than fish or fish product reaches to consumer through the retailers.

Out of the above four channels, middle two channels (II and III) are most popular and common in Indian fish markets. In case riverine and reservoir fisheries the fishermen get more profits than other market intermediaries, because of the low input cost. More profits are found in shorter channels.

7.6 Management of Markets

Sale proceed at markets

At the landing center, the fish is sold in many ways. Although, it is not possible of marketing in India. At the landing centers, the fish is methods of marketing in India. At the landing center, the fish is assembled and sorted out by the agents or wholesalers of fishermen's group leaders. At Chilka lake area in Orissa, the fish is collected by the leader of fishermen party who is known as 'bahanias'. Similarly, in Kakinada area, of

Andhra Pradesh, the fish is mostly collected by the pettamdars, whereas in Kerala, Thruvilarya. In Gujarat and Maharashtra the primary collectors are known as Tindels. The fresh water fish in most of the cases is sorted out species-wise and also size-wise. Then the fish is packed in ice and kept in bamboo baskets or wooden boxes for dispatch to the distant markets particularly in Calcutta.

Sale proceed at production centres

The fish producers sell their produce at the ponds site to the rural masses at the time of harvesting. It is not a popular practice and only a fraction of total production is sold in this manner.

Sale at district headquarters

The producers bring their produce to the district headquarters and sell fish door to door as vendor it is also not a popular practice and only small quantity is sold in this manner.

Intra-districts marketing

Although there is a Government contractors shop at every headquarter, fish transported from one district to the popular fish market of other district with the idea to have good price.

Sale of fish at the fish markets, outside the state

It has been observed that good portion of fish is sent to the markets outside the state for sale.

Role of co-operative in fish marketing

A four-ties structure gets operated in by fishery co-operatives: National Federation of Fishermen's Co-operatives, State Level Co-operatives. (mostly at district level), and Primary Co-operatives. The co-operative at central and primary levels are divided into two sectors – marine and inland (some have jurisdiction covering both the marine and inland sectors).

Price and price determinator of fish

The fluctuation in fish price is very prominent. The changes are so frequent to predict any trend. There maybe one price in the morning while another in the evening in the same market. Sometimes prices change at short intervals of time. This happens not only due to the sudden supply and demand of particular variety of fish but also due to prices of other varieties in the market. The perish ability tendency of fish, has a definite role to play in determining the price of fish market when many auctions take place simultaneously. When fresh fish reaches early in the morning a high price is quoted. Generally, the fish prices fall as day advances.

Factor affecting prices.

The following are the factor influencing the price offish in fish markets.

Elasticity of demand.

Wherever there is a demand of fish markets, the price of fish tends to rise. In period of no demand offish during the particular days near festivals, the fish consumers take no fish due to religious conception. Similarly to take no fish also plays important role in affecting the price pattern.

Type, Sex, Weight and quality of fish

Large size and fresh fish fetches goods price in the markets. Sex never plays and role in fixing the price. In few places, for example in Andhra Pradesh, people like black fish like murrels and cat fishes, mostly they prefer live fish in markets. In other places (ex. West Bengal), people [refer major carps.

Distance of procuring centers to markets

The distance of procuring centre to fish markets also play an important role in the procuring of fish. Low catch is normally transported by buses early in the morning. The larger the distance so covered, the greater would be the spoilage which naturally has adverse bearing on the fish price.

Fishermen's share in consumer rupee

Since fish moves from producer to consumer through market intermediaries, there is no unique price if fish even for a particular quality, at one point of time, and at one particular location.

It is often alleged that because of this gap, neither the fishermen receivers a remunerative price for his produce nor the consumer gets his consumption basket at a reasonable price. Incidentally, it should be pointed out that the presence ofintermediary is not necessarily, harmful, for theyare productive as theyadd value to the fishbytransporting it fromplaces ofsupplyto the places of demand and byis storing the product between the time of harvest and the time of purchases by the consumer.

Strategy for fish market development

Since all the fish markets are not organized in wellmanner, a thrust is is required to reform the markets bymodernizing the traditional fish marketing methodsbyintroducingnew management techniques. There are manyenvironmentalopportunities for fishmarketing as there are manyplace where fish is not marketed. The tourist complexes established bytourismcorporation where good fish sale stall can be established. Like wise, in Universitycampus and sports school much stalls can be set-up. This kind of environmentalpossibilities exist in manyareas and more areas canbe found out byconducting survey.

Afisheryfirmcan take up arelevant marketing action in whichit is likely to enjoyadifferential advantage over the firms. This is because of its experience and technical resources available with the firm. Afish firm can set up ice plant and net fabricating unit to give a boost to the fish marketing process.

Aparticular firmcanhave thespecific advantage bydealingthe particular kind of fish. Cat fish group is in great demand particularly inwinter season. The need of people can be met by importing cat fish from neigh bouring state and exporting the major carp group in lieu of this. It can also explore the possibility of marketing of major carp as wellas

Market Analysis ----Analysis---→ setting of objectives
Formulation of New Scheme ----- Planning---→ Developing of fish demand
Marketing operation ---Control--→ Marketing Control

A core marketing need to be designed for the market development. This system has three type of classifications – Intensive growth, Integrative growth, Diversificationgrowth.

Risks of Fish Marketing

Fish marketing involves the following risks and difficulties.

1. Fish is a ***perishable*** product. Hence it should be sold off within 8 hours.
2. Fish landing is ***seasonal.***
3. Landing is ***enormous*** in one season and ***nil*** on some days.
4. Fish landing is non-uniform in seasons, quantity and size.
5. The fish ***landing places*** remain scattered.
6. The fish are captured in small quantities and different varieties by individual fisherman. They have to be ***collected, assembled*** and ***assorted.***
7. The fish has to be ***transported*** from catching areas to consumption areas.
8. Fish marketing needs complex ***processing*** and ***preservation.***
9. Fish trading involves many ***middlemen*** between fish farmers and consumers.
10. Fish marketing in India is ***traditional*** and ***unorganized.***

Short Answer Type Questions

1. Define market.
2. What is Terminal market?
3. Write any two names of fish marketing intermediaries.
4. Expand FFC and CUM.
5. Write any two names of flows channels.
6. Write the functions of the fish market.
7. Which type of market channel is useful to the consumer.

Long Answer Type Questions

1. What is market? How it is useful to sale the fish?
2. Describe various marketing intermediaries and explain their role in fish marketing.
3. Discuss various fish marketing channels.
4. Describe the factors affecting on the fish price in markets.
5. What are the measures to improve the marketing facilities in India and risks in fish marketing?

UNIT 8

Economic Status of the Fisher-Man

Structure

8.1 Introduction

Our countryis blessed with vast inland water resources in the form of rivers, estuaries, natural and man-made lakes, brackish water impoundments and mangrove wetlands. The length of coast line of India is about , 8,129 km, a coast line length is 972 km. in addition to this it has 2.25 million hectare of fresh water ponds and tanks, 1.3 million hectare of bheels and derelict waters, 0.12 million hectares of irrigation canals and channels, 2.3 million hectares of paddyfields and 1.41 million hectares of brackish water and estuarine area. Such a vast water resource, yet under exploited, could be wisely used to boost India economy to a greater extent. Aquaculture stands as a plausible answer to it and India is all poised to wards "Blue revolution".

8.2 Socio-economic status of fisher folk

A fisherman is a person who collect fishes. There can be commercial fishing only with fisher men. There can be anynumber of devices to facilitate fishing, but fishermen will have to be there to operate the nets. The fishing result are directly related to the efficiency of fishermen. It is there fore axiomatic that the fishing activitywill develop well onlywhen fishermen are developed.

The problem of development of fishermen is often looked into from a narrow angle allover the country. The development of fishermen is often restricted to traditionalfishing communities. Traditional fishermen's communities should no doubt receive all attention, however, fishing activities are now no longer the monopoly of traditional fishing communities. Persons from other communities have now entered the field and several have become fishermen, irrespective of caste and community. All these fishermen deserve all facilities from the Government to upgrade their skills and rise up in their profession.

All those belonging to traditional fishing communities are not in the business of fishing at the present day. Severalof these pursue avocations other thanfishing. The aspect has to beborne inmindinimplementing schemesproviding for assistance to traditional fishermen.

Social interaction

Representatives of Government i.e. fisheries officials have to first become part of the fishermen community. The relationship should be so intimate that it should pave the wayfor planting new ideas. Fishermen have a great attachment towards their traditional festivals. The customs and beliefs of the community have to be closely studied and understood. With this background, it will be easier to gain their attention and enlighten them.

Catch themyoung

More than these, action that is necessaryis to catch the fisher children in their tender age and educate and train them in fisheries schools, specially set up for them. Government have to set up such schools, and attract as many fisher boys as possible from the age of 8 or less. This approach is the surest way to develop our traditionalfishermen. When theycomplete their training such boys our traditional fishermen. When theycompleted their training such boys should be able to end up as skippersor engineers or vessel-owners, with various facilities provided by the government. With their training they will be in a position to appreciate the facilities and avail of them.

Mechanization on the socio-economic status

Mechanization has been introduced through power-driven fishing craft or by motorization of the traditional craft. These reforms have enabled the fishermen to increase the rate of fish catch along the off-shore region. Thus Fishing is regarded as powerful income and employment generator asit stimulates the growth of a number of subsidiary industries (Srivastava etal, 1982). Introduction of modernfishing techniques has increased fish catch compared to traditional methods, which has led to increases in the income of fishermen. The impact of technological changes in fishing depends on the levelof controlover resources and the traditional fishermen and the nature of technological changes in terms of labour displacement/absorption.

problems identified

Increase of income of fishing households, leading betterment of their living conditionare inhibited for the following reasons.

(a) Poor management of fishing resources : Absence of closed season, closed area, adjustment ofnumber of fishing units among different fishing gears resulting lower catch and thereby income.

(b) Absence of fishing harbours : Makes it impossible to enlarge the size of fishingboats.

(c) Absence of fish auction market : Make the prince of fish sold unreasonable.

(d) Absence of fishing co-operative society : Makes it difficult for Government to render various services to all fishermen.

(e) Lack of ice supply : Makes the fish price lower due to loss of freshness of thecatch.

(f) Poorcondition of road to consuming areas : Makesfishmarketing difficult.

(g) Lack of side jobs during slack season of fishery : Results lower income of fishermen.

Credit forfishermen

Fishermen need fund. For the purpose of production, acquisition of fishing boats, improvement of conversion boats, purchases of engines, purchases of fishing gears and equipments, construction of fish ponds, fuel oil, maintenance of engine and gear, advance to crews, housing, purchases of daily necessities, education of childrenand medicare care, ceremonies such as marriage.

Difficulties of fish fishermen to obtain credit and the consequences.

- Poor financialstanding
- Small scale and dispersed
- Little collateral to offer
- Riskynature offisheries
- No proper insurancearrangement.

Consequences

i. Commercial banks are reluctant to lend money.

ii. Fishermento go individuals, private money-lenders, middlemen for funds both for production and house hold expenses.

iii. Highrate of interest.

iv. Pledge to sell the catch to middlemen.

v. Chronical debt and vulnerable to exploitation.

Need for Government intervention

i. Establishment of government loanfund for fisheries.

ii. Allocation of fund for fisheries bynational development banks.

iii. Promotion of credit fisheryco-operatives.

vi. Government loan guarantee.

vii. Interest subsidy.

viii. Government assistance to fishing boats insurance.

Suggestions

The socio-economic condition of the traditionalfishermen using non- mechanised craft areas are far from satisfactory on account of lack of infrastructure and areas are from satisfactory on account of lack of infrastructure and communication facilities, An apprehension has been created among the traditional fishermen that harbours are hampering than basic having mainlybecause mechanised vessels owners tryto catch fish in the exclusive zone of earmarked for the traditional fishermen.

There is a great need to improve the living conditionsofthese traditional fishermen. Efforts should be made to provide basic infrastructural facilities like pucca road, drinking water supply, sanitation facilities, transportation, schools, and medical facilities etc..

8.3 Co-operatives in Fisheries Sector

Collective efforts in a trade are known as co-operative movement. This movement has gained importance in fisheries trade also. This movement guards the interest smallentrepreneurs in the trade, saves them from the clutches of the exploitation ofmiddlemen and promotes the trade. Fishermenare living at a line below poverty level, and have an unorganized trade, hence the fishermen cooperative societies are extremelyessential to get things done smoothly.

Fisheries Development in Co-operative Sectors

An astonishing paradox is that while the harvests have been good, fishermen remain underfed. 50% of the consumer‘s moneygoes to the middlemen. Therefore, one method and probablytheonlymethod to check such exploitation would be to encourage cooperatives of fishermen.

In India fishermenco-operative societies are found. The Government is also trying to improve the condition of cooperatives. These include enactment offisheryregulations, subsidiesand loanfacilities to fishermenthroughcooperative movements, better education, training and research centres, extension services and ruralintegrationprogrammes.

Principles of Co-operatives

Principles of cooperatives gradually evolved after the cooperative movement started in a England (1844). Six principles of cooperatives were amended and adopted at the ICA conference in 1966.

These are

1. Voluntarymembership, election, or appointment of office bearers in an agreed manner bymembers.

2. Co-operative societies are democratic oranisations, their affairs shall be administered bypersons elected. Members shall enjoyequalright of voting – one member one vote, and participation in decisions affecting their societies.

3. Share capitalshall onlyreceive a strictlylimited rate of interest, if any.

4. The economic results, arising, out of the operation belong to the members of the society and shall be distributed in such a manner as would avoid one society and shall be distributed in such a manner as would avoid one member gaining at the expense of others, which shall be achieve.

(a) By provision for development of the business of the society

(b) Byprovision of common services

(c) Bydistributionamongthemembersinproportiontotheir transactions with the society.

5. Societies shall make provision for the education of their members.

6. Collaborationamong cooperatives at local, national and international levels having as their the achievement of unityof action.

The cooperativesocietyhas a minimumof 11 members andno maximum limit. Everypersonshould pay Rs. 10-00 to become a member and get eligibility for voting. The society also gets money from members who go for fishing in society tanks and ponds. Whatever profit they get, is distributed among the members equally. Each member contributes 10% of his profit to the society for its smoothmaintenance. The tanks, ponds or reservoirs are leased to the society by the government. Previously they used to give a three years lease, and then extended to five years. But, at present, the government is giving only one year leases to avoid the amount for a water body and is collected in one or more instalments.

The primary fishermen cooperative societies are found at village or mandal levels. Each society has one or more water bodies for fishing activities. Generally these societies have few members depending on the fishermen population of that areas. At the district level, the cooperative societies are found with more members. The regional societies have more member than above two societies. Allare under the control of Fisheries Department.

NCDC and FisheryDevelopment

NCDC started promoting and development fisheries cooperatives after its Act was amended in 1974 to cover fisheries within its perview. In order to discharge its functions effectively, NCDC has formulated specific schemes and pattern of assistance for enabling the fisheries cooperatives to take-up- activities relating to production, processing, storage, marketing, etc. Such assistances providing to fishermen cooperatives for the following purposes.

1. Purchases of operational inputs such as fishing boats, nets and end lines.
2. Creationof infrastructure, facilities for marketing (transport vehicles cold storages, retail outlet, etc.).
3. Establishment of processing units including ice-plants, cold storages etc.
4. Development of inland fisheries, seed forms, hatcheries, etc.
5. Presentationofexperts under technicaland promotionalcellscheme.
6. Appointment of export under technical and promotionalcellscheme.
7. Integrated Fisheries Projects (marine, inland and brackish water).

Activities of Societies

The business and non-business activities of fishermen cooperative societies are

i. Credit

Societyreceives deposits, current or ordinarydepositsand time deposits. Member‘s deposits are encouraged by regular depositing of a part or whole of the proceeds of member‘s fish catch. Deposited funds used for

(a) Extending loans

(b) Reserve for payment

(c) Capital funds of the society

(d) Purchase of craft gear and fish seed.

ii. Loans

Loans for both production and consumption purposes are necessaryto cover fishermen‘sneeds. Animportant considerationis to fix amaximumamount of loans to be extended to one member at the generalmeeting, is that as manyas members as possible can get the benefit of the credit. By and large, normal banking businessprocedures are followed e.g., collaterals, securities, guarantors.

Co-operative banking system consists of primary fishermen‘s cooperatives, their regionalcredit ederation and Central Co-operative bank facilities adjusting both at regionalandnational levels surplus anddeficit offunds of cooperatives to meet the credit need ofthe member fishermen.

iii. Supply

Asupplybusiness either in the regionalor nationalscale throughregional federation and primary cooperatives is essential to maintain supply both for production requisites and household consumption goods.

iv. Marketing

Also includes related activities such as, ice making, storage, transport, processing. Marketing is the most important business among other in items of turnover, even througha little risk is involved, as the business is conducted on a commission basis regarding the proceeds of member s catch sold at auctions operated bycooperatives.

v. Joint Utilisation

Service facilities, e.g. slip-way, dock facilities; boat and engine repair service, and net repair facilities are made available by the cooperatives.

vi. Advisory Service

Co-operatives canrender educational and informationalservices to their members bythe way.

i. Consultationor advice-giving regarding fishing techniques, plan of operations, business management.

ii. Educationand information bymeans ofbulletins, seminars, meetings and Extension work.

iii. Welfare and cultural activities.

iv. Prevention ofaccidents.

v. Promotion of accidents.

vi. Promotion of fishing boats insurance, mutualaid.

vii. Representationoffishermen‘s interests to the Government authorities for the purpose of legislations, financial assistance.

vii. Fishing

although fishermen‘s cooperatives normally gives services (credit, marketing, supply) to member fishermen, who are dependent and carry out their fishing activities themselves, apart from their services to the members. In such cases, the FisheryCo-operative Law provides that one half or more of the workers shall bethe members of the cooperative and that a written agreement is required fromtwo thirds or more of the members ofthe cooperative.

In Japan, most of the fishery co-operatives have their own shop for supplyofengines, spare parts fishing material, etc. in terms of business turnover, the supply of business is comparatively small in Japan.

viii. Insurance

In Japan, separate cooperatives have been set to deal with fishing boats and fish catch insurance. The Government gives financial assistance in the form of premium, subsidy and reinsurance, thus spreading the risk of the insurance.

E. CROP INSURANCE

The General Insurance Corporation and its subsidiaries are constantly striving their level best to evolve various insurance schemes for financial security of the rural and agriculture sector. The prawn Insurance scheme, which ws evolved in 1984 with the active co-operation and assistance of MPEDA is a noted addition to the various rural insurance schemes.

The United India Insurance Company has covered many brackisnwater shrimp farmers, expecially on the east coase of Tamil Nadu, Andhra Pradesh, Orissa and West Bengal with culture fishery insurance schemes. These insurance schemes are working very well providing the much required financial protection to this sensitive and riskprone trade.

1. Objective of the scheme

The Objectives of the scheme are:

a) To provide insurance cover against total loss of nursed prawn seeds in hatcheries owned by state Government. FFDA, State Fisheries Corporations. MPEDA or such other organizations, and

b) To provide insurance cover to financial institutions to protect interests and recover loans advanced for such freshwater prawn farming in the event of loss.

2. Basis of valuation

The Scheme will cover either input cost or fixed value of the produce.

For hatcheries: In case of prawn seeds/juveniles/fry of a hatchery owned by the State Government/State Fisheries Dev. Corporation, MPEDA etc. the cover will be only for the input cost.

3. For prawn farmers

If the insured wants to cover the risk on input cost basis only then the premium will be charged on the input cost basis. Only then the premium will be changed on the input cost only and fixed by a nominated officer of FFDA/Fisheries Department/ CIFRI/MPEDA issued at the time when the proposal is made for insurance. This will be treated as a part of the policy and shall from the basis for claims settlement.

8.4. Government schems

A.P. Fisheries Policy 2015 envisages incentives and subsidies for promotion of Fisheries and Aquaculture in the state.

Highlights of the AP Fisheries Policy 2015-20:

- ❖ For shrimp processing units including cold chain maintenance, Capital subsidy of 50% inclusive of land cost with upper ceiling limit of Rs.5 crore, will be provided.
- ❖ For fish processing / filleting units including cold chain, land cost etc., subsidy of 50% with upper ceiling limit of Rs. 7 crore will be provided.
- ❖ Interest subvention of 6% will be provided on bank loan subject to maximum of Rs.2.5 Crore for 5 year period to aqua processing units, ice plants and cold storages
- ❖ For Reefer vans, a subsidy of 50% with maximum of Rs. 10.00 Lakhs per vehicle.
- ❖ Power will be supplied to Shrimp and Prawn culture farms at Rs.3.75 ps/ unit. (On 26-5- 2018 the Hon'ble CM announced the power will be supplied at Rs.2.00ps/unit for a period of One year)
- ❖ Financial assistance for farm mechanization like pumps and aerators with 50% subsidy.
- ❖ Solar pumps, solar lights and solar based aerators will be given on 60% subsidy to the prawn and

shrimp farms up to maximum of 2 ha per farmer per annum.

- Cold storage at ports/ Fishing harbours with subsidy on par with Industrial policy.

MEASURES TAKEN TO ACHIEVE SUSTAINABLE GROWTH

- Awareness and Capacity Building programmes on BMPs. Aqua farmers, lab and hatchery technicians have been trained during current year.
- Regulation on Aqua Inputs: Inspecting 325 Hatcheries and 874 Aqua feed and feed supplements Shops inspecting by Task Force Teams to regulate antibiotic usage in aquaculture.
- Desilting and De weeding of Creeks and Drains: 56 creeks identified with estimated cost 213.19 crores in 468.06 Km. Works completed in an extent of 80 Km with a value of Rs.25.45 crores and the works in 33 km with a value of Rs.23.66 crores is in progress under NEERU- PRAGATHI programme.
- Aqua Zonation: Taken up in 9 coastal districts with geo references for both existing and potential aquaculture areas for sustainable growth. Govt. will notify the Aqua Zones in the state shortly.
- Convergence with MGNREGS Works: Fish Ponds, Drying Platforms and Approach Roads have been sanctioned for 3699 works with an estimated value of 197.17 crores. Works completed so far 1802 works with a value of 29.30 crores
- Establishment of Power lines and power tariff concession: To reduce the input cost proposed to establish power lines and transformers in aquaculture areas with an estimated cost of Rs.468 crores and Govt extended power tariff concession by reducing unit rate from Rs.3.89 Paise to Rs.2.00 Paise with subsidy grant of 397 crores per annum

SHORT ANSWERS QUESTIONS:

1. Mention coast line length of India?
2. Mention coast line length of AP?
3. Define Blue Revalution?
4. What is EEZ?
5. What is NCDC?
6. Expand GDP and NDP?

LONG ANSWER QUESTIONS

1. Write about Socio – Econimic status of Fishermen?
2. Describe the role of Co-operatives in fishers sector?
3. Write about the Principles of Co-operatives in fishers sector?
4. Write about Insurience in fishers sector?
5. Write about Problems fishireies co-operative sector?
6. Write about AP government schemes for develop the fishers sector?

UNIT 9

Fisheries Economics - Principles

Structure

9.1 Role of fisheries sector in India's economics development

9.2 Potentials

9.3 Job opportunities and career guides

9.1 Role of Fisheries sector in India's Economic Development

The role of fisheries sector in the country economic development is amply evident. It generates employment for a large coastal and other population, raises nutritional standards, increases food supplyand earns foreign exchange.

The fisheries and aquaculture production contributes around 1% to India's Gross Domestic Product (GDP) and over 5% to the agricultural GDP. According to Food and Agriculture Organization (FAO) report "The State of World Fisheries and Aquaculture 2018" apparent per capita fish consumption in India[average(2013-15)] lies between a range of 5 to 10 Kg.

Keeping in view of the potential fisheries resources in the aquaculture, inland fisheries, coastal & marine fisheries and substantial scope of export augmentation, The Fisheries division of Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India is implementing various developmental schemes under the umbrella of "Blue Revolution Scheme" for overall development of fisheries sector, including enhancement of production and productivity, improving the livelihood of the fishers and welfare of fishermen for realizing "Blue Revolution" in the country. Besides, Cabinet Committee of Economic Affairs (CCEA) has also approved the setting up of a dedicated Fisheries and Aquaculture Infrastructure Development Fund (FIDF) worth Rs.7,522 crore on 23rd October, 2018 to fill the large infrastructure gaps in fisheries sector in the country through developing infrastructure projects such as fishing harbours/ fish landing centres, fish seed farms, fish feed mills/plants, setting up of disease diagnostic and aquatic quarantine facilities, creation of cold chain infrastructure facilities such as ice plants, cold storage, fish transport facilities, fish processing units, fish markets, etc.

The funds released under the various schemes supported by the fisheries division of the Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India to to promote fisheries in the country during the last three years and current year as below;

Financial Year	**Funds Released (In Rs. Crores)**
2015-16	416.80
2016-17	424.11
2017-18	337.53
2018-19 (till date)	312.80
Total	**1491.24**

The objectives of National Fisheries Development Board (NFDB) are as below;-

i. To provide focused attention to fisheries and aquaculture (production, processing, storage, transport and marketing).
ii. To achieve sustainable management and conservation of natural aquatic resources.
iii. To apply modern tools of research and development including biotechnology for optimizing production and productivity from fisheries.
iv. To provide modern infrastructure mechanisms for fisheries and ensure their effective management and optimum utilization.
v. To train and empower women in the fisheries sector and also generate substantial employment.
vi. To enhance the contribution of fish towards food and nutritional security.

National Fisheries Development Board (NFDB) is being implementing various schemes and components since its inception in the year 2006 for development of Fisheries in the country namely Intensive Aquaculture in ponds and tanks, reservoir fisheries development, Coastal Aquaculture, Mariculture, Seaweed cultivation, Infrastructure: Fishing harbor and Fish Landing Centres, Fish dressing centers and solar drying of fish, Domestic marketing, Technology upgradation Projects, Human resources development programs in fisheries sectors, Deep sea fishing and tuna processing, Ornamental Fisheries, Innovative Projects Quality seed dissemination program, Cage and pen culture in open water bodies etc. However, from 2016-17 onwards the NFDB scheme has been subsumed in umbrella scheme of the Centrally Sponsored Scheme on "*Blue Revolution: Integrated Development and Management of Fisheries*" and National Fisheries Development Board (NFDB) has become one of the major component of the said restructured scheme. Further, there is no component-wise specific outlay made including for Inland Fisheries and Aquaculture as the schemes are demand driven. However, Under the Centrally Sponsored Scheme on "*Blue Revolution: Integrated Development and Management of Fisheries*" an amount of Rs. 3000 Crores has been approved towards budget outlay for a period of five (5) years from 2015-16 to 2019-20.

The fisheries growth in India is essential to meet three major targets

i. Increase in production to meet protein requirements.

ii. Development of export potentials.

iii. Improving the socio-economic status of fishermen.

Contributions of fisheries sector

The fisheries sector is contributing to India economy mainly through the following ways.

i. Food Supply : The per capita yearly consumption of fish has been 3.2 kg on an average up to 1992 (5.13 kg for fish eating population/year) as against the estimated requirement of 15 kg. Pisiculture has the potentiality due to its on the spot food characteristic, balanced nutrients and above all, affordable price.

ii. Raising nutritional standards : Fish is considered as the "poor man's diet". It cost much less in comparison to its food value. It is an almost zero carbohydrate food, for diabetes and other such patients. Fish is rich source of protein, vitamins and minerals with approximate composition as crude protein, 14.2-22.8%, fat 0.6-2.4% and energy 76-61 Kcal/100gm. A special feature of fish flesh food is content of vitamin B12 which is absent in plant food and also a good source of calcium and vitamin A. fish also contains polyunsaturated fatty acids which are known to provide protection from cardio-vascular diseases. This has got advantage over the other flesh food like meat. Fish has a better biological value (BV) and protein efficiency ratio (PER) than other meat food.

The monthly per capita consumption of fish in India was highest in Lakshadweep (3.38 kg) followed by Kerala (1.59 kg) and Goa (1.38 kg). it can be noted that per capita requirement is 12 kg as recommended by ICMR (Indian Council of Medical Research) and assuming India's fish eating population till 2025 to be around 6.90 million, the requirement of fish will be around 8.2 million tones.

iii. Employment generation : Fisheries sector provides employment to about 24 lakh full time engaged fishermen and 36 lakh partially engaged fishermen. Around 10% of these are engaged in allied activities related to fishing, marketing, net marking, fish curing and processing.

iv. Income generation : The average gross income for all categories of farmers is @Rs. 1L/ha for small, Rs. 1.25L/ ha for medium and Rs. 1.5L/ ha for large scale formers.

Quick growth of fisheries has also created positive impact on ancillary industries like packaging, cold storage and ice plants, transport by insulated vans, excluding net and other such material manufacturing enterprises generating additional employment opportunities. Several externally aided projects are under-way which may provide employment to shrimp farmers and allied workers.

It is worth mentioning that, fish farmers, artisan fishermen and fisherwomen engagedinfishculture, collection of fish seed from natural resources, fishing in closed and open inland and coastal waters, processing, transport and marketing etc, are the focal objects for sectoral development and welfare schemes.

v. Foreign exchange : In last three decades fishery exports has drastically increased During the last three-four years particularly sea products displayed a quantumjump of 50% byvolume and 100% by earnings frozen shrimps accounts for about 70% of the foreign exchange earnings. Other items of exportsare frozen fish, lobsters and dried fish items. The major markets of these products are Japan, US, Western Europe and West Asia,. With systematic planningand management three is a good scope for improving India's share in the International market from 2%. Present status given in tabler forms in this Unit

9.2 Potentials

Indian Exclusive Economic Zone (EEZ) is 200 nauticalmiles into the sea and the total area is 2.02 million sq. km, the potential of which 2.57 million tones is awaiting a total production limit of 3.92 million tones. This zone is exploitable inaccordance withthe UN's guidelines of"right to fish is conditional and accompanied bythe dutyto manage and conserve resource for present and future generation".

It is considered that marine fish production towards the end of X five year planwould increases to 3.25 million tones with the inland fisheries catching up withit soon. Apotentialmarket for fresh water fisheries, particularly Indian carp is West Asia. The actual yield frominland fisheries is about 40-50 thousand tones intotal. A vast water resource, yet under exploited, could be wisely used to boost Indian economy to a greater extent. Aquaculture stands as a plausible answer to it and India is allpoised towards "Blue revolution". Therole offisheries sector in the country economic development is amply evident. It generates employment for a large coastaland other population, raises nutritional, standards, increases food supplyand earns foreign exchange.

In India fishermenco-operative societies are found. The Government is also trying to improve the condition of cooperatives. These include enactment offisheryregulations, subsidiesand loanfacilities to fishermenthroughcooperative movements, better education, training and research centres, extension services and rural integration programme. The business and non-business activities of fishermen co-operative societies are credit, loans, supply, marketing, joint utilization, advisoryservice, fishing and insurance.

9.2.1 Potentials of AP

FISHERIES DEPARTMENT - VISON

By 2022	To achieve 50 LT of fish Production with an estimated GVA value of Rs. 1.00 Lakh Crore by 2019-20 Promotion of Value added products (Present level of 12% to above 40%) By 2021-22- AP to become one of top three best States in Asia in aquaculture
By 2029	To achieve 72 LT of fish production by 2029 by integration with IPAT, advanced scientific based technologies. Organic Aqua farming and FPO approach Promotion of fish processing and value addition to 60% by 2029 from the present level of 12%
By- 2050	To make Aquaculture capital of the world and marine processing hub of the country To achieve 100 lakh MT fish and prawn production with more than 60% share in Sea food Exports in the country Largest producer of the shrimp in the world

ZONATION OF AQUACULTURE

The Government of AP with a main objective to promote sustainable aquaculture in the state and regulate unauthorized conversion of productive agriculture land in all coastal Districts, issued GOMS No. 16, AHDDF Dept. Dated 20-4-2018 for notifying the both existing and potential aquaculture area in all coastal districts.

Benefits of Aquaculture Zonation:

- ✓ Provides better regulation in the zoning area for eco-friendly and sustainable aquaculture
- ✓ Condense the conflicts among aqua farmers and other land users
- ✓ Easing of Aquaculture Registration / Licenses process
- ✓ Helps to expand the aquaculture in identified potential areas with species specific basing soil and water characteristics and water source
- ✓ Facilitate to plan for creating supporting infrastructure facilities like approach roads, power lines and de-silting of creeks/ Drains
- ✓ Enables the Govt. to promote cluster approach, Better Management Practices and FPOs with backward & forward linkages in hatchery, feed, farming, processing & Value addition with the coordination of allied aquaculture supporting agencies.
- ✓ Ultimately to enhance the production and productivity through aquaculture

FISHERY RESOURCES OF ANDHRA PRADESH

1. Inland Fishery	
Reservoirs(116 nos)	2.42 lakh ha
Tanks(27678 no s)	3.17 lakh ha
Kolleru Lakes	0.90 lakh ha
Rivers & Canals	11,514 kms
2.Freshwater Aquaculture	
Freshwater resources	8 lakh ha
Area under culture	1.38 lakh ha.
3. Coastal aquaculture (Brackish water)	
Potential	1.74 lakh ha
Area Developed	0.74 lakh ha
Area under culture	0.58 lakh ha
Total area under culture (FW+BW)	1.96 lakh ha
4.Mangrove Area	**352 sq.km**
5.Feed mills	**28 (1.5 M Tons / Yr) (fish feed > 6 nos)**
6.Shrimp hatcheries	**325 nos (Inland- 32 nos)**
7.Aqua labs (Govt & Private)	**234 nos**
8.Aqua Shops	**874 nos**
9.Coastal districts	**9 nos**
10.Coast line	**974 kms**
11.Fishing harbours	**4 no s**
12. Ports	**(3) Visakhapatnam, Krishnapatnam & Kakinada**

13. Registered exporters	**110 nos (manufacturer 64 nos)**
14. Total seafood processing plants	**74 nos (3632 MT/ Day)**
15. EU approved units	**64 nos**
16. Non EU units	**10 nos**
17. Cold storages	**89 (45753 MT Capacity)**
18. Freezing plants	**45 (1MT. Capacity/ yr)**
19. Ice plants	**2000 No's (6.0 Million capacity)**

SPECIES WISE CULTURE AREA IN THE STATE

Sl. No.	**District**	**SPECIES WISE AREA UNDER CULTURE (HA.) AS ON 31.03.2018**					
		Total *L.vannamei*	***P. monodon***	**Mud Crab**	**Sea Bass**	**Fish**	**Total area under culture**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	Srikakulam	1111.35	0.00	0	0	225.95	1337.3
2	Vizianagaram	35.34	0.00	0	0	71.56	106.9
3	Visakhapatnam	685.05	0.00	0	0	105.66	790.71
4	East Godavari	9656	468.6	1914	12	5827.51	17878.11
5	West Godavari	19958	0.00	60	200	52727.5	72945.5
6	Krishna	24823.33	0.00	3624.21	1331.35	41516.45	71295.34
7	Guntur	7602.89	0.00	1500	50	1388.64	10541.53
8	Prakasam	7338.7	0.00	250	0	355	7943.7
9	Nellore	8460	2659.25	15.6	15.6	2082.34	13232.79
	TOTAL	**79670.66**	**3127.85**	**7363.81**	**1608.95**	**104300.61**	**196071.88**

Fish Production Achievement – 2017-18 and Targets for 2018-19 (Indicator wise) (Prod in MTs and GVA in Rs. Crore) (constant prices)

Sl. No.	Indicator	2017-18					2018-19			
		Target	Achievement	GVA	Growth Rates		Target	Proposed GVA	Growth Rates	
					Prod.	GVA			Prod.	GVA
1	Marine Fish	474000	479626	2355	1.68	1.73	502000	2465	4.66	4.67
2	Inland Fish	1961000	1994871	12039	23.33	23.36	2805000	16929	40.61	40.62
3	Total Prawn	949436	975061	26934	44.02	41.77	1178200	33438	20.83	24.15
	Grand Total	**3384436**	**3449558**	**41328**	**24.7**	**33.32**	**4485200**	**52832**	**30.02**	**30.26**

Bench mark of Ap Fisheries among States of India

Sl.no	Parameter	World	India	States of India (in Descending order of rank)					Year and source
1	Total Fish Production (LMP)	1710 (2016)	**114.09 (2016 - 17)**	AP- 27.66	WB - 17.01	Gujarat - 8.12	TN - 6.69	Maharastra - 6.62	2016 - 17, Gol
2	InLand Fidh Production (LMP)	916 (2016)	61.36 (2013 - 14)	AP- 15.08	WB - 13.92	UP - 4.64	Bihar - 4.42	Odisha - 2.93	2013 -14, Gol
3	Shrimp Export Production (LMP)		4.97 (2015 - 16)	AP - 3.02	WB - 0.72	TN - 0.45	Gujarat - 0.35	Maharastra - 0.08	2015 - 16, MPEDA
4	Marien Fish Production (LMP)		34.43 (2013 - 14)	Gujarat - 6.95	Kerala - 5.22	Maharastra 4.67	AP - 4.38	TN - 4.22	2013 -14, Gol
5	Shrimp Productivity - Kg per ha			Gujarat - 7.51	AP - 7.05	TN - 5.68	Maharastra - 4.51	Odisha - 3.2	2015 -16, MPEDA

9.3 Job opportunities and career guidense :-

Fisheries is an important vibrant sector witnessed as the primary source of protein for millions of the people. Its contributing to the national GDP is around 1.4% and 4.5% GDP contribution to the agriculture sector as a whole. In broad terms it involves capture including inland and sea, aquaculture, gears, navigation, oceanography, aquarium management, fish breeding, processing, export and import of seafood, special products and by-products, research and related activities. India is the fourth largest producer of fish in the world and the second largest producer of inland fish. India's long coastline with rich biodiversity offers great scope for aqua-farming of fish, crustaceans and aquatic plants for recreation or consumption. The sector is considered to be equally important due to the dependence of large section of poor fisherman community as a main source of income generating livelihood source. This has been a highly potential sector to offer huge opportunity exists for the development of fisheries through aquaculture and mariculture farming practices.

Eligibility for Entry in Fisheries Science:

To get the entry in fisheries discipline, individuals desirous to become a fisheries graduate has to pass 4 year degree from Fisheries Colleges of State Agricultural Universities. For admission in B. F. Sc (Bachelor of Fisheries Science) course he /she can apply after 10 (+) 2 having PCB group. Admission is given as per merit score of candidates and the availability of seats. Special quota for outside state candidates is allowed to the candidates who have passed entrance exam of ICAR and are getting- fellowship too. Special reserved seats are there for Jammu & Kashmir, Mizoram, Arunachal Pradesh and Nagaland. B. F. Sc involves courses such as inland aquaculture, freshwater aquaculture, mariculture, industrial fisheries, fish processing and post harvest technology, fish nutrition, pathology, environment, ecology and extension. The syllabus contains practical experience like opportunities to work on sea cruise on fishing vessels and for data collection and fishing in processing plants.On-farm studies under Fisheries Work Experience Programme (FIWEP) helps students to gain practical learning on aqua farms, hatcheries, fish processing units, value addition, resource management etc. through educational programme of ICAR.

Higher Education:

After completion of B.F.Sc, candidates can opt for M.F.Sc (Master of Fisheries Science) for taking admission in Central Institutes in India through all India level Common Entrance Test conducted by ICAR. There are eight fisheries institutes under the ICAR set up in India mainly CIFE, CIBA, CIFA, CMFRI, CIFT, CIFRI, NBFGR and DCFR. These institutes are engaged in capture, culture, value addition processing, repository, conservation and bio-diversity addressing educational and legal issues in addition to their mandate of research programme. Students can avail opportunities for masters and specialized education upto the doctoral level in these institutes. In addition there are about 18 fisheries colleges under the independent Veterinary and Animal Science University and also State Agriculture Universities offering B.F.Sc and M.F.Sc courses. Based on the availability of the infrastructure and State of Art Facility, fishery colleges are also offering doctoral programmes under their setup. Master's and

Doctor of Philosophy (Ph.D.) programs in aquaculture and fisheries are available through several schools. Students can choose programmes that fit with their research interests in subject areas viz. fish nutrition, water quality, aquaculture engineering, fish genetics, hatchery production and fish pathology. Most master's programs require a thesis, while Ph.D. students are typically required to complete a dissertation. There are research activities in the areas like culture and breeding of fish, integrated fish- livestock farming, fish health management and nutrition, development of post harvest and processing including intensive fish farming and environment management.

Farm Based/ Skilled Based Training:

Krishi Vigyan Kendras under ICAR conducts trainers training in collaboration with their institutes and offering fisheries as a vocational course at 10(+2) level with active assistance from NCERT. Coastal States have fisheries schools at fishermen's dominating villages conducts regular programme on skill development among the fisherman. Training programmes are also offered on Deep Sea Fishing and Navigation by Central Institute of Fisheries Nautical & Engineering Training (CIFNET). The short term duration training in Scuba diving are conducted by various private agencies in India which supports employment generation in the deep sea fishing and resource utilization, mapping and assessment.

National/ State Fishery Institutes:

1. Central Institute of Fisheries Education, Versova, Mumbai,www.cife.edu.in
2. Central Institute of Brackishwater Aquaculture, Chennai,www.ciba.res.in
3. National Bureau of Fish Genetic Resources, Lucknow, www.nbfgr.res.in
4. Central Institute of Fisheries Nautical and Engineering Training, Kochi,www.cifnet.nic.in
5. Tamilnadu Fisheries University, Nagapattinam, TN,www.tnfu.org.in
6. Indian Institute of Technology, Kharagpur, W.B,www.iitkgp.ac.in
7. Andhra University, Telibagh, Waltair, A.P,www.andhrauniversity.edu.in
8. Goa University, Goa,www.unigoa.ac.in
9. SIVE.Board at 10+2 level in all states under Board of Intermediate Education
10. Deploy in fisheries avaible in Sre Venkateswara Voctornry University Tirupathi in AP

Fisheries Colleges under State Agricultural/ Veterinary Universities:

1. College of Fisheries Science Muthukur, Nellore, Andhra Pradesh.
2. College of Fisheries, Shirgaon, Ratnagiri, www.dbskkv.org
3. College of Fishery Science, Telangkhedi, Nagpur, M.S,http://cofsngp.org
4. College of Fisheries, Mangalore, Karnataka, www.kvafsu.kar.nic.in
5. College of Fisheries Science, Pantnagar, UP,gbpuat.ac.in/acads/cfsc/index.html
6. Punjab Agriculture University, Ludhiana, www.pau.edu
7. Institute of Fisheries Technology, Thiruvallur, Chennai,http://iftponneri-tnfu.org/index.php
8. College of Fisheries Science, Kulia, WB, www.wbuafscl.ac.in
9. College of Fisheries, Veraval, Gujarat, http://www.gsauca.in/
10. An optional subject permeted at graduation and post graduation level aquaculture avaible in all Universities.

Job opportunities

Career for fisheries and aquaculture graduates are available with a variety of employers, including state and central government agencies, academic institutions and fish farms. Government agencies and industry organizations recruit positions like aquaculture farmer, shellfish culturist, hatchery technician, biological science technician, fish research assistant etc. Many career options exist in this field in both public and private sectors in aquaculture to sea farming of fish, shellfish and marine organisms. Entry-level aquaculture jobs require either a high school diploma or an undergraduate degree in aquaculture and fisheries, but more advanced positions require a master's or doctorate degree.

In State Governments, job opportunities exist in fisheries department for fisheries graduate for the post of Assistant Fisheries Development Officer (AFDO)/ Fisheries Extension Officer (FEO) and District Fisheries Development Officer. Career opportunities also exist for high school diploma holders in aquaculture farming. However, an increasing number of employers in this industry prefer job candidates with some post secondary education. Certain aquaculture careers even require a graduate-level education and higher degree programs for research and teaching at many colleges and universities.

In foreign countries associate's and bachelor's degrees in fisheries or aquaculture provide the skills and knowledge needed to pursue a variety of aquaculture careers. Students in 2-year programs can typically pursue an Associate of Applied Science degree to enter the job market upon graduation and can earn an Associate of Science to transfer into a 4 year academic programme. Apart from scope for higher education in fisheries in countries such as USA, Canada, Australia, Japan, China and European countries, there are demand for fisheries professionals in the aquaculture and processing sectors in Gulf and African countries also. There are number of fisheries graduates doing business in foreign countries in field of aquaculture, export & import.

The fisheries graduates and higher qualified personnel gets good job opportunities with attractive salary and perks. They are appointed as Assistant Director, Research Assistant and Fisheries Inspector etc. in government establishments. The government sectors offer a pay which is less compared to the private sector, but is stable. In private sector, a post graduate in fisheries sciences has lots of opportunities to work as Quality Control Officer, Fish Processor, Aquaculturist, Farm Assistant/ Manager etc. The pay varies according to the type of job and specialization of the candidate.

Fish industry provides ample employment opportunities of which some of them are;

1. Field Assistant/Field Technician in Fish Farms
2. Assistant in Laboratories dealing with Aquaculture
3. Seed Production Assistant in Fish Seed Farms
4. Hatchery Operators
5. Marketing Assistants
6. Marketing Units of Aquarium, Ornamental Fishes & Accessories
7. Ornamental Fish Breeding & Supply of Seed, Aquatic Weeds
8. Aqurium Maintenance in Institutions on Contract Basis
9. Net Making
10. Weed Control Contracts
11. Fish Seed Transport
12. Fish Transport/Container Services/Dry Fish Marketing/Fresh Fish Marketing
13. Ice Production Units
14. Cold Storage Units
15. Ice Box Production Units
16. Pituitary Gland Banks
17. Dealership of Nets/Fishing Equipment
18. Fisheries Extension Assistant!
19. Preservation of Biological Specimens & Supply
20. Dealership of Fish Feed/Prawn Feed/Hatcheries/Boats/Nets and Audiovisual for Fisheries Education
21. Dealership of Fish Farms/Hatcheries/technical surveys by Govt/NGOs/ Banks
22. Assistant conduct Socio-economic/technical serveys by Govt/NGOs/ Banks
23. Harbour Maintenance Assistant
24. FRP Boat Repairs
25. Seed Collection trade for F.W. Prawns
26. Maintaining Permanent civil structure for storage of fish at landing centers
27. Fabrication & Supply of Bambo/Aluminium Cages for seed rearing/fish culture
28. Assistant for erection of Pens in Reservoirs and perennial tanks
29. Secretaries for Management of Fishermen Coop Societies
30. Fish marketing information services
31. Starting Fish seed farm/seed rearing
32. Starting farms for rearing fish/prawn
33. Starting cage culture in reservoirs
34. Mechanised fishing vessels for exploration of marine fishery
35. Laboratory Attender in 10+2 Vocational Jr. Colleges

Short Answer Type Questions

1. Mention the present status india in world Aqua Production.
2. Mention the present status india in world fish Production.
3. What is the AP status of fish production among the Indian states.
4. Name the Distics leads the fish production in Ap.
5. Name the Distics leads the shrimp production in Ap.
6. Mention total area under fish culture in AP.
7. Mention the total mangrove area avaible to AP.
8. Name the fishing ports avaible in AP.
9. Expand AFDO & FEO
10. Write any two benfites with Aquo Zotion.

Long Answer Type Questions

1. Write about AP vision in fisheries development.
2. Write about Cerrier Guidenes in fisheries Education.
3. Write about job opportunites with Aqua Industry.

UNIT 10
Export and Quality Control

Structure

10.1 Introduction

India's exports ofmarine products had their beginning as earlyas 1938 - 39. May be a starling revelation but nevertheless true. This historic year was recorded in gold in the Annual Statement of the Sea-borne trade of British India with British Empire and foreign countries. The exports included dried, salted or smoked fish, aquatic animals oils, fish meal and fertilizers and miscellaneous aquatic animals and plant products.

Most of the dried fish to be exported to east Asian countries such as Hong Kong, Singapore, Myanmar (Burma) and Sir Lanka as a result of these steps. In this year, 21,874 t valued at Rs. 73, 16 lakhs were exported. By 1945-46, the exports of the same complex ionreached a level of 32,282 t valued at Rs. 269 lakhs. By 1959, Sir Lanka (then Ceylon) remained to be the only countryfor theexport of Indian dried fish. During that year exports were 25,932 t valued at Rs. 4.43 crores, but declined later to 4703. Trading pattern of this kind, however, dwindled down over years. So far as dried prawns (shrimps inpresent dayparlance) are concerned, India exported to 22 countries 3067 t of them valued at Rs. 89.43 lakhs in 1962 and 2808 t valued at Rs. 93.24 lakhs in 1963. Over half of these exports went to (Burma) present Myanmar. By 1967, these exports came down to 1540 t valued at Rs. 89.61 lakhs. Later, in 1968, the exports plummeted further to 1410 t valued at Rs. 72.58 lakhs. The export of this commodity came down to 139 t by 1972 from 684 t in 1971. After 1972 export of dried fish and prawn products from India dwindled. With an annual production of over one million tons one million tons of fish, India is one among the eight major fish- producing countries of the world. The National in come from fisheries is estimated at about Rs 600 crores per annum. Present status given in tabler forms.

The Sea Fisheries resources consist of a large varietyoffishes such as. Sardiences, Mackereland prawns. Severalother favorite varieties like Pomfrets, Seer fish, Indian salmon, etc., are also available in large quantities. Fishing is generally confined to the narrow coastal belt of about 6 to 10 miles from the cost and the production is the hands of nearly a million fishermen.

The costal fisheries are largely season Surplus productions are obtained in some months and large-scale expansionof the fishing industrydepends up on increased off-shore fishing activity which is being fostered by mechanizing the indigenous crafts, byintroducing small-powered crafts and by employing large modern vessels. The west coast of India at present account for over three - fourths of our total sea fish production. With the gradual development of the marine fishing industry, the export industry was makinga turning point on modern scientific lines. To ensure a high quality of marine products exports, the Government of India has bought in quality control and preshipment inspection for marine products on al volunturing basis. Amarine product on the measures to be taken for implementing compulsory quality control of various marine products.

10.2 Export Promotion Measures

Supply of tin plate Against Export of Tinned Fish

The ministry of Commerce and Industry in Government of India have introduced a schemefor supply of tinplate against export oftinned fish. According to the scheme, the Deputy Chief controller of imports and

Exports Ernakulam (Cochin), will register persons who are engaged in canning fish and wish to take advantage of the scheme, provided they have been dealing in the export of fish or sale of fish in the international market for at least one year. Those who do not fulfil the fisheries DevelopmentAdviser, Ministryof FoodandAgriculture, New Delhi.

Supply of Other Requisites for Canning Fish

There are someitems in whichthe internal relationship between imports and exports is direct and intimate. The ability to export some of these manufactured goods depends largely on the facility with which the exported or the manufacture can procure the basic raw materials required in the manufacture. With a view to promoting the export of such goods, a scheme has been devised for thegrant of special import licences to replace imported raw material content of the exported product, or to provide an inducement for larger exports.

The foundation for the exports of frozen marine products, which is a revolutionary milestone in the historyof marine products exports of India.

Records show that exports of marine products of all categories including canned product of all categories including canned products from Indian were 19,700t valued at Rs. 2.46 crores in 1950-51. In 1953 frozen shrimp entered the export basket. There was a drop in the quantity exported by 1960-61 to 15,700t but with a higher value (Rs. 3.92 crores). The drop was for the reason that caned shrimp exports came downowing to prohibitive cost of cans. From then onwards there was a steady growth, with exports reaching 97,200t with a value of RS. 531 crores by 1987-88. by 1990-91, exports touched a level of 139, 419t valued at Rs. 893 crores.

Export Trends

The export trends were presented in table these had been a major spurt in the export in terms of quantity by 1994-95 (Qty 307, 337 t; value Rs. 3575.62 crores). Which moved up by 1999 - 2000 to 340,003 t value and at 12.24% in terms of volume over the previous year. For the first time, seafood export crossed Rs. 5000 crores. The total volume exported increased from 302,934 t in 1998-99 to 340,003 t on 1999-2000. It is expected that Indian export maycross the level of Rs. 6000 crores or US$ 1.3 billion by March 2001. Present status given in tabler forms.

Features of Exports

(a) Exports of frozen shrimp increases by 7.2% in terms of volume and 8.7% in terms of rupee realization and 5.6% in terms of US$.

(b) Export offrozen fish increased by7.6% in terms of rupee realization and 4.5% in terms of US4.

(c) Export of frozen squid increased by 7.4 % in terms of volume and 9.1% in terms of rupee realization and 5.9% in terms of US4.

(d) Export of chilled items showed an increase of 17.79% in terms of volume and 54.14% terms of rupee realization and 49.7% in terms of US$.

(e) Export ofcuttle fish declined in terms ofvolume by6% but increased by 4% in terms of rupee realization and 1% in terms of US$.

(f) Export of dried items declined by 2% in volume and increased by 5.8% in terms of rupee realization and 21.8% in volume, 19.3% in rupee realization and 21.6% in terms of US$.

Frozen Shrimp

Frozen shrimp, considered to be one of the major item in our export which, contribute 71% of total marine products exports in 2017 - 2018 by value. The share of frozen shrimp in the total exports, the export of frozen shrimp as such increased by 7.21% in terms of volume and 8.67% in terms of value. The unit value realization of shrimp has increased by 7.21% in terms of shrimp has increased marginally from Rs. 12,769L (US$ 1929) to Rs. 16131L (US$ 2533).

The totalquantity of shrimp exported to USA was 21.391 mt fetching a value of Rs. 633.73 crores which was respectively 18.54% and 35.68% more in volume and value than the previous year. The export of shrimp to South East Asian market and other markets also increased both in volume and during the year when compared to the previous year.

Frozen Fish

Frozen fish continued to be the largest item in our export contributing a share of38% in terms ofvolume while invalueterms it is the second largest item contributing 10.45% of Indian marine products export earnings. As in the previous years, Ribbon fish contributed the major share (30%) among fin-fish varieties, followed by Promfret (24.53%) Croaker (8.55%), Mackerel(7.75%), Seer fish (5.73%) and the rest of other fishes. The value-added products made out of finfish varieties were fish fillets, fish loins/steaks and shark meat which contributed 3.80% of the total over the previous year. The value of this item grew from Rs. 8.85 croces to Rs. 20.22 crores during the year. China is the largest importer of frozen fish which accounted for about 46% in terms of value and 57.69% in items of quantityin the overall export of frozen fish.

Present status given in tabler forms.

Cephalopods

European Union was the major importer of the cephalopods, accounting for about 53% of the total export from India in terms of value. Spain alone contributed to 2.5% (value wise) ofthe total export of frozen cephalopods.

Other Items

Export of frozen Lobsters also increased by 26.76% in volume and 63.86% invalue. Export of Chilled items also registered an increase of 17.68% volume and 54.11% by value while dried and live seafood items have declined over the last year.

Major Markets

The main market for our seafood products are Japan, member countries of European Union, USA, South East Asia and Middle East countries. Among the markets, Japan continued to be number one market sharing 19.6% in terms of volume and 44% in terms of value (Rs. 2263 crores, US$526. 10 million.). Present status given in tabler forms.

Market Shares

The share of the different markets in India‘s total exports are as follows

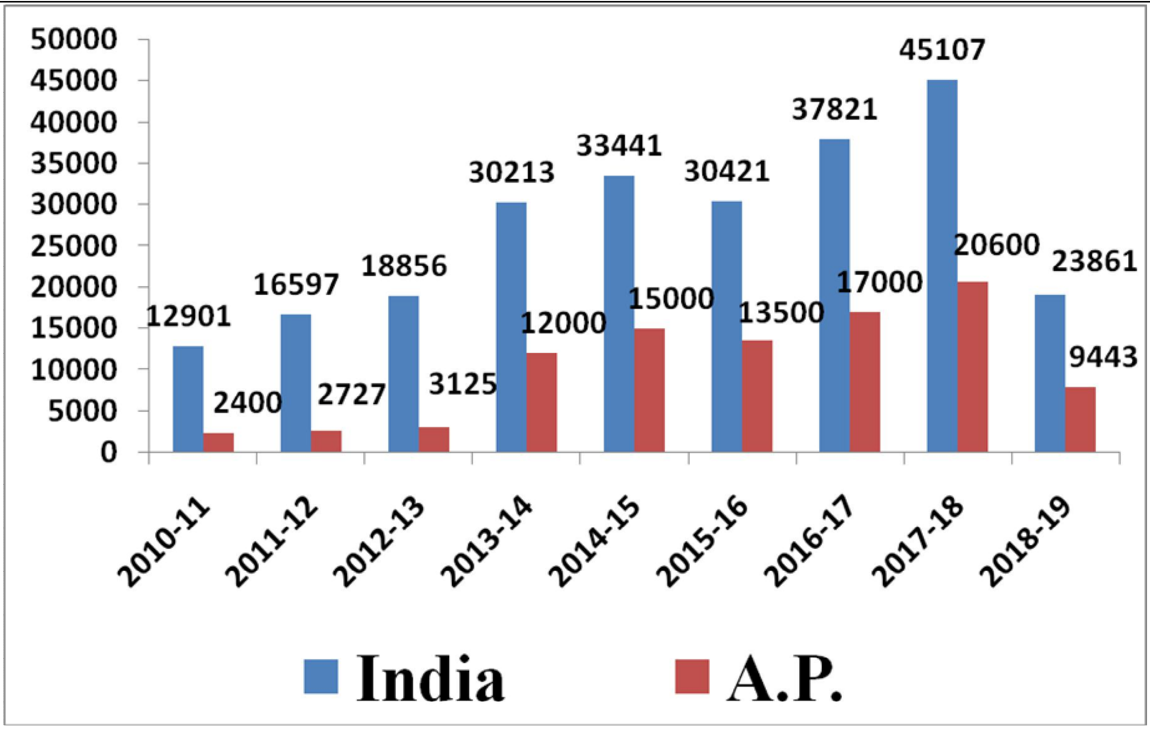
The diversified range of exports now cover canned shrimp/fish, several items in frozen from such as headless and head on shrimp, PUD and PD, and several value-added products such as peeled tail-on shrimp, peeled tail on stretched, butterfly tail-on shrimp, blanched/boiled peeled shrimp, breaded round shrimp, squid rings , squid tubes, stuffers tubes, peeled squids, cuttle fish fillets, dried squid, head-on squid whole fish, fish fillets surimi, shark fins, shark, meat, live crabs, crabmeat, fish maws, Becha-demer, dried fishes, particularly Bombay Duck, ribbonfish, masmeen, and quite few other products. IQF and Accelerated/ Freeze Dried products have also become an important part of exports.

Exports of fish maws clubbed under other miscellaneous items commenced in 1980. Export of frog legs was banned by the government in 1987. Present status given in tabler forms.

ITEM WISE EXPORT FROM ANDHRA PRADESH						
Q: Quantity in Tons, V: Value in Rs. Lakhs, $: US$ Million						
ITEM		**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**
FROZEN SHRIMP	**Q:**	112127	137983	158100	208368	276666
	V:	8207.72	9502.85	9174.85	12792.7	16131.4
	$:	1355.93	1570.06	1416.75	1929.12	2533.44
FROZEN FISH	**Q:**	8116	6934	6990	11315	10235
	V:	99.87	82.56	92.26	156.02	122.81
	$:	16.36	13.52	14.09	23.55	19.3
FR CUTTLE FISH	**Q:**	887	764	1584	2081	1441
	V:	8.16	7.41	23.15	40.95	28.24
	$:	1.35	1.22	3.54	6.17	4.44
FR SQUID	**Q:**	55	36	105	266	106
	V:	0.36	0.22	1.29	4.71	1.58
	$:	0.06	0.04	0.2	0.71	0.25
DRIED ITEM	**Q:**	238	240	0	196	467
	V:	2.29	2.45	0	3.94	7.69
	$:	0.37	0.41	0	0.6	1.21
LIVE ITEMS	**Q:**	28	8	25	30	16

	V:	0.33	0.17	2.2	3.18	0.79
	$:	0.05	0.03	0.34	0.47	0.15
CHILLED ITEMS	**Q:**	135	709	1142	972	1313
	V:	4.4	26.33	38.02	28.89	42.57
	$:	0.74	4.35	5.88	4.34	6.7
OTHERS	**Q:**	389	407	376	408	277
	V:	37.36	49.33	37.98	35.8	46.33
	$:	6.29	8.16	5.87	5.39	7.26
TOTAL	**Q:**	**121975**	**147081**	**168323**	**223636**	**290521**
	V:	**8360.49**	**9671.32**	**9369.76**	**13066.2**	**16381.4**
	$:	**1381.17**	**1597.79**	**1446.67**	**1970.36**	**2572.75**

Contribution of A.P. to Sea Food Exports in India (Figures in Rs. Crores)



Source: SEAI & MPEDA

2018-19 figures are up to September, 2018 and are provisional

10.3 Quality Control

The development of the export trade of India, certain proposals for subjecting Fresh, Frozen and Processed Fish and Fishery products to quality control and inspection prior to export, were published as required by sub-rule
(2) of rule 11 of the Export (Quality Control and Inspection) Rules, 1964 in the Gazette of India, Part-II, Section 3, Sub-section (ii) dated 1st November, 1994 under the Order of the Government of India in the Ministry of Commerce No.
S.O. 785 (E) dated the 1st November 1994.

1. Fish and fishery products freshly caught are in principle free of contamination with no micro-organisms.

2. However, contamination and subsequent decomposition may occur when handled and treated unhygienically.

3. Therefore, the essential requirements should be laid down for correct hygienic handing of Fresh, Frozen and Processed Fish and Fishery Products at all stages of production and during storage and transport.

4. It is expedient that these control measures should be introduced to guarantee the uniform application and to ensure smooth operation of the provisions of notification and that the measures apply in an identical manner.

5. Provisions should, therefore, be made for procedure for monitoring to ensure the above conditions of equivalence with reference of importing countries.

6. The Government of India nominated competent authority should ensure the effective compliance of the quality standards in the country.

7. In this Order, Fresh, Frozen and Processed Fish and Fishery Products mean. All sea water and freshwater animals or part three of, including their roes, in fresh and chilled frozen or processed from, but excluding Frogs.

8. Floors, walls and partitions, ceilings or roof linings, equipment and instruments used for working on fishery products must be kept in a satisfactory state of cleanliness and repair, so that they do not constitute a source of contamination for the products.

9. Rodents, insects and any other vermin must be systematically exterminated in the premises of in the equipments. Rodenticides, insecticides, disinfectents and any other potentially toxic substance must be stored in premises or cupboards which can be locked; their use must not present any risk of contamination of the product.

10. Working areas, instruments and working equipment must be used only for work on fishery products. However, on authorization by the competent authority they, may be used for work on other food- stuffs also.

11. Potable water or clean seawater must be used for all purpose. However, by way of an exception, non potable water may be used for steam production, fire-lighting and the cooling of refrigeration equipment, provided that the pipes installed for the purpose preclude the use of such water for other purposes and present no risk of contamination of products.

12. Detergents, disinfectants and similar substances much be approved by the competent authority and used in such a way that they do not have adverse effects on the machinery, equipment and products.

General Conditions of Hygiene Applicable to Staff

The highest possible standard of cleanliness is required of staff. More specifically.

1. Staff must wear suitable clean working clothes and headgear which completely encloses the hair. This applies particularly to persons handling exposed fishery products.

2. Staff assigned to the handling and preparation of fishery products must be required to wash their hand at least each time work is resumed. Wounds on the hands must be covered by a water proof dressing.

3. Smoking, spitting, eating and drinking in work and storage promises of fishery products must be prohibited.

The employer shall take the requisite measures to prevent persons liable to contaminate fishery products from working on and handing them, until there is evidence that such persons can do so without risk.

When recruited, any person working on and handing fishery products shall be required to prove, by a medical certificate, that there is no impediment to such employment. The medical supervision of such a person shall be governed by the national legislation in force.

A check on storage and transport conditions.

Organoleptic Checks

The competent authority shall carry out inspection at the time of landing or before fist sale and also during subsequent stages of processing, storage and transport to check whether the products are fit for human consumption. The inspection shall comprise of organoleptic checks carried out by sampling.

1. If the Organoleptic examination reveals that the fishery products are not fit for human consumption, measures shall be taken to withdraw them from sale and to dispose them off in such a way that the rejected material is not used for export.

2. If the organoleptic examination reveals any doubt to the freshness of the fishery products, use may be made of chemical checks or microbiological analysis.

Parasite Checks

Before they are released for human consumption, fish and fishery products must be subjected to a visual inspection by way of sample, for the purpose of detecting any parasites that are visible. Fish or parts of fish which are disposed of in such a way that such material is not used for export.

Histamine Check

Wherever necessary samples shall be drawn and tested for Histamine content. Ninesamplemust be takenfrom each batch. This must fulfil the following requirements.

- The mean value must not exceed 100 ppm.
- Two samples may have of more than 100 ppm, but less than 200 ppm.
- No sample may have a value exceeding 200 ppm.

These limits apply only to fish species of the following families; Scombridae and Clupeidae. However, fish belonging to these families which have undergone enzyme ripening treatment in brine mayhave higher histamine levels but not more that twice the above value. Examinations must be carried out in accordance with reliable, scientifically recognized metheods such as high performance liquid chromatography(HPLC).

Contaminants Present in theAquatic Environment.

Without prejudice to the rules concerning water protection and management and in particular those concerning pollution of the aquatic environment, the fishery products must not contain in their edible parts contaminants present in the aquatic environment such as heavymetalsand organ chlorinated substances at such a levelthat the calculated dietaryintake exceeds the acceptable daily or weekly intake for humans.

A monitoring system must be established bythe competent authority to check the level of contamination of fishery products.

Microbiological analysis

Wherever necessary samples shall be drawn and tested for microbiological factors. Sampling plans, methods of analysis and acceptance criterias for this purpose shall be.
As per the requirements ofimporting countries Or As per the Manual ofAnalytical Methosd for Fish and Fishery products issued by the Quality Development centre, Madras.

Packaging

1. Packaging must be carriedout under satisfactoryconditionsofhygiene to preclude contamination of the fishery products.

2. Packaging material and products liable to enter into contact with fishery products must complywith all the rules of hygiene and in particular.

- Theymust not be suchto impair the orgenoleptic charactaristic of the fishery products.
- Theymust not be capable of transmitting to the fishery products sub- stances harmfulto human health;
- Theymust be strong enough to protect the fisheryproducts adequately.

3. Boxes/Containers used for carring of raw materials to the processing plant shall not be used to store the accepted raw material and also in subsequent processing, such Boxes/containers shall be identifiable by suitable colour or marks.

4. With the exception of certain boxes/containers made of impervious, smooth and corrosion resistant which are easyto clean and disinfect, which may be re-used after cleaning and disinfecting, packaging material may not be re- used. Packaging material use for fresh material may not be re-used. Packaging material used for fresh products held under ice must provide adequate drainage for meltwater.

5. Unused packaging materials must be stored in premises away from the production area and be protected from dust and contamination.

Storage and Transport

1. Fresh, Frozenand processed Fish and FisheryProducts must, during storage and transport, be kept at the temperature laid down in this notification and inparticular.

- Fresh or thawed fisheryproducts and cooked and chilled crustacean and molluscan shellfish products must be kept at the temperature of malting ice.
- Frozen Fisheries Products with the exception of frozen fish in brine intended for the manufacture of canned foods, must be kept at an even temperature of-18^0C or less in allparts of the products, allowing for the possibility of brief upward fluctuations of not more than 3^0C, during transport;
- Processed products must be kept at the temperature specified by they manufacture, when the circumstances so require.

2. Where frozen fishery products are transported from a cold storage/ plant to anapproved establishment to be thawed on arrival for the purposes of preparation and/or processing and where the distance to be covered is short, not exceeding 50 km., or 1 hour journey laid down in point 1 second para.

3. Products may not be store or transported with other products which may contaminate them or affect their hygiene, unless they are packaged in such a wayas to provide satisfactory protection.

4. Vehicles used for the transport offisheryproductsmust be constructed and equipped in such a way that the temperature laid down in this notification can be maintained through out the period of transport. It ice is used to chill the products, adequate drainage must be provided in order to ensure that water from melted ice does not stay incontact with the products. The inside surfaces of the means of transport must be finished in sucha waythat theydo not adversely affect the fresh frozen and processed fish and fisher products. They must be smooth and easyto clean and disinfect.

5. Means of transport used for fresh, frozen and processed fish and fisheryproducts maynot be usedfor transporting other products likely to impair or contaminate fisheryproducts, except whenfisheryproductscanbe guaranteed uncontaminated as a result of such transport being thoroughly cleaned and disinfected.

6. Fresh, frozen and processed fish and fishery products may not be transported invehicle or container which isnot cleanor whichshould have been disinfected.

7. The transport conditions of Fresh, Frozen and Processed fish and Fishery Products to be exported shall be such that they do not adversely affect the products.

General Principles

It is recommended that a model of a logical approach be followed, of whichthe following principle from the essential components:

- Identification of hazards, analysis of risks and determination of measures necessary to control them.
- Identification of critical them;
- Establishment of critical limits for each critical point;
- Establishment of corrective action to be taken when necessary;
- Establishment of monitoring and checking procedures;
- Establishment of verification and review procedures;
- Establishment ofdocumentationconcerningallproceduresandrecords;

Short Answer Type Questions

1. What type of aqua products are exporting from India?
2. Define brine.
3. What is smoking ?
4. Which type of main steps are more beneficial to export fishery products other countries.

Long Answer Type Questions

1. Give an account on export of aqua – products.
2. Describe the characteristics of fish trade.
3. Describe the quality control measures during the export.
4. List out the employment opportunities in fisheries sector.

FISHERIES

II YEAR

PART-B, VOCATIONAL COURSE

PAPER-I THEORY

POND MANAGEMENT

Periods/Week :05 **Periods/Year:110**

Time Schedule Weightage And Blue Print

S.No	Name of Unit	No.Of Periods	Weightage In Marks	Short Answer Questions	Essay type Questions
1	Introduction to Pond Management	5	2	1	-
2	Lay out of Fish Farms- Site selection criteria, designing, construction of fish farm	10	8	1	1
3	Nursery Pond Management:- pond preparation Stocking and post- stocking management.	10	8	1	1
4	Rearing and stocking pond management Pre stocking, stocking, post stocking Management.	10	8	1	1
5	Culture practices:- Liming, Manuring, Eradication of weeds and insects, sanitizers, and pro-biotics.	10	8	1	1
6	Natural Food:- Food and feeding habits of Fish and prawn, natural food organisms Role of plankton and their culture	10	8	1	1
7	Artificial food:- Nutritional requirements – Supplementary feeds and their application FCR- Quality feed.	10	8	1	1
8	Health management- Common fish and shrimp diseases and their control, , good health management.	20	16	2	2

9	Water Quality Management in ponds-physical factors, chemical factors and biological factors and their management, Water filtration	16	16	2	2
10	Routine pond management- daily and monthly management, reasons for fish and prawn kills	10	10	2	1
	Total	**110**			

FISHERIES

II YEAR

PART-B, VOCATIONAL COURSE

PAPER-II THEORY

AQUA CULTURE

Periods/Week :04 **Periods/Year:110**

Time Schedule Weightage And Blue Print

S.No	Name of Unit	No.Of Periods	Weightage In Marks	Short Answer Questions	Essay type Questions
1	Aquaculture- Introduction types of aquaculture, economic importance.	15	8	1	1
2	Polyculture:-Advantages, management, superior over monoculture.	15	8	1	1
3	Intregated Fish farming – fish cum paddy, fish cum poultry, fish cum duckery, fish cum dairy.	10	6	1	1
4	Sewage fed fish culture, cage culture, pen culture.	15	14	1	2
5	Crustacean fisheries - Scampi, Shrimp, Crab, Lobster,	15	10	2	1
6	Molluscan fisheries - Edible oyster, Pearls, Mussel.	10	8	1	1
7	Air breathing , Ornamental Fish culture	10	10	2	1
8	Moder n Aquaculture:- (RAS) – Recirculating aquaculture Types,,Biofloc System .	10	8	1	1
	Seaweed culture –morphology structure,types,economic importance.1	10	8	1	1
	Total	**110**			

FISHERIES

II YEAR

PART-B, VOCATIONAL COURSE

PAPER-III THEORY

RESORVOIR FISHERIES

Periods/Week :05 **Periods/Year:110**

Time Schedule Weightage And Blue Print

S.No	**Name of Unit**	**No.Of Periods**	**Weightage In Marks**	**Short Answer Questions**	**Essay type Questions**
1	Introduction for Reservoir Fisheries and Post Harvest Technology	5	2	1	--
2	Reservoir Fisheries – Reservoir Ecology, Classification ,Reservoirs in India and A.P., Management of Reservoir Fishery	15	10	1	1
3	Sports fisheries in India, Kolleru and Pulicat lake fisheries.	10	4	2	--
4	Over fishing, effect of dams and barrages on fisheries and fish migration	5	4	2	--
5	Fish processing, preservation - Reasons for spoilage of fish and prawn, methods of fish preservation	15	14	2	--
6	By products of fish and prawn, value addition to fishery products	15	14	1	2
7	Marketing – Types of Markets – Marketing Intermediaries , flow channels and management of markets	15	14	1	2
8	Economic status of the fisher - man, government schemes, role of co-operative Societies in fisheries sector.	10	8	1	1
9	Fishery Economics – Principles, Economic development, Potentials ,Job- Opportunities in fisheries sector	10	8	1	1
10	Export and Quality Control	10	8	1	1
	Total	**110**			

FISHERIES

II YEAR

PAPER I POND MANAGEMENT

TIME: 3 Hours **Max. Marks: 50**

SECTION-A

Note: (i) Answer all the Questions
(ii) Each Question carries 2 marks **10X2=20**

1.. Explain the benefits of Lime?
2. What are supplementary feeds?
3. What are the characters of Nursery pond
4.Define Pond
5. What are the reasons for fish mortality in ponds?
6. What is the role of dissolved oxygen in aquaculture?
7. What are the functions of aerators?
8. Name any four Zooplankton
9. What is Bern?
10. give any two diseases in fishes?.

SECTION-B

Note: (i) Answer any five Questions
(ii) Each Question carries 6 marks **5X6=30**
(iii) Draw the diagram

11. Explain the role of chemical factors of water for enhancing fish production in ponds?
12. Write the steps involved in construction of fish pond
13. Discuss the nutritional requirements for shrimp.
14. Describe the viral diseases in fishes.
15. Explain the daily management of fish ponds
16. Describe the natural food of fish?
17. Describe the Management of stocking pond?
18 What are the advantages and disadvantages of Aquatic weeds in fish ponds?
    Explain the Type s of Aquatic weeds?

FISHERIES

II YEAR

PAPER II AQUA CULTURE

TIME: 3 Hours **Max. Marks:50**

SECTION-A

Note: (i) Answer all the Questions
(ii) Each Question carries 2 marks **10X2=20**

1. what is Intergated fish farming?
2. What is Sewage?
3. Define acqua culture?4. Define Periphyton
5. Name any four Sea Weeds?
6. write the use of Azolla?
7. Name any four Air-breathing fishes?
8. What is Poly culture?
9. Give two examples of lobsters?
10. Name any two ornamental fishes?

SECTION-B

Note: (i) Answer any five Questions
(ii) Each Question carries 6 marks **5X6=30**
(iii) Draw the Diagram

11. Discuss the management practices in composite fish pond.?
12. Describe biofloc system?
13. Describe the culture of crabe?
14. Explain paddycum fish culture?
15. Describe the breading and culture of gold fish?
16.Explain the advantages of cage culture?
17. Write the advantages of sea weeds?
18. Write an essay on pearl culture?

FISHERIES

II YEAR

PAPER III RESORVOIR FISHERIES

TIME:3 Hours **Max. Marks:50**

SECTION-A

Note: (i) Answer all the Questions
(ii) Each Question carries 2 marks **10X2=20**

1. Define Reservoir.?
2. Name any two sport fishes?
3. What is overfishing?
4. What is Canming?
5. What is lentic eco system
6. What type of aqua products are exporting from India?
7. Where Kolleru and Pulicat Lakes found?
8. What are the aims of co-opoerative Socities?
9. What is Isinglass?
10. Define markets?

SECTION-B

Note: (i) Answer any five Questions
(ii) Each Question carries 6 marks **5X6=30**
(iii) Draw the diagram

11. Explain about fish By-products?
12. Describe the reserviour fishery management?
13. Explain the socio-economic status of fisher man?
14. Explain different types of fish markets?
15. What are the reasons for fish spoilage?
16. Write the functions of fish co-operative societies?
17. what are the effects of over fishing?
18. Describe the preservation of methods of fish?