A MANUAL
ON
COMPOSITE FISH FARMING

2008

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Treatment:
- Bath treatment in 5ppm KMnO4 (Potassium permanganate) for 2-3 minutes.
- Draining of pond water and exposure of pond bottom to sunlight for at least 24 hours helps in killing the parasite.

**D) EPIZOOTIC ULCERATIVE SYNDROME (EUS) DISEASE**

*Causative agent:* can be virus, bacteria, fungus or parasite.

*Symptoms:*
- Abnormal swimming behaviour.
- Head projected out of water.
- Red spots on the body cavity
- Localised ulceration.
- Bigger ulcers.
- Deep sores often with peripheral black melanistic ring especially in the abdomen and caudal peduncle.
- In advanced cases the peduncle falls off.

*Treatment:*
- Application of lime at a dose of 200-500kg/ha pond is effective.
- Bath treatment of affected fish in NaCl solution at a concentration of 3-4% is fairly effective.
- CIFAX, a chemical developed by CIFA, Bhubaneshwar, when applied at 1 litre/ha water area was reported to cure the disease in 7 days.
Symptoms:
- They are found on the gill filaments.
- Fading of colours of gill filaments.

Treatment:
- Short bath in 1:2500 formalin solution (i.e. 1gm formaldehyde in 2.5 litres of water) for 30 minutes.
- Short bath in salt water (5% NaCl)

c) Gyrodactylosis

Causative agent: Helminth/worm called *Gyrodactylus*

Symptoms:
- Fading of colours of skin.
- Dropping of scales.
- Excessive mucus secretion.
- Peeling of skin.

Treatment:
- Badly affected fish should be destroyed.
- Mild infections should be treated with short bath in 1:2500 formalin solution for 30 minutes.

d) Argulosis

Causative agent: Caused by *Argulus* or fish lice.

Symptoms:
- Irritation.
- Very weak.
- Stunted growth.
- Loss of scales.
- Red spots.
b) Eye disease

Symptoms:
- The eye disease is epidemic.
- Formation of a tuft of white or grey threads, resembling cotton wool, hanging out of the eye.

Treatment:
Apply 1-2 % Silver nitrate solution with the help of a brush in the affected area.

C) PARASITIC INFECTIONS (crustaceans, helminthes, protozoans)

a) Lernaeasis

Causative agent: Parasite Lernaea

Symptoms:
- It affects the skin causing ulcers
- Loss of weight.
- In severe cases, the fish is found floating on the surface with belly and abdomen facing up.

Treatment:
- Supply of infection free water.
- Disinfection by means of drying the pond.
- Prevent entry of carriers of Lernaea parasite such as coarse fish, frogs etc.
- Bath treatment of fish in 3-5% Sodium chloride solution for 5-10 minutes for 3 days.

b) Dactylogyrosis

Causative agent: Helminth/worm called Dactylogyrus

PREFACE

Nagaland is one of the hot spot of freshwater biodiversity in the country where rivers and streams form an intriguing network of water resources. It consists of 1600 Km of several rivers and streams. About 50% of the total area has economic cultivable land and the main stay of the state is land-based where developmental works on fisheries sector can be achieved.

Fish culture has been an age old practice since decades. The value of polyculture, integration of agriculture and animal husbandry with fish-culture through Aquaculture has increased recognition to ensure adequate supplies of animal protein for mankind.

Though, various techniques of fresh-water fish culture have been successfully developed to enhance fish production, an extensive publication on this line for dissemination of knowledge to students, fish farmers and entrepreneurs alike is still wanting. The present manual deals with most aspects of fresh-water "Composite Fish Culture" which can be profitably adopted indifferent fresh-water bodies. This manual mainly on composite fish culture where suitable fast growing compatible fish species of different feeding habits are selected and stocked together in order to utilize fully the pond’s productivity for obtaining higher production. Carps satisfy these demands and since they feed on the lower links in the food chain and accept low-cost feed, they are economical to be cultured. The objective of raising healthy and economically viable fish crops is realized through appropriate manipulation of fish stock and pond ecology.

The various steps involved in management are made elusive in the manual, which would give and insight to students, fish farmers and entrepreneurs in the practical application of composite fish culture technology, and to achieve good production per unit area of pond.

Authors
**About KVK, Mokokchung**

Krishi Vigyan Kendra (Farm Science Centre) is a multi disciplinary (agri and allied) office located at Yisemyong which is 17 Km from the district headquarter Mokokchung. The main objectives of the centre is to train the farmers, farm women, rural youths and extension functionaries in skill and production oriented activities in agriculture and allied fields, to undertake On-Farm-Testing (OFT) of the technologies developed by State Agriculture University, Indian Council of Agricultural Research and other research institutions, to demonstrate the technologies in plot of selected farmers through Front Line Demonstrations (FLD), to provide farm advisory services and information support and to develop linkages with different research and developmental departments.

c) Dropsy

In case of dropsy disease, infection is caused due to accumulation of liquid (exudates) in one or other of the internal organs like the kidney. In fish, it usually affects the belly.

**Symptoms:**
- The belly swells to a considerable extent
- Inflammation of the intestine.
- Liver badly affected.

**Treatment:**
Application of antibiotic chloromycetin using a dosage of 20 ppm (mg/l) in the tank or dip treatment in 5ppm KMnO4 is effective.

**B) FUNGAL DISEASE**

a) Gill rot disease

This disease is common in ponds with poor water quality.

**Symptoms:**
- Gill filaments become blackish red in colour and the rest becomes whitish/ yellowish.

**Treatment:**
- Maintain water quality.
- Introduce cool water.
- Prevent undue turbidity of water and organic pollution.
- Discontinue feeding.
- Add lime to the water @ 250 kg/ha
- Bath treatment in 3-5% Sodium Chloride solution (50g salt in 1 litre water) for 5-10 minutes.
4. Prevent transfer of infected stocks.
5. Removal of unwanted fish and other organisms.
6. Lime application as a preventive measure.
7. Regular monitoring of health status.
8. Vaccine development.

What are pathogens?
Pathogens are organisms that can cause disease. They are bacteria, fungi, virus and parasites. Pathogens invade the different parts such as skin, scales, mouth, nostril, eyes, gills and digestive tract.

SOME COMMON DISEASES, THEIR SYMPTOMS AND TREATMENT.

A) **BACTERIAL DISEASE**

a) Fin/Tail rot disease

**Symptoms:**
- The fins losses its fin rays.
- Fatal to younger fish.

**Treatment:**
Bath treatment for 1-2 minutes in 1:2000 Copper sulphate solution or application of antibiotic tetracycline @ 10-50 ppm in the tank.

b) Ulcer disease

**Symptoms:**
- Red spots appear on the skin.
- These spots develop into ulcers.
- Loss of scales
- Affects major carps.

**Treatment:**
Bath treatment for 1 minute in 1: 2000 Copper Sulphate solution for 3-4 days.

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4. FISH DISEASES, THEIR CONTROL AND TREATMENT

When disease occurs in fish, their treatment becomes difficult. Therefore it is better to prevent the occurrence of diseases.

Diseases in fish can be classified into two types:

1. Non pathogenic
2. Pathogenic

1. Non pathogenic disease occurs due to the following reasons:
   i. Injuries caused due to rough handling.
   ii. Poor water quality
   iii. Improper stocking
   iv. Malnutrition
   v. Environmental stress.

Non pathogenic diseases occur mainly due to negligence.

2. Pathogenic diseases are caused by virus, bacteria, fungi, and protozoans/ parasites.

GENERAL SIGNS AND SYMPTOMS OF DISEASED FISH

Disease in fish is manifested by behavioral abnormalities.

1. Abnormal swimming behavior.
2. Lethargy.
3. Abnormal change in color.
4. Loss of appetite.
5. Abnormal color of gills.
7. Poor escape response.
8. Mortalities.

SOME GENERAL PREVENTIVE MEASURES.

1. Maintenance of water quality.
2. Maintenance of environmental parameters.
3. Adequate nutrition.
MISCELLANEOUS:

FRESHNESS GRADING SYSTEM

<table>
<thead>
<tr>
<th>Grade</th>
<th>Highly acceptable</th>
<th>Acceptable</th>
<th>Fairly Acceptable</th>
<th>Not Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>Bright, shining,</td>
<td>Waxy, slight loss of bloom</td>
<td>Dull</td>
<td>Dull, gritty and shrinkage</td>
</tr>
<tr>
<td></td>
<td>iridescent or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>opalescent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outer slime</td>
<td>Transparent or</td>
<td>Milky</td>
<td>Yellowish grey,</td>
<td>Yellow-brown,</td>
</tr>
<tr>
<td></td>
<td>water white</td>
<td></td>
<td>some clotting</td>
<td>heavy, clotted and thick</td>
</tr>
<tr>
<td>Eyes</td>
<td>Convex, black</td>
<td>Plane, slightly opaque pupil, slightly opalescent cornea.</td>
<td>Slightly concave, grey pupil, opaque cornea.</td>
<td>Completely sunken, grey pupil, opaque discoloured cornea.</td>
</tr>
<tr>
<td></td>
<td>pupil, translucent cornea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gills</td>
<td>Bright red, mucus</td>
<td>Pink, mucus slightly opaque</td>
<td>Grey, mucus opaque and thick</td>
<td>Brown, mucus yellowish grey and clotted</td>
</tr>
<tr>
<td>Peritoneum</td>
<td>Glossy, brilliant</td>
<td>Slightly dull, difficult to tear from flesh</td>
<td>Gritty, fairly easy to tear from flesh</td>
<td>Gritty, easily torn from flesh</td>
</tr>
<tr>
<td></td>
<td>difficult to tear from flesh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smell &amp;</td>
<td>Fresh, strong</td>
<td>Slightly weedy, no odour, trace of musty mousy etc</td>
<td>Definitely musty mousy etc, bready and malty</td>
<td>Acetic, fruity amines sulphide faecal</td>
</tr>
<tr>
<td>Internal odour</td>
<td>weedy odour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vent</td>
<td>Closed</td>
<td>Closed in many cases</td>
<td>Open in most cases</td>
<td>Open and gut content oozing</td>
</tr>
</tbody>
</table>

INTRODUCTION

Fish is a cold-blooded aquatic animal breathing by means of gills and balances its movement by means of fins. Their body temperatures are suited to dwell in water throughout their lifetime.

The quantum of fish from natural water bodies in our state and the North East region as a whole is inadequate to meet the demand of the ever-increasing population. Hence, we have to tap additional sources of supply and mobilize water resources. In this context, the importance of “Aquaculture” is greatly felt as that of agriculture and animal husbandry.

A Chinese proverb says.

“Give a man a fish
He will eat only once
Teach him fish culture
He will eat through out his life”

Aquaculture is the ‘Farming’ and husbandry of economically important aquatic animals and plants under controlled condition.

Fuller utilization of the pond’s productivity for obtaining high production per hectare of water body is achieved through intensive culture of fast growing compatible species of fish of different feeding habits are stocked together in the same pond, so that, all its ecological niches are occupied by fishes and full utilization of the pond nutrients/resources is achieved. When compatible fishes of different feeding habits are stocked together, they secure for themselves in the most efficient manner, all life requisites available in the pond for fish production without harming each other. This technique of fish culture is called Composite fish culture or Poly-culture or Mixed farming. The main objective of this Composite fish culture is to select and grow compatible fish species of different feeding habits, in order to exploit all types of food available in different region of the pond for maximizing fish production.
A pond can be divided into three distinct zones, according to the depth of the pond.

I) Upper surface zone

II) Middle column zone

III) Bottom zone

To utilize fully the productivity of the pond and depending upon the feeding habit of the fish, selection of species combination is a must. In case of mono-species culture, only one zone is being utilized or exploited while, the other zones remain unutilized. Therefore, the entire ecological area is not utilized, resulting in poor production. For example: - if only catla is cultured in a pond, only the surface zone will be utilized and the other zones remain unexploited. If all the ecological niches of the pond are exploited, greater production is possible.

In mixed culture the fish usually stocked are a mixture of plankton feeders and macrophyte (waterweed) feeders. The nutrients added to the water are taken up by both phytoplankton and the macrophytic water weeds, but as with land plants, they may not grow at the same pace, so that one group may use up most of the nutrients leaving little for the other. In ponds we try to maintain a balance by using both the phytoplankton to feeders and the water-weed eaters. If we use only fish that eat waterweeds, these may be heavily grazed and the nutrients released may then be taken up by the phytoplankton, which becomes denser and denser, shading out the submerged water-weeds and preventing them from growing again. If we only use the plankton feeders, the phytoplankton may become so heavily grazed, that the ungrazed submerged water-weeds grow very fast and use up all the nutrients. The plankton feeders will then starve. Sometimes not all the phytoplankton is grazed and we then have zooplankton developing (minute crustacea, rotifers, etc.). These also can be grazed down. We try therefore to achieve a balance where both phytoplankton and water-weeds can grow, and to have different species of fish grazing down both.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Items</th>
<th>Cost (Rupees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Expenditure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Weed clearance</td>
<td>1,000.00</td>
</tr>
<tr>
<td>2</td>
<td>Mahua oil cake (2500 kg @ Rs 5/kg)</td>
<td>12,500.00</td>
</tr>
<tr>
<td>3</td>
<td>Lime (1500 kg @ Rs 8/kg)</td>
<td>12,000.00</td>
</tr>
<tr>
<td>4</td>
<td>Cow dung (10,000 kg @ Rs 100/quintal)</td>
<td>10,000.00</td>
</tr>
<tr>
<td>5</td>
<td>Urea (250 kg @ Rs 8/kg)</td>
<td>2,000.00</td>
</tr>
<tr>
<td>6</td>
<td>Single super phosphate (300 kg @ Rs 8/kg)</td>
<td>2,400.00</td>
</tr>
<tr>
<td>7</td>
<td>Fingerlings (10,000 Nos @ Rs 100/1000)</td>
<td>1,000.00</td>
</tr>
<tr>
<td>8</td>
<td>Feed: Rice bran (2625 kg @ Rs 10/kg)</td>
<td>26,250.00</td>
</tr>
<tr>
<td></td>
<td>Oil cake (2625 kg @ Rs 10/kg)</td>
<td>26,250.00</td>
</tr>
<tr>
<td></td>
<td>Flour (10 kg @ Rs 15/kg)</td>
<td>150.00</td>
</tr>
<tr>
<td>9</td>
<td>Netting</td>
<td>2,000.00</td>
</tr>
<tr>
<td>10</td>
<td>Miscellaneous</td>
<td>10,000.00</td>
</tr>
<tr>
<td></td>
<td>TOTAL EXPENDITURE</td>
<td>1,05,550.00</td>
</tr>
<tr>
<td>B. Return</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Production (3000 kg @ Rs 60/kg)</td>
<td>1,80,000.00</td>
</tr>
<tr>
<td>C. Profit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>(B-A) (1,05,550-1,80,000)</td>
<td>74,450.00</td>
</tr>
</tbody>
</table>
production of about 2500 to 3500 kg/ha/year can be obtained, and a net profit of about Rs. 70,000 to Rs. 80,000 can be expected.

It is to be noted that catla, grass carp, silver carp and common carp under proper management can attain the marketable size of 1 kg in about 4–5 months. Periodic harvesting of such fishes and replenishment of the harvested stocks with fingerlings not only helps growth of other fishes by reducing the biomass, but also helps in raising more than one crop of a species in the same pond in a single year. Under intensive fish culture, over 6,000 kg/ha/year of fish production can be obtained and a net profit of about Rs. 1,00,000 to Rs. 1,50,000 can be expected.

Final harvesting is done by seine net, either during the summer months when the water level falls or after the monsoon, or when the market demand is highest. However, harvesting in larger and deeper ponds poses serious problems. While surface feeders are easily caught with a seine net or drag net, bottom-dwellers usually escape. It has been seen that the conventional drag net can collect about 90% of surface and column feeders, whereas only 20–40% of bottom-dwelling fishes are caught with the same number of hauls in small ponds. To obtain the maximum catch of bottom-dwellers from large and deep ponds, a trap net is recommended.

The technology of polyculture or mixed culture of Indian major carps includes the removal of predatory fishes from the pond by using suitable ichthyocide, fertilizing the pond with both organic and inorganic fertilizers and feeding the stocking fishes with supplementary feed.

Further the introduction of exotic Chinese carps e.g. grass carp, silver carp and Bangkok strain of common carp into India in the late fifties added these species to the family of cultured carps. These exotic species are non-predatory, fast growing and compatible with Indigenous ones.

There are two major system of carp culture in Asia. They are Chinese system of culture which involves Chinese carps such as (i) silver carp, Hypophthalmichthys molitrix, a phytoplankton feeder (surface feeder); (ii) grass carp, Ctenopharyngodon idella, the macrovegetation feeder (column feeder); and (iii) common carp, Cyprinus carpio, an omnivore (bottom feeder).

Indian system of culture involves the Indian carps such as (i) Catla, Catla catla, a phytoplankton and zooplankton feeder (surface feeder); (ii) Rohu, Labeo rohita, a vegetable matter, detritus etc. feeder (column feeder); and (iii) Mrigal, Cirrhinus mrigala, an omnivore (bottom feeder).

This system of farming is widespread and the systems differ according to the availability of the species, local preferences etc. The selection of suitable species for stocking depends on the nature of soil and water of the ponds, the availability of stocking material, consumers' preference and the kinds of fish food organisms available.
**FISH FARMING**

**WHAT IS FISH FARMING?**

Fish farming is the raising of fish under controlled conditions for own consumption or commercial purpose.

**WHY DO WE RAISE FISH?**

1. Better use of our land and our water.
2. Fish provides cheap source of protein.
3. To earn sustainable income.
4. To raise the nutritional level of the rural population.

**WHAT DO YOU NEED TO RAISE FISH?**

1. A suitable land with gentle slope.
4. Proper management practices.

### iii) Liming:

Liming should be done once in a month @ 25 kg/ha (i.e. 300 kg/ha/year). It should be done 1 or 2 days after the application of organic manure.

### iv) Raking:

A day after liming, raking of pond bottom should be done for proper mixing of lime, as well as, it helps to release the obnoxious gases formed in the bottom soil.

**Growth and Health Care**

Healthy fish grow well and feed voraciously. To check the growth and health of fish, periodic netting at least once in two months is recommended. By observation, if the feed provided are not consumed, either the fish are suffering from some disease or the water quality may be deteriorated. A check on the water quality, hygiene of the pond and the health of the fishes are necessary to take remedial measures.

**Netting for growth and health check**

**Prophylactic treatment**

**D) Harvesting and production**

In fattening ponds, fish normally attain table-size within one-year, therefore, fish culture in ponds and tanks is generally practiced at least for 12 months. During this period, generally, catla attains a weight of about 800 gm to 1 kg, rohu 600 to 800 gm, mrigal 400 to 600 gm, silver carp 1 kg to 1.2 kg, grass carp 1 kg to 1.5 kg and common carp 800 gm to 1 kg. If all the above measures are followed properly, a
Grass carp feeds voraciously and can even consume feed almost equal to their body weight. They feed on aquatic, terrestrial vegetation, fodder grasses and vegetable waste. Therefore it should be fed with adequate aquatic weeds, viz. Wolffia, Lemna, Azolla, Spirodella etc. or fodder grasses such as Napier, Barseem, or even lawn grass and vegetable wastes such as cabbage or cauliflowers leaves. Because of their voracious feeding habit, it is advisable to feed them at least one hour before the application of supplementary feed to other fish. A rectangle frame made of split bamboo poles can be used to provide food to grass carp as feeding tray.

Common weeds preferred by Grass carp.

![Galinsoga parviflora](image1) ![Crassocephalum crepidoide](image2)

frame for grass carp

Bamboo feeding

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**FARM LOCATION**

**WHERE TO PUT YOUR FISH POND (SITE SELECTION)**

1. Do not build a pond on land that could be better used for something else.

2. It is best to put a pond in a place with a gentle slope or on a hillside so you will not have to dig too much soil to build it. A pond built on a slope is also easier to drain.

3. Do not build your pond in a place that is so low that it can be flooded during the rainy season.

4. The site should be easily accessible.

5. The desirable pond should be preferably 0.5 hectare in area, rectangular in shape, 2 to 3 meters deep and an even bottom.
WATER SUPPLY

1. Your pond must be near a good supply of water such as a spring, stream, lake or reservoir with plenty of water all year round.

2. You must be sure that you have enough water to fill your pond when it is time to fill it and to add more water when you need it.

3. Do not depend on rainwater to fill your pond.

4. Your water must come from a place that is higher than the pond so that the water will flow into the pond by itself.

5. The water should not have a bad smell, taste or colour. It should not be too muddy.

6. The water should not have wild fish in it. Wild fish in your pond may prey upon the cultured fish or keep them from growing.

Fertilization should not be done during persistent cloudy weather or when algal bloom appears. The use of fertilizers may be either reduced or completely stopped during winter months in old ponds or otherwise rich ponds.

ii) Supplementary feeding:

Supplementary feeding is very important in fish culture practices for achieving faster growth. Spawns are voracious feeders. Therefore supplementary feed can be prepared with the cheapest and readily available ingredients, comprising of 1:1 mixture of, any oil cake (mustard/groundnut/til/coconut) and rice polish or rice/wheat bran and fed to the spawns @ 8% of the body weight of spawn stocked. The quantity of feed, however, can be adjusted depending on the rate of consumption through daily observation. The feed is better utilized, when one time feed is given in two batches and fed twice daily in the morning and in the evening.

In rearing and stocking ponds, fish are fed @ 2-4% of the body weight of fish stocked. Other ingredients such as wheat bran, groundnut oil cake, fish meal, broken rice etc. are also used as supplementary feed. Vitamins and mineral mixture are also used.

The mixture of oil cake, rice polish/bran with some water and a little flour (as binder) forms a dough, which is then made in to small balls and kept in a trays made of bamboo. The trays are then placed at a particular depth of the pond, tied to a pole, fixed on the embankment, to avoid displacement of the trays. For a hectare pond, 10 to 15 trays placed at different locations are sufficient.
Stocking ponds are large in size and are used for producing table fish. Pond size may vary from 0.20-0.5 or up to 1 ha. A depth of 1.5-2.0 m is maintained. Fingerlings are stocked at a density of 10,000 numbers/ha or even higher in case of intensive fish culture.

C) POST STOCKING MANAGEMENT

The growth of fish is well established, when natural food is supplemented by artificial feed containing high grade of protein. The production of natural fish food organisms in the pond should be kept at a higher level of abundance by periodic fertilization and supplementary feeding.

i) Fertilization:

Fertilization with both organic and inorganic fertilizers helps in meeting the requirements of carbon, nitrogen and phosphorus in addition to other nutrients.

a) Organic manure:

Raw cow dung is commonly used organic manure. The dose is recommended at 10,000 kg/ha/year. But higher dose is necessary for soils which are poor in organic contents or where the seepage rate is rather high.

b) Inorganic manure:

Inorganic manure such as urea @ 250 kg or ammonium sulphate @ 450 kg or calcium ammonium nitrate @ 450 kg/ha/year is recommended. But ammonium sulphate should not be used in acid soils. Single super phosphate @ 300 kg or triple super phosphate @ 100 kg/ha/year may be applied in neutral or slightly alkaline soils.

Application of inorganic manure should be done 15 days after application of organic manure. Inorganic manure are applied after mixing with silt/mud at the ratio of 1:4 (1 part of inorganic manure to 4 parts of silt/mud). The mixture is kneaded and made in the form of small balls and thrown in to the pond. In no case should the inorganic manure be thrown directly into the pond before mixing with silt/mud.

SOIL QUALITY

1. The soil where you build your pond should not be too sandy.
2. In sandy soil the water will sink into the ground and there will not be enough water for your fish.
3. The soil where you build your pond should have enough clay in it. Clay soil holds water very well.

TESTING SOIL

1. You should test the soil to see if it is good for building a pond.
2. The first test is easy. Take a handful of soil from the surface and squeeze it into a ball.
3. Throw the ball of soil into the air and catch it.
4. Bad soil with too much sand or gravel in it will not stick together and the ball will fall apart.
5. If the ball sticks together well the soil is considered good.
MANAGEMENT

Management adopted in composite fish culture can be broadly divided into:

A) Pre-stocking management
B) Stocking management
C) Post-stocking management.

A) PRE-STOCKING MANAGEMENT.

This management refers to pond preparation to ensure maximum survival and proper growth of cultured fishes and involve clearance of weeds, eradication of weed and predatory fishes, liming to correct physicochemical properties of water and soil, manuring and repairs of embankments.

II) Weed clearance:

The adverse effects exerted by the excessive aquatic weeds/plants on the pond with regard to living space, sunlight penetration, oxygen circulation, sheltering of fish enemies, should either be kept under check or cleared from the pond because excessive aquatic weeds can be detrimental for fish culture. It causes various hazards for the normal growth of fish. The disadvantages are as follows:-

i). It reduces the living space and cause obstruction for free movement.
ii) It prevents sunlight from entering the pond water, thus, hampers natural fish food production
iii) It takes in nutrient of the pond, which otherwise could be utilize for production of fish food organisms.
iv) It provides shelter to enemies of fishes particularly insects.
v) It causes obstruction for management and harvesting.
vi) Dense growth of weeds, particularly during cloudy days cause serious problem by upsetting the oxygen balance.

Depending on the altitudinal variations, fingerlings should be stocked in the following ratio:

a) Lower altitudes (up to 2500 feet msl) with warm temperature.

b) Medium altitudes (up to 3500 feet msl)

c) High altitudes (above 3500 feet and below 4500 feet msl)
   Silver carp (4): Grass carp (2.5): Common carp (3.5)

DIFFERENT TYPES OF POND FOR FISH CULTURE:

There are different ponds for rearing different stages of fish. They are Nursery pond, Rearing pond and Stocking pond.

The management aspects are same for all the different kinds of ponds.

1. Nursery ponds are usually smaller. A size of 0.08-0.20 ha having a depth of 1m can serve as a nursery pond. Fish spawn are reared for 10-15 days in the nursery pond to produce fry. Fish spawns are stocked at 15-20 lakhs per hectare. The nursery pond should be free from any kind of pests and weeds. All weed fishes and pests should be eradicated. This can be done by complete dewatering of the pond or by soap-oil emulsion method where dewatering is not possible.

2. Rearing ponds are larger than nursery ponds. Here, the fry are reared for 3 months to produce fingerlings. Pond size may vary from 0.15-0.30ha with a depth of 1- 1.5 meter. Fish fry is stocked at a density of 1-2 lakhs per hectare.
iv. **Silver carp**: Silver carp is basically an inhabitant of major river system of south and central China from where it has been transplanted throughout India. It is a surface dweller feeding mainly upon planktonic organisms and readily accepts supplementary feed like oil cakes and rice bran. It does not breed in pond condition. However, through the technique of hypophysation they are induced to breed in ponds during the monsoon season. A fecundity range of 1.45 to 2.00 lakh egg has been found from silver carp weighing 3-6 kg respectively. It takes about 2-3 years to mature. Male matured earlier than the females. In composite fish culture ponds, it usually attains over 1.5 kg within one year of rearing.

v. **Grass carp**: Grass carp is also a native of the river system of China. It is suitable for aquaculture and control of aquatic weed infestation. In early life, it feeds on planktonic organisms and gradually feeds on grass, leaves, weeds, etc. However, they also accept supplementary artificial feed material. In India male attain maturity by the end of first year but female usually takes two years to obtain sexual maturity. The total number of eggs range between 3,08,800 to 6,18,100 from fishes weighing between 4 to 7 kg respectively. The fish does not breed under pond condition and hence seed production is achieved through hypophysation. Usually it grows to over 1.5 kg in composite fish culture pond.

vi. **Common carp**: Originally a native of temperate region of Asia, especially China. The common carp is now the most cultivated carp species throughout the world. It is an omnivorous bottom dweller feeding mainly benthic fauna and decaying vegetable matter. It also readily accepts supplementary feeds. In tropical conditions (warm weather), it attain maturing within 1 year and spawns throughout the year with two peak periods, one from January to March and the other during July and August. In composite culture ponds, it grows to about 1 kg within one year.

Clearance of weeds is achieved by (i) increasing the depth of the pond, (ii) manual means, (iii) mechanical means, (iv) chemical means, and (v) biological means.

Scanty infestation can easily be removed manually. But, when choked densely, suitable weedicides can be used. Various weedicides chemicals are, sodium salt formulation of 2,4-D (Toficide, Hexemex and Ferroxone), applied at ranging from 8 to 10 kgs/ha of water body for water hyacinth, lilies, sedges, etc. and gamaoxone @ 0.5 to 1 kg/ha for water lettuce. Submerged rooted weeds can be eradicated by the application of ammonia @ 15 to 20 ppm/ha. The application of 2,4-D, gamaoxone and ammonia can be sprayed by using a sprayer.

Varieties of weeds such as duck weed, hydrilla, najas, ceratophyllum, etc. can be effectively controlled by releasing grass carp in adequate number. Algal bloom especially microcystis can be controlled by diuron @ 4 kg/ha-m water area.

II) **Eradication of weed and predatory fishes:**

A well managed pond should be free from weed fish and predatory fish, which, otherwise, is not at all desirable in the culture pond.
Weed fish utilize the nutrient from the water and also, compete with cultured fish for food, space and oxygen. Similarly, predatory fish do the same as well as prey on the cultured species. So, their eradication from the pond before stocking is an important step in scientific management.

Dewatering/draining of pond ensures complete removal of unwanted fish. However, repeated netting where draining is not possible would help remove the predators and complete removal is ensured by the application of pesticides. For using pesticides, the ponds have to be poisoned with fish toxins of plant origin. Use of chemicals pesticides (fish poison) is not desirable as their detoxification process is prolonged, they leave harmful residual effect in the pond and the fish thus killed are not safe for human consumption. Mahua oil cake is a popular fish poison of plant origin and is effective at a dose of 200-250 ppm (i.e. 2000-2500 kg/ha-m), this poison at a later stage also serve as a manure.

III) Liming:

Ground limestone (Calcium bicarbonate) or slaked lime (Calcium hydroxide) or quick lime (Calcium oxide are applied at the pond bottom or spread over the water surface for correcting the acidity of the pond water i.e. pH of water and soil, maintaining the sanitation of the pond, checking marked fluctuations in pH, increasing the D.O level of water indirectly, destroying germs of various diseases and toxic gases and

### ii) Species combination:

Species combination and proportion in our region depends on the altitudinal variations and agro-climatic conditions. More over, due attention should be given on the productivity of the pond water and availability of aquatic/terrestrial weeds for grass carp.

i. **Catla:** Catla is the fastest growing Indian major carp species. It inhabits the surface layer and feeds upon phytoplankton, zooplankton, decayed debris and mollusc. It attains maturity in the second year of life and carries over 70,000 eggs/ kg body wt. It naturally breeds in river during monsoon season and under control condition in bunds as well. It does not breed in pond however, it responds well to hypophysation technique. Seeds are easily reared in undrainable ponds of relatively smaller size. Under composite fish culture in ponds it usually grows to over 1 kg in one year.

ii. **Rohu:** Rohu is the natural inhabitant of river system in India. Normally it occupies the column region of ponds and feeds mostly on vegetable matter, detritus, plankton, etc. Like Catla, it naturally breeds in rivers and under special condition in bunds. It never breeds in ponds but it responds quickly to hypophysation. It attains sexual maturity during the second year. Fecundity varies from 2, 26,000 to 2, 80, 00 egg per 1 kg to 7.6 kg. body weight of fish. Rohu spawns during monsoon (April to Sept). Seeds collected are easily reared in ponds and it grows up to 900g within a year under pond culture condition.

iii. **Mrigal:** Mrigal inhabits all the major river system of India. The adult feeds upon green algae, diatom, decayed vegetables, mud and detritus. It is a bottom feeder and usually attains maturity within one or two years depending upon the agro-climatic condition of the location. Fecundity ranges between 1.0- 1.5 lakhs per kg body wt. of female. Spawning season is linked with the onset and duration of the South West monsoon. It does not breed in ponds, but can be easily breed by hypophysation. Under pond culture condition it grows to over 1kg in one year.
iv.

i) **Stocking density:**

Fingerling of 60-100 mm size, at a moderate density of 7,500 fingerlings/ha is recommended. But a density of 10,000 fingerlings/ha is also justified. When the rearing period is limited to about 8 to 10 months, a density of 6,000 fingerlings/ha is most suitable.

**Aeration of water before releasing of fish seeds**

**Releasing spawns in nursery pond.**

**Fish fry for stocking.**

hastening mineralization of organic matter. A pH range of 6.5 to 7.5 is most suitable for fish culture. It should be noted that liming is done 7 days after the application of fish poison Mahua oil cake.

The dose of lime is adjusted according to the PH of the soil and water. Under Indian conditions, lime is used in stock ponds at the rates of 200–1000 kg per hectare per year in installments based on soil pH as given below:

**Table-1**

<table>
<thead>
<tr>
<th>PH of soil/water</th>
<th>Type of soil/water</th>
<th>Dose of lime (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixing of lime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.5-5.0</td>
<td>Highly acidic</td>
<td>2000</td>
</tr>
<tr>
<td>5.0-6.0</td>
<td>Moderately acidic</td>
<td>1200</td>
</tr>
<tr>
<td>6.0-6.5</td>
<td>Mildly acidic</td>
<td>1000</td>
</tr>
<tr>
<td>Applic.ation of lime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.5-7.0</td>
<td>Near neutral</td>
<td>400</td>
</tr>
<tr>
<td>7.0-7.5</td>
<td>Mildly alkaline</td>
<td>200</td>
</tr>
</tbody>
</table>
IV) Manuring:

Manuring keeps the metabolic cycle in operation, increases natural productivity, production of fish food organisms and in return increases fish production. Both organic manure and chemical fertilizers can be used. But depending on the economic viability and availability, organic manure is most preferred. Organic manure such as cow dung, poultry dropping should be applied 7 days after the application of lime and should be in dried form or in the form of slurry. Apply cow dung @ 1500kg/ha or vermicompost @ 500 kg/ha. In case of mahua oil cake application, the dose of organic manure should be 5000 kg/ha, whereas, if mahua oil cake is not applied, the dose of organic manure should be applied @ 10,000 kg/ha. This organic manure application should be done 15 days before stocking of fish seeds. Liming can also be done after 7 days of organic manure application, to correct the acidity as well as to keep the pond hygienic.

Under crowded conditions fish compete for the food supply, and they also suffer stress due to aggressive interaction. Under stress fish are found to eat less and grow more slowly, while in static ponds there is reason to believe that the excretory products of the fish may themselves tend to suppress their growth. If we look at actual total production as compared with the number of fish stocked we get a curve as in figure 1.

The effect of increasing the stocking rate on the total fish crop in ponds:

![Graph showing the effect of increasing the stocking rate on the total fish crop in ponds](image)

Fig.1 : Number of fish per hectare

It will be seen that as the number of fish is increased, production of fish increases to a maximum and then decreases again. Thus, there is an optimum stocking rate which gives the highest production. In running water, where the excretory products are washed away, the production rises to a maximum and remains at that level however much we increase the number of fish. Thus in increasing the number of fish beyond the optimum point, all we are doing is increasing oxygen consumption by the fish, with its obvious dangers, without increasing the crop of fish. A mistake can cause mass death of fish with disastrous suddenness.