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मत्स्यपालन, पशुपालन और डेयरी मंत्रालय
MINISTRY OF FISHERIES, ANIMAL HUSBANDRY AND DAIRYING

Sustainable Aquaculture for Food and Livelihood
SAFAL

Farmer's Handbook

Sustainable Aquaculture

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We are committed to creating a welcoming and inclusive environment for all users of this Farmer's Handbook. We believe that this knowledge product would go a long way in helping the pond-based fish farmers in their effort to practise sustainable aquaculture in an environment-friendly and profitable manner. The knowledge products would also be helpful to academicians and researchers in understanding the problems of pond-based fish farmers and designing practical solutions. In conclusion, the efforts could allow fish farmers to optimise their practice of sustainable aquaculture for generations to come.

Pratap Sinha

Project Leader, SAFAL, GIZ India

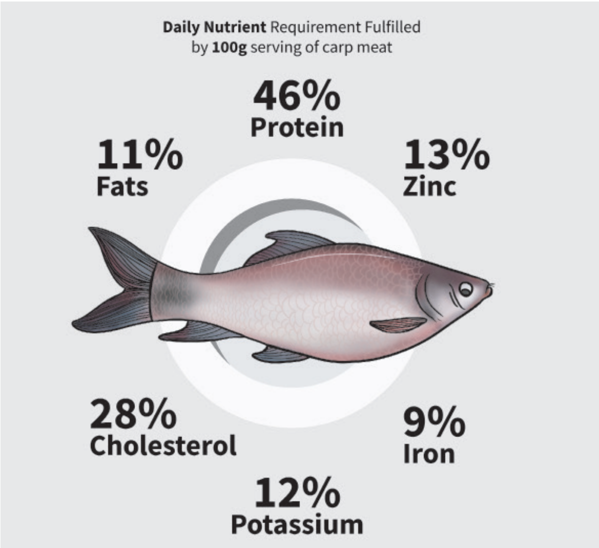
Contents

Introduction

Chapter 1

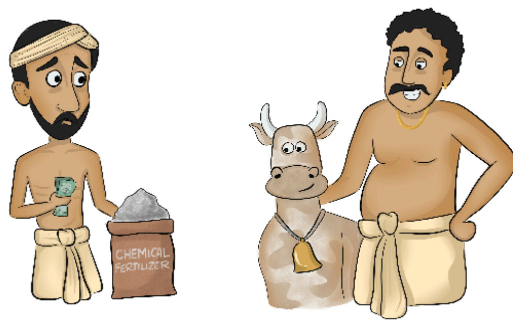
The aquaculture, an allied agricultural activity is considered as a major sector in boosting social and economic development in terms of providing employment and livelihood in addition to food and nutritional security. Fish is an important nutritious and health food item. Fresh water aquaculture, is an integral part of farming activities in Eastern and North eastern states.

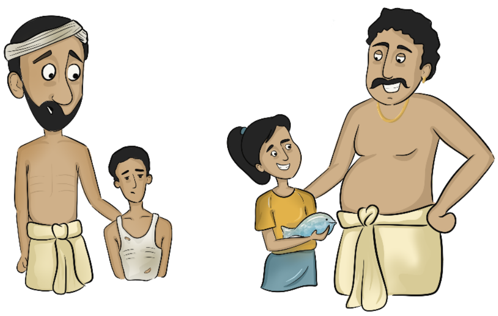
Fresh water aquaculture in India is dominated by carp species contributing over 85% of the total aquaculture production and hence focus is on carp aquaculture. Carps feed at the primary and secondary level in the food web and are efficient utilizers of plankton to meet their major protein and other requirements from natural food and require minimum additional supplementation to meet energy requirement. The preference to carps specially Indian Major Carps (IMC and other carps is also attributed to availability of seed, availability of technology, know how on carp farming and most importantly consumer preference and steady demand for carps in the market. Aquaculture has to be a sustainable activity to face the challenges in the present and future. Sustainable aquaculture focuses on environmental, economic and social sustainability to improve capacity building and effective utilization of available land for aquaculture purpose.



Nutritional value of carp

Health benefits of eating fish





Environmental sustainability
Farming practices should be eco-friendly and not impose any serious threat to environment, biodiversity and ecosystem

Economic sustainability
The aquaculture practice should result in long term sustained production resulting as a profitable activity in long term prospects

Social sustainability
Practices should be socially responsible and contribute to the welfare of the local community

Importance of sustainability

Farming practices should be eco-friendly and not impose any serious threat to environment, biodiversity and ecosystem to make it environmentally sustainable. The aquaculture practices should result in long term sustained production resulting in a profitable activity to make it and to bring in economic sustainability and also contribute to the welfare of the society. Aquaculture, to be a sustainable activity needs to be supported by technically sound and adaptable package of practices. In this manner basic concepts include:

Pond site should be located in a suitable place and fish pond constructed in a more user friendly way for ease of operation and management.
Use of fish species which are fast growing, efficiently converting natural fish food available in the pond into fish flesh in a reasonably short time Furthermore, they should be, compatible to each other and do not compete for food and space so that they can be grown together for rational and efficient utilization of available food and space in the pond. Also, they should have the ability to tolerate a wide range of environmental changes likely to happen.
Use of organic manures (Biological waste of animals) in appropriate quantity and no or minimal use of chemical fertilizers
Use of supplementary feed made out of locally available feed ingredients (farm made feed) to make it chemical free product and also reduce the feeding costs.
Good Management Practices(GMP) in post stocking management practices (water quality, feeding practices and fish health management) to have a sustained aquaculture production.
Reduce the cost of production to increase profitability in a sustained manner by following Standard Operating procedures(SOPs) in reality and avoiding excess use of inputs.

This hand book is prepared keeping in mind the aquafarmers as the main target groups to use this hand book and hence the contents are focused primarily on what farmers have to know to decide what needs to be done to make their aquaculture business sustainable. The hand book also contains relevant illustrations and few frequently asked questions(FAQs) that farmers might ask and these are also provided at the end of each task /chapter.

Risk Factors:

- **Defective pond site location:** If selected pond site is not suitable for aquaculture operations, construction cost, pumping cost, manuring cost and other operational costs are going to influence the final economic viability of the project. So, ideal site selection for pond construction is the most important factor to initiate the aquaculture operation.

- **Undependable source of quality water:** Water is the primary requisite to commence aquaculture operation. If the source of water is unreliable or the water availability of the selected source is inconsistent, entire aquaculture operation is going to be affected. So, careful selection of water source is another important factor of ideal pond construction site identification.

- **Aged ponds:** Use of same pond more than 5 years continuously (without preparation between the production cycles) gap and cleaning may lead to increased incidence of diseases. The infectious disease incidence was 43% in farms of above 5 years of age as against 15% in farms less than 5 years age.

- **High intensive practices:** Farmer who wants to adapt high intensive fish farming needs to make sure that the infrastructure and resources should be ample to support the selected mode of fish farming operation. If not, it will affect the survival, growth, health and finally the profitability of the venture.

- **Lack of knowhow of technologies:** This risk factor is going to create havoc in the entire fish farming operation, having the basic knowledge about aquaculture operational methodology and minimal farm management skills are very much essential. Absolute objective of this knowledge material is to provide required knowledge to the end user.

FAQs

- Why we should grow fish?
- What are the benefits of aquaculture?
- How to I make an aquaculture system sustainable?
- Are there any negative impacts of aquaculture on the environment?

Chapter 2

Pre-stocking

Pre-stocking operation involves following key phases like proper site selection, good cost optimized pond construction plan, proper execution of the construction plan and how to prepare the pond well for development of optimum planktonic density in the pond. These factors are directly related to the productivity, profitability, and sustainability of your aquaculture operation.

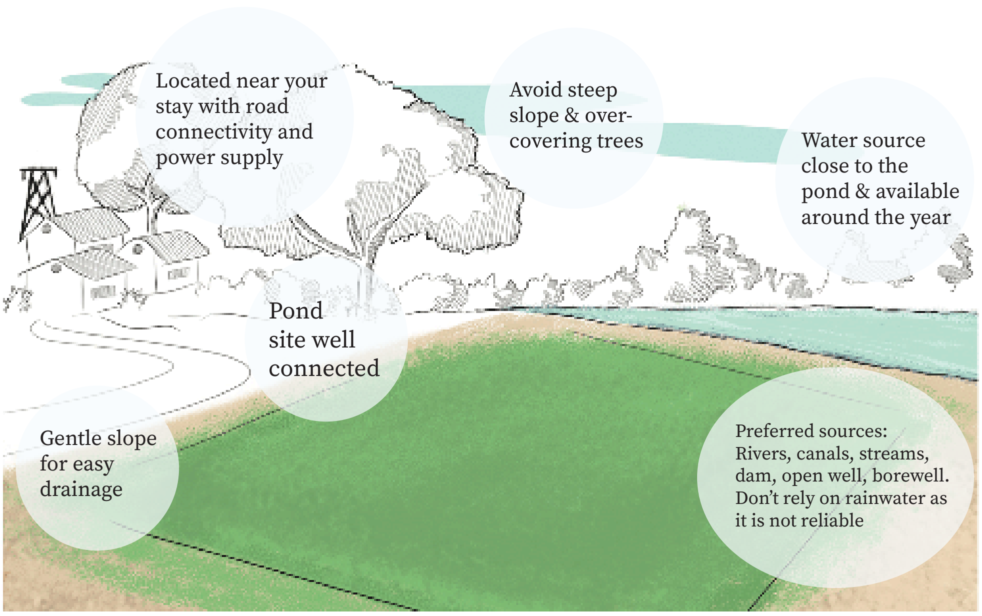
2.1 Construction of new pond

Building a new aquaculture pond consists of numerous influencing factors which needs to be understood and well planned before venturing into sustainable aquaculture operation. These factors are directly related to the productivity, profitability, and sustainability of your aquaculture operation. Core aspects involved in building a new aquaculture pond are listed and explained in detail below.

2.1.1 Site selection

Criteria for selection of site suitable for pond constrution:

Land: Less suitable for other agricultural activity can be used for constructing a fish pond.



Ideal site location for the pond

Use land with gentle slope for constructing the fish pond to make it easy to empty enabling easy netting and fish harvest and drain out the water.
Do not use the land in a very low lying area, which is close to a river as it is likely to be flooded during rainy season and may dry up during winter/summer season.
A steep hill is not suitable for building a pond as access to water may be difficult, more seepage and construction cost may also increase.

Source of water: Locate your land for fish pond where water is available all-round the year to enable maximum culture period. Do not depend only on rain water for your pond because it is not reliable. Water rich in nutrients, well oxygenated slightly alkaline and uncontaminated is called good quality water.
The most suitable water source is from natural sources like reservoirs/canals with a mechanism to prevent entry of wild fish (by putting screens) and avoiding silting of pond in the long run by providing silt traps.

Water source type	Advantages	Disadvantages
Perennial River (Water should be available throughout the year)	1. Suitable water source 2. Less pumping cost 3. Can pump large volumes of water in less time 4. Can do quick water exchange during emergency situations	1. Pollution threat 2. Weed fish entry 3. Organic loads during rainy season 4. Flooding 5. Bacterial & parasitic infection possibility
Perennial creek (Water should be available throughout the year)	1. Suitable water source 2. Less pumping cost 3. Can pump large volumes of water in less time 4. Can do quick water exchange during emergency situations	1. Pollution threat 2. Weed fish entry 3. Organic loads during rainy season 4. Flooding 5. Bacterial & parasitic infection possibility
Agriculture canal (Water should be available minimum during the culture cycle)	1. Suitable water source 2. Less pumping cost 3. Can pump large volumes of water in less time 4. Can do quick water exchange during emergency situations	1. Pollution threat 2. Pesticide contamination 3. Bacterial & parasitic infection possibility 4. Weed fish entry 5. Organic loads during rainy season

Reservoirs or lakes or dams (Water should be available minimum during the culture cycle)	1. Suitable water source 2. Less pumping cost 3. Can pump large volumes of water in less time 4. Can do quick water exchange during emergency situations	1. Pollution threat 2. Pesticide contaminations 3. Bacterial & parasitic infection possibility 4. Weed fish entry 5. Organic loads during rainy season
Borewell (Water should be available throughout the year)	1. Sterile water 2. No bacterial contaminations	1. More manuring and water culture cost 2. More pumping cost 3. Takes more time for pumping 4. Quick water exchange is not possible
Agriculture drains (Water should be available minimum during the culture cycle)	1. Ample water availability 2. Can do quick water exchange 3. Lesser water culture and manuring cost 4. Lesser pumping cost	1. More organic loads 2. Pollution & pesticide threat 3. Weed fish entry 4. Flooding 5. Bacterial & parasitic infection possibility

Table 1: Pros and cons of different water sources

Access to a good road network and communication systems for supply of inputs from outside and also for transportation and marketing of fish are very important.

Availability of relatively reliable power source (Electric/solar other renewable energy source) to allow for pumping, aeration and light should be given.
Preferably locate the pond close to your homestead/stay, so it is easy accessible for better management and security of fish.
Locate the pond in a pollution free area (away from industrial area).
Locate the pond in a soil with good water holding capacity.

Loamy, clay loamy and silt clay soil types are most suitable for pond construction. A good quality gravel should not exceed 10 percent. Thus the rocky, sandy, gravel and limestone soil types are to be avoided. Soil plays an important role in regard to the fertility of fish ponds.
Avoid sandy soil as water retention is very poor.
The water retention can be assessed in the filed by taking a handful of soil, moist it and squeeze in to a ball and throw in the air and catch it. If it holds together it is a good soil that has water holding capacity. The more accurate method is to get the soil texture analysis done in a laboratory.

2.1.2 Pond construction

The type, number, and shape of the ponds to build depend on the topographical profile of a site. To choose a good site for a fishpond, there is a need to measure several things, including:

- The area of land available.
- The slope of the land.
- The elevation (height) of the land in relation to the source of water that will be used.
- The distance between the source of water and the location of the ponds.
- The best way to supply water to the ponds.
- The easiest way of draining the ponds.

The core aspects involved in building a new aquaculture pond are listed below:

Pond details

Type:

Earthen pond is best suited for carp culture. Production of plankton - natural food for carps to meet their nutrient requirement is very essential and for which soil base is a must. Construction cost of earthen pond is low compared to stone riveted and concrete ponds.

Even if the pond sides are covered with plastic lining/granite pitching/ concrete to prevent water seepage, soil bottom is a must for carp aquaculture to produce plankton for improved fish growth and health.

Shape:

Ponds of any shape could be used for aquaculture purpose but for operational ease, rectangular shaped ponds are preferred as they are easy to construct & facilitate operations & maintenance like cleaning or handling the fish. (less workforce with lesser length drag net).

Size of the pond and water depth:

There is no specific size for aquaculture purpose. Water body of any size and shape with minimum water depth of around 1m can be utilized for producing fish.

Very small ponds could also be used for producing fish for self-consumption but may not be very economical.

Very large ponds are not preferred from operational point of view.

Hence, for economic and operational purpose some sizes and shapes are preferable.

Size of pond	Type of aquaculture
Less than 0.02 ha	For small scale production mainly for self-consumption
Water Area 0.02 -0.2 ha (25x6 or 40m x 25m (L x B)) Water depth 1-1.5m (Pond depth 1.75m)	Can be used for fish production but would be better to use for seed rearing (Nursery and rearing ponds) and 2-3 crops can be obtained in a season
Water Area: 0.2-1ha (800sq.m)-40x20m to 1 ha(10000sqm) -250mx40m or 200mX50m Water depth 1.5-2m)- Pond depth 2.5 m	Grow out ponds for producing table sized fish or fish of marketable size

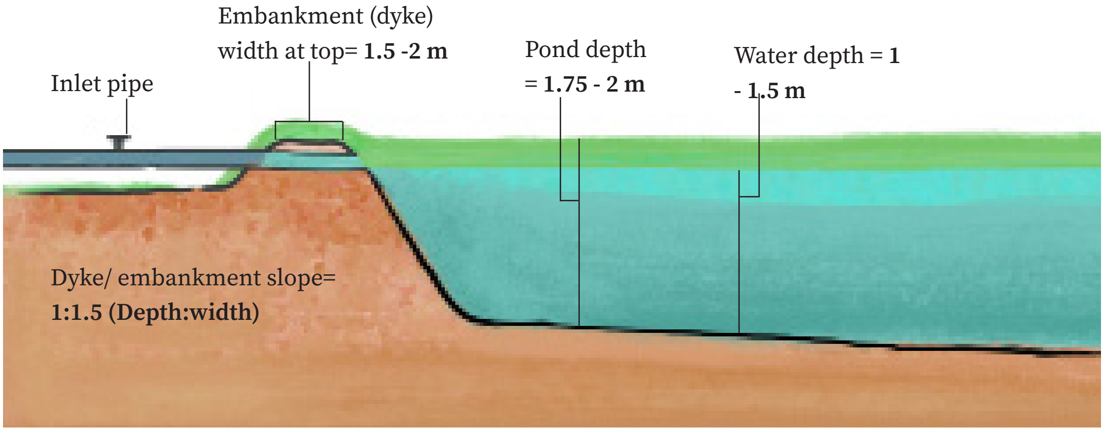
Table 2: Suitable pond size for different operations

Construction details

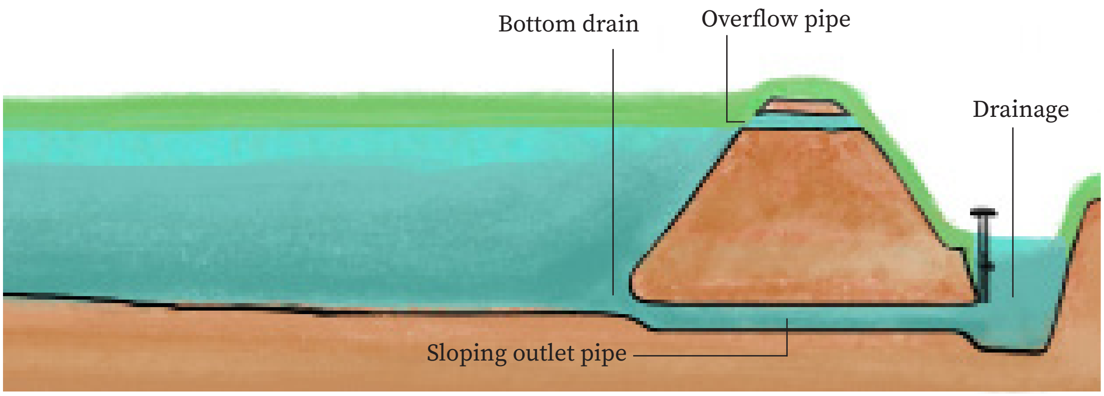
Pond details like height, width, slope, pond depth are key factors in construction of an ideal fish pond.

Parameters	Recommendations
Embankment height Embankment width at top Embankment slope	0.75 - 1 m above the water level (free board) 1.5 - 2 m 1:1.5
Pond bottom	Levelled with a gentle slope towards outlet point (lower end)
Over flow point	At the top water level (where free board starts)
Water supply point (inlet)	From the top –opposite to over flow/out let point(upper end)
Drainage point (outlet)	At the bottom of the lower end bank- opposite to inlet (lower end) with a control valve outside the pond Make its bottom about 10 cm below the deepest point in the pond A concrete fish collection chamber (0.75x0.75x0.75m) near the out let point for collection of fish

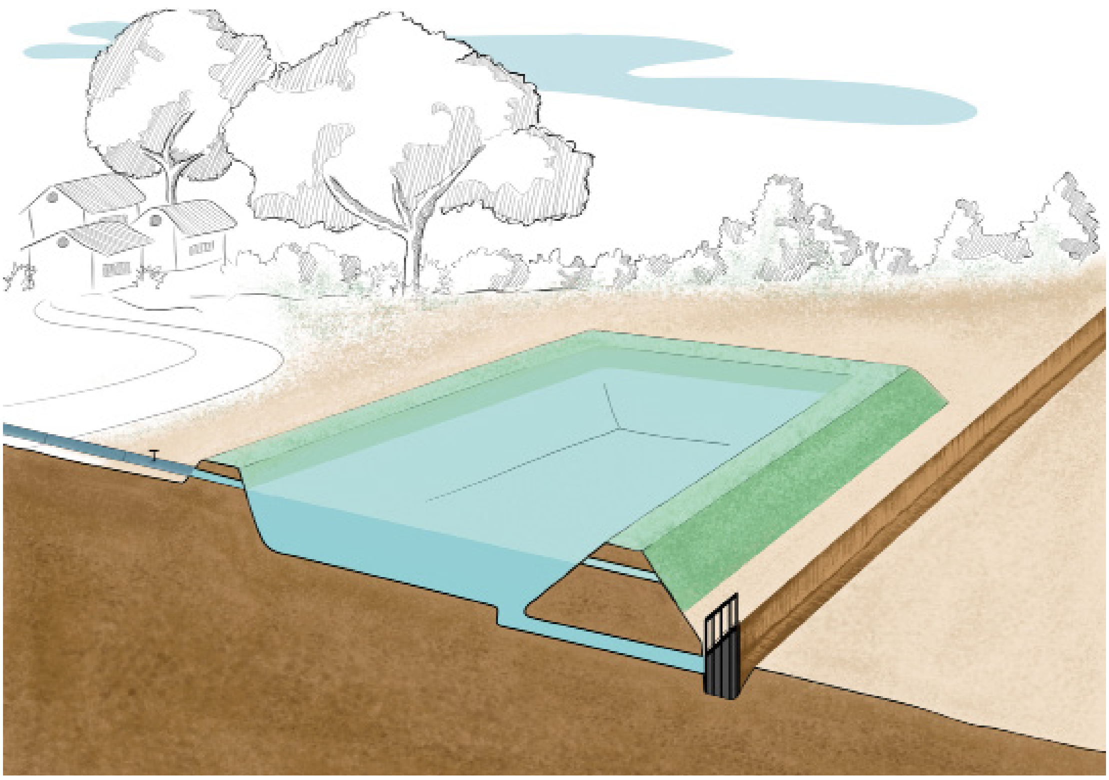
Table 3: Pond construction details



Pond cross-sectional details (inlet side)



Pond cross-sectional details (outlet side)



Completed pond

2.1.3 Pond preparation & existing pond renovation

In this section we will know about different steps involved in pond preparation and to repair existing dykes, pond bottom, and the inlet and outlet systems of the pond.
Steps involved in pond preparation for existing ponds involves

- Dewatering
- Removal of sludge (silt)
- Sun drying (until soil is cracking)
- Ploughing, raking
- Lime application
- Water filling (first only 30 cm until plankton develops)
- Organic manure application
- Fill it to required depth

2.1.3.1 Ponds that are drainable

Dewatering and repairs

If pond can be de watered either by draining though natural draining or by pumping out, empty the pond completely.
Remove sludge (silt) from the pond bottom once in year during summer months and this can be recycled as manure for agricultural crops .
Allow it to sun drying for till cracks are developed: Advantages are aerating surface sediments, oxidizing reduce compounds such as such as H_2S, NO_3, NH_3, Ferrous iron, Methane and decomposition and mineralization of organic matter.

Cleaning and repairing

Turf/grass pitching in the pond bank area will avoid erosion of dykes.
During rainy days covering top of the pond bank with low cost polythene sheet or dry paddy hay will reduce soil erosion.
Free the pond from all aquatic /terrestrial plants grown on the dykes (both outside and inside).
Level the pond bottom with gentle slope towards the outlet (drainage point)
Repair any crevasses on the pond dykes and the sides are levelled to get proper slope.
Strengthen/repair the dykes by proper compacting to avoid seepage of water.
Compact soil of affected area either manually or, apply sodium bentonite (Bentonite clay).
Manual compacting is suggested for small ponds. Bentonite clay (Sodium bentonite), a natural clay which acts as natural sealant can be used for large

ponds for control of seepage as it expands as soon it comes in touch with water. The dosage required ranges from 150-300tons/ha depending the soil type. Sandy soils require more whereas soil with clay mix will require less quantity. The cost is around 1600 Rs/ton.
Ensure that inlet and outlet are working properly.
Fencing of pond to a height of 1 m using pegs and nylon netting on the periphery of the pond to prevent entry of snakes, frogs and other predators (biosecurity) in to the pond.
Avoid bird predation –Options

1. Covering the pond with nylon net. More effective but costly
2. Tying cassette Tapes/lines at 50 cm to create sound due to wind effect will scare away the birds- comparatively low cost but they may tear away if the wind is very strong
3. Manual bird scaring by beating drums/ tin cans during early morning and evening hours

Clean surroundings

Clear all the bushes on the dykes and surrounding the pond. If trees are present surrounding the pond, trim all the branches extending over the pond if any, to avoid falling leaves and debris in to water
Turf/grass pitching in the pond bank area will avoid erosion of dykes
Remove trees very close to pond dyke to avoid roots creating hole in the dyke and may result in pond leakage.

2.1.3.2 Ponds that are not drainable

If the existing ponds are not drainable either due to various reasons like improper outlet and drain positioning, drain blockage or flooding, the following approach can be adapted for the renovation process.

2.1.3.3 De-watering

If the ponds cannot be drained completely, dewater to extent possible by pumping it out.

2.1.3.4 Cleaning and repairing

Remove all the fish by repeated netting and also manually remove all the aquatic plants in the pond.
Disturb the pond bottom and allow escape of all the poisonous gas.
Use recommended suitable herbal products to eradicate unwanted fish and other small animals from the pond.

Manual cleaning of pond

2.1.3.5 Arrange pond surroundings

Remove all the shrubs and other plants grown inside the pond on the dykes, bundhs.
Trim the branches of tree if any to avoid falling of leaves and debris in to the pond as accumulation of leaves at the pond bottom which may lead to decomposition leading to oxygen depletion. Remove the trees very close to pond dyke as the roots may creep in create hole in the dyke resulting leaking of pond.

2.2 Liming and manuring

Liming and Manuring / fertilizing are the two important steps in pond preparation for a productive culture cycle. Zooplankton and phytoplankton are the main natural food of fish in the pond. Usage of lime and manuring will support this natural planktonic productivity and water quality management.

2.2.1.1 Liming

Liming is an important step in preparation of ponds. Liming increases the total alkalinity, pH and total hardness of pond water by increasing the concentration of bicarbonate ion which is in equilibrium with carbon dioxide. Application of lime has multiple benefits during pond preparation as it kills pathogens and also acts as a disinfectant and buffering agent and

regulates pH. Lime is applied to the soil before water filling during pond preparation as a normal practice to kill the pathogen and treat the soil. It also helps fish to maintain osmotic balance in water.
Liming and manuring are done separately. If we mix together and apply in the water the pH and temperature suddenly increases and the calcium takes carbon di oxide from the water and hampers the photosynthesis process. That is why manure is applied 5 to 7 days after lime application.

Liming

However, in case of old and/or deep pond when drying is not possible, reduce the water level as much as possible, kill the fish and then apply lime. In such cases, use of herbal products to eradicate unwanted fish which also acts as manure after detoxification. Quantity used depends on the pH of the soil. For normal soils (pH 6.5-8.5) recommended dose is 250kg/ha. Best time for lime application is in the afternoon hours.
Apply lime at least 5-7 days before manuring.

2.2.1.2 Types of lime

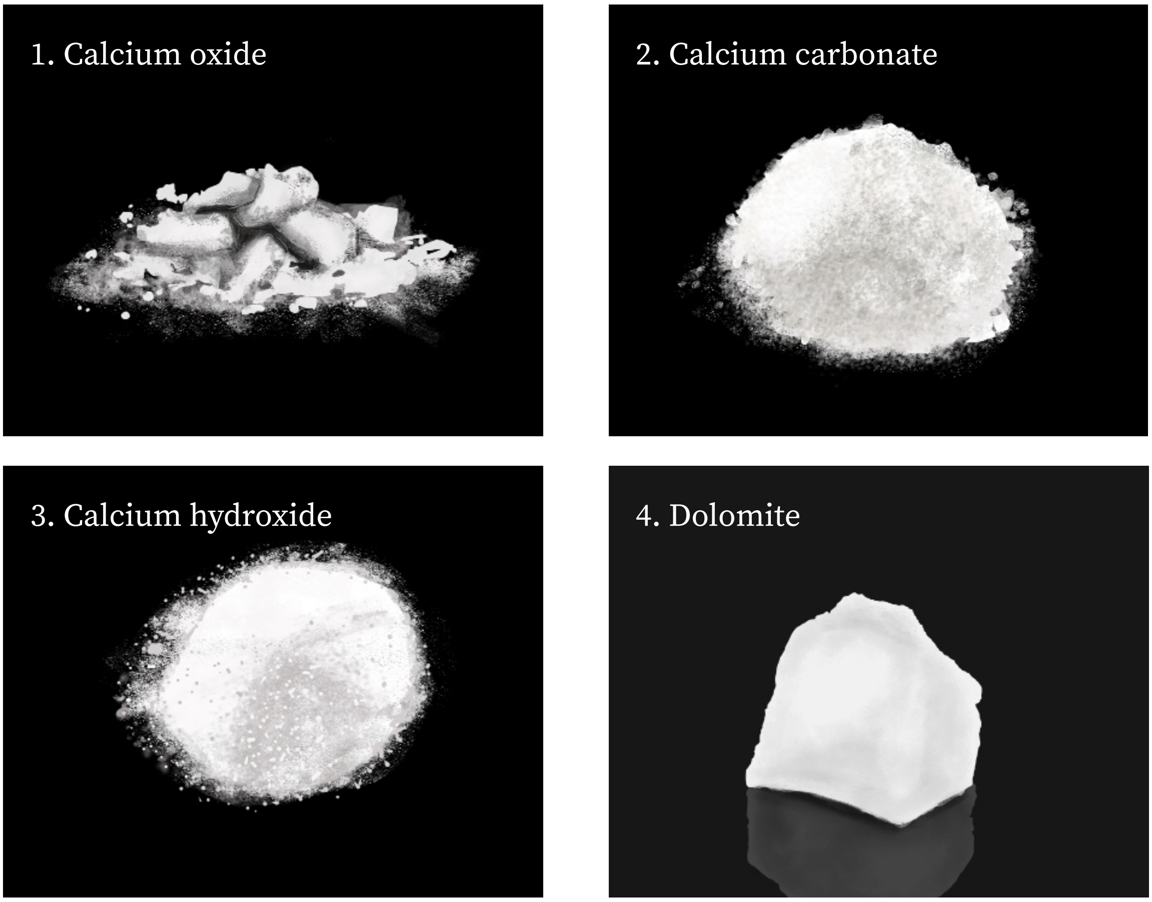
Calcium oxide (Quick lime): CaO
This lime produces heat when it mixes with water and very rapidly increases the PH of soil and water. This lime is very much effective in those ponds which are highly acidic. This lime is also very effective disinfectant and prevents occurrence of diseases.

Calcium carbonate (Agriculture lime or calcite): $CaCO_3$
Acid neutralizing power is very much less than that of other lime. This

lime does not produce heat when it mixes with water. As this lime does not increase the pH of the pond rapidly, so it is suitable to apply during post management applications. It is mixed with water and soaked for 24-48 hours and the milk part is used during post stocking management.

Calcium hydroxide (Slaked lime): Ca $(OH)_2$
Acidity neutralizing power is less than that of quick lime. This lime produces less heat than quick lime. Use of this lime in the pond is very less.

Dolomite: $CaMg(CO_3)_2$
Dolomite is used to treat water, increase the alkalinity of water, provide trace elements and macro nutrients for fish feed and create an environment for for microalgae (Phytoplankton) grow and hence normally used in pH management during post stocking operation.



Types of lime

2.2.1.3 Usage & quantity (dosage)

Quick lime is preferred during pond preparation for its quick action and caustic effect. But care to be taken to cover nose and also use hand gloves as it has caustic effect resulting in heat and vapours.
Agricultural lime or dolomite is preferred as this releases bicarbonate ions slowly & for longer period of time to maintain alkalinity at desired levels.

pH	Agricultural lime(in kg/ha)	Quick lime(in kg/ha)
6.5	250	230
6.0	550	460
5.5	750	690
5.0	1000	920
4.5	1250	1150
4.0	1500	1380

Table 4: Lime requirement for soil treatment during pond preparation for correcting pH

For correcting alkalinity of pond water and reducing pH (if >9.5), agricultural Gypsum (CaSO4) is used. The dosage is around 3.2 tons/ha
Apply the lime covering entire pond bottom.
Application once during pond preparation and subsequently during culture operation depending on the pH of water.

2.2.1.4 Water filling

Water of good quality is very critical for pond productivity.
Check the water for very important critical parameters –Dissolved Oxygen, pH, Alkalinity and Hardness (Specially if bore well water is used).
Fill the water to about 1-2 feet, manure and then fill the water to required depth.
If water from natural source (River, streams, reservoirs, rain water) is directly used, build a silt trap before the entry point to avoid silting of pond and cover the inlet point with nylon mesh to avoid entry of unwanted fish or other material in to pond and ensure water does not flow out of pond.

2.3 Manuring

Manuring of ponds is very essential for carp culture to produce plankton-natural food of carps to meet most of its protein requirements. However, while fertilization can benefit your farm pond, improper management can lead to significant problems such as excessive aquatic vegetation or oxygen depletion.

2.3.1 Manuring for newly constructed pond or that can be completely drained

Sustained phytoplankton production is essential to produce required zooplankton population in the pond as it is preferred food for carps.

Pond manuring (organic manures mixed with small quantity of chemical fertilizers) triggers the enhancement of autotrophic and heterotrophic production in pond ecosystem.
Once the pond is ready for filling water, fill the water to about 2 ft and manure the pond normally 5-7 days before stocking fingerlings.

2.3.1.1 Types of fertilizers, dosage and mode of application

Fertilizers may be organic or inorganic. They each contain varying amounts of nitrogen, phosphorus and potassium. A complete fertilizer usually is one that contains all three nutrients.

2.3.1.1.1 Conventional method

Conventionally Fresh Cattle dung/Poultry manure in combination with nitrogen and phosphorous based inorganic fertilizers are used.

Manuring

Type of Manure/ fertilizer	Recommended quantity	Method of application
Cattle dung (alone)	10-12 tons/ha/year	25-30% as initial dose at the time of pond preparation and the balance in equal instalments at fortnightly interval
Poultry droppings (alone)	4-6 tons/ha/year	
Combination of both	50% each	
Nitrogen based fertilizer (Urea)	100kg/ha/year	Once at the time of pond preparation
Phosphorous based (Single Super Phosphate)	50kg/h/year	Once at the time of pond preparation

Table 5: Ingredients and quantity for preparation of improved manuring technique

2.3.1.1.2 Improved manuring technique

Phased manuring technique using only organic materials

Ingredient	Quantity/ha (kg)
Jaggary	05.00
DORB	25.00
Oil cake	05.00
Yeast	00.25
Curd	1 ltr

Table 6: Ingredients and quantity for preparation of improved manuring technique

Process of preparation:

- Mix all the ingredients
- Anaerobic fermentation for 3-4 days and filter
- Mix with water and spray all over the pond in slurry form

Application method:

- Apply in the morning hours and sunny days are preferred
- Apply initially 3days before stocking fish
- Repeat once in two weeks depending the plankton density in the pond which can be assessed with the help of sechi disc or dipping hand

2.3.2 Manuring pond that cannot be completely drained

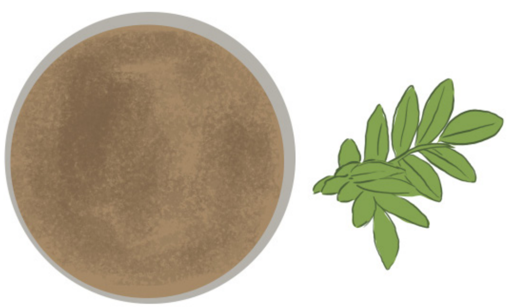
In such cases, use of herbal products (Mohua oilcake) to eradicate unwanted fish which also acts as manure after detoxification. These products are effective at low dosage, non- hazardous to human and livestock, shorter persistence of toxicity; no or minimal residual affect and dead fish suitable for human consumption.
Only when mahua oil cake (MOC) is used as herbal product to eradicate unwanted predatory/weed fishes from the pond, the basal manuring dose of raw cow dung can be reduced to half. The residual toxicity of MOC will remain for 3 weeks (21 days) Apply the herbal product 2 weeks before stocking fish at a water depth of 2-3ft.

2.3.2.1 Type of herbal products, dosage and toxicity period

Name of the product	Reccomended dosage	Active component	Toxicity period
Mahua oil cake (Bassia latifolia)	200-250 ppm (Volume of water is very critical) 2000-2500kg/ha at 1 m water depth	Saponin or Mowrin (4-6%)	2 weeks
Derris root powder	1.5-2.0 ppm(15-20kg/ha at 1 m water depth)	Rotenone (5%)	2 weeks

Table 7: Type of herbal products, dosage and toxicity period

Mahua oil cake



Derris root powder

Herbal products

2.4 Pre-stocking economics

New pond construction cost:

Note: There is a considerable difference in construction cost between exclusive manual labour usage and manual & mechanical hybrid mode. In this economics estimate we considered the hybrid mode. But for the convenience and knowledge of the user we provided both the details separately below. In some places the possibility to use mechanical devises might not be possible, in those places manual mode is the only way. This is for a unit of 1 acre and need to be re calculated for the size of the pond.

One Time Capital Investment Costs	Component	Units	Cost per Unit*	Cost*
Asset acquisition cost	Land purchase cost	1 Acre	Rs. 1,00,000.00	Rs. 1,00,000.00
	Lease cost	1 Acre	Rs. 15,000.00	Rs. 15,000.00
	Soil quality & suitability assessment test	1 Acre	Rs. 2,000.00	Rs. 2,000.00
	Survey, drawing & topographical work plan	1 Acre	Rs. 5,000.00	Rs. 5,000.00
		A	**Total if purchased the land**	**Rs. 1,07,000.00**
		B	**Total if it is a lease the land**	**Rs. 22,000.00**
Construction cost for new pond	Clear vegetation in the site with bulldozer	1 Acre	Rs. 2000.00/hour X 4 hours	Rs. 8000.00
	Remove topsoil with bulldozer	816 M^3	Rs. 2000.00/hour X 12 hours	Rs. 24,000.00
	Build inlet pipe manually	1 M	Rs. 600.00/M	Rs. 600.00
	Dig drainage canal	1.5 M^3	Rs. 600.00/M	Rs. 900.00
	Drainage pipeline installation	15 M	Rs. 300.00/M	Rs. 4500.00
	Build dikes	2500 m^3	Rs. 2000.00/hour X 30 hours	Rs. 60,000.00
		C	**Total**	**Rs. 98,000.00**
Infrastructure Development cost and others	Warehouse	100 M^2	Rs. 300.00/ M^2	Rs. 30,000.00
Pumping system	5 Hp submersible pump cost	1	Rs. 45,000.00	Rs. 45,000.00
Boat	1 M.T volume boat	1	Rs. 10,000.00	Rs. 10,000.00

Others	Drainage pipes, cement, gravel etc	---	Rs. 25,000.00	Rs. 25,000.00
		D	**Total**	**Rs. 1,10,000**
Value for farmer's time spent on the site	Farmer's time for planning and execution supervision	15 days	Rs. 1000.00	Rs. 15,000.00
		E	**Total**	**Rs. 15,000.00**
Total capital investment (For lease pond) B+C+D+E				**Rs. 2,45,000.00**
Total capital investment (For purchased pond) A+C+D+E				Rs.3,30,000.00

* Indicative values, need to be verified and replaced with local cost.
* For example, and calculations purpose the pond size and other dimensions are considered as follows.
Area: 1 Acre (4080 M2); Length:65 Meter; width: 62.77 Meter; Total dike hight 2 Meter; After compaction dike hight: 1.8 Meter; Dike crust width: 2 Meter; Wet side dike slope: 2:1; Dry side Dike slope: 1.5:1; Water filling depth: 1.5 meter.

Cost Variation between Manual Labour and Machinery:

With manual workforce:

Component	Units	Cost per unit	Workforce required	Time	Estimated units for calculation	Cost
Clear vegetation in the site	M^2	Rs.2.00/M	4 people	4 people X 72 hours	4080 M^2	Rs. 8160.00
Topsoil removal/ storage (0.20 m)	M^3	Rs. 36 / M^3	12 people	12 people X 68 hours=816hours ($1M^3$/hour excavation & moving)	816 M^3 (for 4080 M^2 area)	Rs. 29,376.00
Build inlet pipe	M	Rs. 600.00/M	2 people	2 X 2 hours	1 M	Rs. 600.00
Dig drainage canal digging 15 M long &0.1 M2 deep	M^3	Rs. 600.00/M	2 people	2 people X 2 hours =4 hours ($0.75M^3$/ hour excavation & moving)	1.5 M^3	Rs. 900.00
Drainage pipeline installation	M	Rs. 300.00/M	4 people	4 people X 8 hours =32 hours	15 M	Rs. 4500.00
Build dikes (65 M length X 62.77 M width X 2-meter hight and 2-meter crust)	M^3	Rs. 36/M^3	36 people	36 people X 70 hours ($1M^3$/hour excavation & moving)	2500 M^3	Rs. 90,000.00
					Total	**Rs. 1,33,536.00**

With machinery & manual combination work:

Component	Units	Cost per Unit	Resources required	Time	Estimated units for calculation	Cost
Clear vegetation in the site	M^2	Rs.2000.00 /hour	1 Bulldozer	4 hours	4080 M^2	Rs. 8000.00
Topsoil removal/ storage (0.20 m)	M^3	Rs. 2000 / hour	1 Bulldozer	12 Hours (excavation & moving)	816 M^3 (for 4080 M^2 area)	Rs. 24,000.00
Build inlet pipe	M	Rs. 600.00/M	2 Bulldozer	2 X 2 hours	1 M	Rs. 600.00
Dig drainage canal digging 15 M long &0.1 M2 deep	M^3	Rs. 600.00/M	2 Bulldozer	2 people X 2 hours =4 hours (0.75M3/hour excavation & moving)	1.5 M^3	Rs. 900.00
Drainage pipeline installation	M	Rs. 300.00/M	4 Bulldozer	4 people X 8 hours =32 hours	15 M	Rs. 4500.00
Build dikes (65 M length X 62.77 M width X 2-meter hight and 2-meter crust)	M^3	Rs. 2000/ hour	1 Bulldozer	30 hours (excavation & moving & compaction)	2500 M^3	Rs. 60,000.00
					Total	**Rs. 98,000.00**

Risk Factors:

- Locating pond in close proximity to rivers/streams can often result in flooding of ponds and loss of fish and damage to pond
- Depending only on rain water or undependable source of water
- Pond construction in soil with low water retention will increase demand for more water
- Construction of pond without proper slope and weak dykes may result in erosion of pond dykes leading to pond damage
- Partial draining of pond and non-removal of sludge for many years may lead to increase in chances of disease outbreak and deterioration of soil quality (particularly in non-drainable pond). The incidence rate of infectious diseases in non-drainable ponds farms was 39%; while in completely drained ponds, it was only 19%
- The incidence rate of infectious diseases was observed to be 32% in the ponds which were sun dried against 26% in ponds not sun dried till the bottom show cracks

FAQs

- How do I prepare my pond before stocking fish seed?
- Why should I use lime to my pond?
- What are the different types of limes available in the market and which are more suited?
- What precaution we should take while applying lime?
- Why should we manure my fish pond?
- What are different types of manures that can be used?
- What are the advantage of organic manuring?
- Why we should not use more chemical fertilizers?
- How do I prepare and manure my pond which is not drainable?
- What are the advantages of herbal products for eradicating unwanted fish in the pond?
- How do I select site for locating my fish pond?
- What are the reliable source of water for fish pond?
- What is the ideal size of the pond for aquaculture?
- I have a undrainable pond and how do I prepare the pond?

On-stocking

Chapter 3

3.0 On stocking

Aquaculture practices can be classified in several ways, depending upon the different aspects and conditions involved in the culture practice. Some major and important classifications are given below based on the different aspects involved in aquaculture.

Basis	Variant				
Salinity	Freshwater farming	Brackish farming	Marine water farming		
Intensity	Extensive fish farming system	Semi-intensive fish farming system	Intensive fish farming system		
Fish species	Monoculture	Polyculture			
Enclosure	Pond culture	Cage culture	Pen culture	Race-way culture	Indoor farming
Integration	Agriculture cum fish farming	Animal husbandry cum fish farming			

Table 8: Different types of aquaculture practices

3.0.1 Culture systems in aquaculture

In this section we will be focussing on pond based freshwater fish farming. So, the classification pertaining to this segment will only be discussed on the basis of intensity of inputs and stocking density.
Fresh water aquaculture is primarily carp based with three Indian major carps Catla, Rohu and Mrigal are grown with three exotic carps, silver carp, grass carp and common carp as the six species mixed species farming, also known as polyculture or composite fish culture. Carp culture in most cases is undertaken in earthen ponds or ponds with soil bottom. Over the years culture practices are evolved utilizing variety of carp species, manures, fertilizers, feed, water quality management, health management etc.

Based on the level of management and out put the culture systems are categorised in to Extensive, Semi intensive and Extensive systems.

Extensive

Fish seed is the principal input and plankton (natural food) forms the only source of nutrition for fish n this system. Natural productivity is augmented by use of low inputs such as animal dungs/Biogas slurry etc.,as manure to trigger plankton production   and stocking of fingerlings at low stocking density –(2500-3000/ha).

Semi intensive

In this system, supplementary feed (Conventional feed of Rice bran and oil cake) is given in addition to manures for enhancing fish growth and production. Proper pond preparation, appropriate stocking density(5000-7500/ha), supplementary feeding water quality monitoring are the key feature of this technology.

Intensive or High input system

High stocking density (10000-15000) combined with higher feed inputs (balanced diet), good water quality management, aeration, water exchange and additional inputs like probiotics, growth promotors etc.,   are the key characteristics of intensive farming system aimed at higher fish production from unit area.

3.0.2 Selection of fish species

Criteria for selection of fish species for Aquaculture

- Fast growing species (attain marketable stage in a reasonable time (6-8months)
- Feed at lower level in the food chain (short food chain- Plankton),
- Efficient food conversion

Compatible to each other and remain in their suitable niche / sub-niche

- Accept external feed (supplementary feed)
- Tolerance to fluctuating environmental variations and to diseases and parasites
- Good consumer demand and fetch Good market rate
- Relatively Low cost of production/kg of fish

3.0.3 Fish Seed selection criteria – sourcing

Sourcing good source is important as it is the key input determining production.

Source it preferably from a certified hatchery (if available) or from a reputed hatchery using good breed, following good brood stock management, hatchery practices (no mixed species breeding) and seed rearing techniques.
Preferable to visit seed supplying hatchery prior to selection .
If required in small quantity it is preferable to get from nearby hatchery for easy transportation and reduce cost of transportation.
Avoid seed from mixed breeding hatchery as this may be a mix of two different species.

3.0.4 Identification of good quality seed

On field observations to identify good quality seed are

- Active movement in groups
- Body shining
- Uniform in size
- Healthy in appearance. No physical injuries
- Free from external parasites
- No body deformities and slippery scales
- Their body should be covered with a thin mucus layer (Protective shield)

3.1 Species stocking

When selecting a species to grow in an aquaculture system, there are a variety of factors to consider ensuring you are choosing a species that will do well in a controlled environment and is also marketable. Some of the more important characteristics to consider include nutritional needs, reproductive habits, disease resistance, stocking density, ability to succeed in polyculture, and marketability Species combination primarily depends on the consumer/market demand and availability of seed of required species at right time in required quantity.

3.1.1 Stocking size and density

The number of fingerlings to be stocked depends on the type of farming practice - Extensive (low input), semi intensive (medium input) and intensive (high input) culture systems. All the three types are in practice depending on the pond size, water depth, availability of external inputs like feed and also the investment and managerial capacity of the farmer.

Culture system	Preferred size at stocking	Water depth	Stocking density/ha	Anticipated fish production /ha
Extensive	Fingerlings (8-10cm)	1-1.5 m	2500-3000	2-3 tons/ha
Semi intensive	Advanced (10-15 cm) fingerlings	1.5-2 m	5000-7500	5-8 tons/ha
Intensive	Fish weighing 50-100 g(stunted fish of 5-6 months old)	2-2.5 m	15000-20000	10-15 tons/ha

Table 9: Suggested stocking size and density for different aquaculture systems

3.2 Species composition

Species combination primarily depends on the consumer/market demand and availability of seed of required species at right time in required quantity The technology of aquaculture has seen major changes over the years with incorporation of compatible medium and minor carps (Puntius gonionatus; fimbriatus) and small indigenous species(SIS) such as mola in small quantities in major carp based production systems and also number and varieties of species used in poly culture system. Recently two genetically improved strains of rohu (Jayanthi Rohu) and Amur common carp are finding place in carp polyculture system.
Select fish species that are compatible to each other and do not compete for space and food in the pond ecosystem and carps meet most of the requirements as good species for aquaculture
Manipulation of species combination and ratio to avoid competition for food and space at different trophic level will help in efficient utilization of pond food resources.

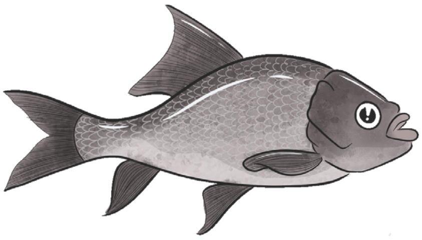
Suggested species

Carps meet the most of the criteria of suitable aquaculture species and hence carps are the most commonly grown species across all forms of farming systems using Indian major carps(IMC) are major species, either alone or in combination with exotic carps and a few selected locally available indigenous species for efficiently utilizing available food resources in the pond. A proportion of 30-40% surface feeders, 30-35 % column feeders and 30-40% bottom feeders is the ideal combination for rational utilization of pond food resources. A few different combinations are suggested below and the farmer can decide the combination according to their choice based on the pond productivity, seed availability and managerial capacity.

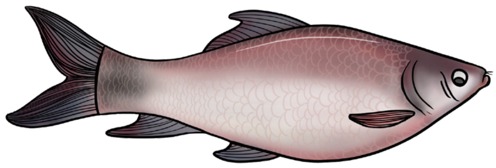
Species (Scientific name)	**Common English Name**	**Vernacular Name** (if any to be added)	**Feeding Zone**	**Feeding Habit**
Major species				
Catla catla *Latest- Labeo catla*	Catla		Pond Surface Area	Zooplankton Feeder
Labeo rohita	Rohu		Pond Column Zone	Decayed vegetation, periphyton and diatoms
Cirrhinus mrigala	Mrigal		Bottom Zone	Diatoms(Unicellular or colonial eukaryotic alga characterized by symmetrical body-also called red algae) and algae; semi decayed vegetable matter
(Hypophthalmichthys molotrix)	Silver carp		Surface Area	Phytoplankton
Ctenopharyngodon idella)	Grass carp		Surface, Column and Marginal areas	Herbivorous-aquatic and terrestrial plants
Cyprinus carpio	Common carp		Bottom zone	Omnivorous
Labeo gonius	Kuria Labeo			Detritus(Detritus food chain is the type of food chain that starts with dead organic materials. The dead organic substances are decomposed by microorganisms.) and plankton
Cyprinus carpio Vr	Amur common carp (Genetically improved variety)		Bottom zone	Omnivore & accepts external feed

Additional species/varieties that can be used based on the need or specific requirements/demand based				
Labeo rohita	Jayanthi Rohu (Genetically improved species)		Column zone	Detritus feeder and plankton
Cyprinus carpio	Amur common carp (Genetically improved species)		Bottom zone	Omnivore
Amblypharyngodon mola	Mola		Column/ Bottom	Plankton Feeder
Labeo gonionatus	Gonionatus		Column Feeder	Detritus & Plankton

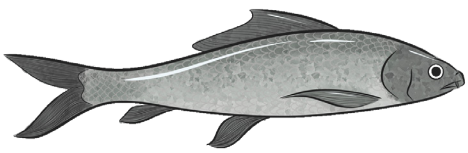
Table 10: Suggested species and their feeding zones



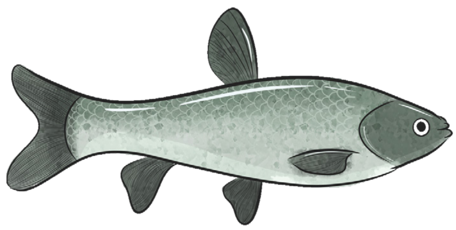
Catla *(Catla catla)*



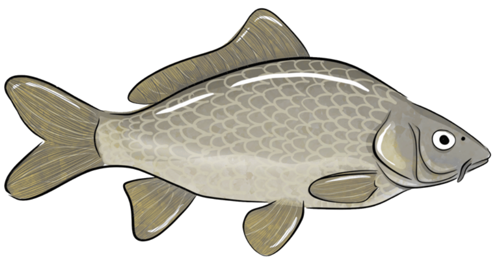
Rohu *(Labeo rohita)*



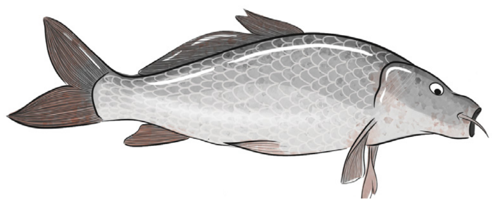
Mrigal (*Cirrhinus mrigala)*



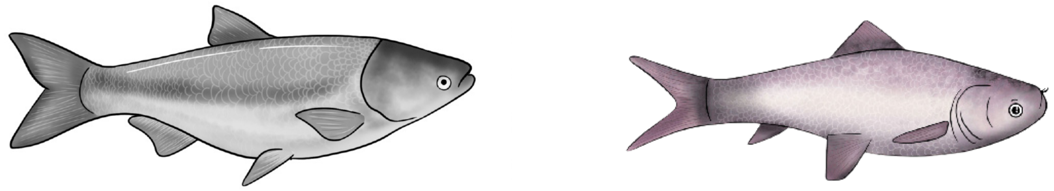
Grass Carp *(Ctenopharyngodon idella)*



Common Carp *(Cyprinus carpio carpio)*



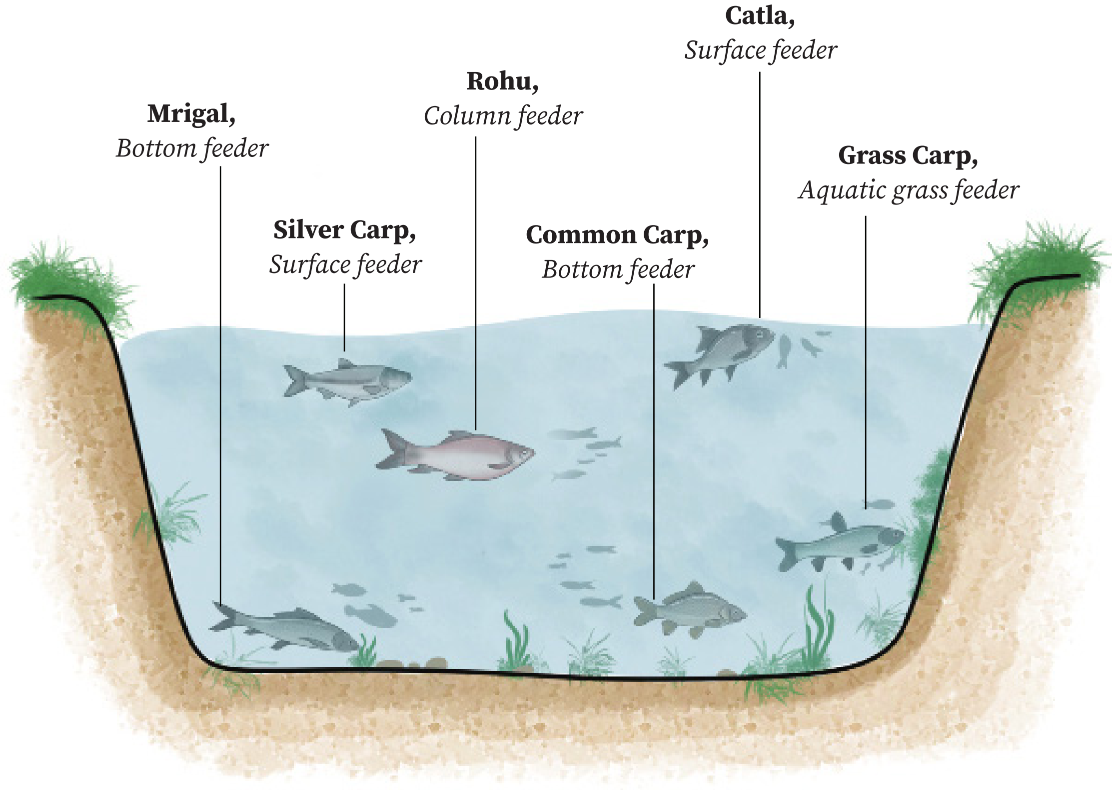
Amur Common Carp *(Cyprinus carpio)*



Silver Carp *(Hypoptholmichthys molitrix)* **Jayanthi Rohu** (*Labeo rohita)*

Fish species

Combination and stocking ratio options



Feeding zones of different species

Species Combination	Species	Stocking Ratio	Remarks
2 Species	Catla and Rohu	50 :50	They can utilize both phyto and zoo plankton efficiently
3 Species (Only IMC)	Catla, Rohu and Mrigal	30 :40: 30	This is the best combination for efficient utilization food resources in the pond
3 Species (Only Exotic Carps)	Silver Carp Grass Carp and Common Carp	40:30:30	In this combination there is no species that can utilize zooplankton

4 Species	Catla, Rohu, Mrigal and Common Carp	30:40:15:15	Use of bottom feeders need based
6 species (Most recommended subject to availability of seed of all the species and feed for grass carp)	Catla, Rohu, Mrigal, Silver Carp, Common Carp and Grass Carp	30: 40: 10: 5: 10:5	Grass carp will be a good choice if aquatic plants are present in the pond as it can control excessive growth of aquatic plants in the pond
Species like Jayanthi Rohu, Amur common carp, mola can also be included by replacing/reducing the proportion of species having similar feeding habit and have good consumer demand. Ex. Ex. Jayanthi Rohu and Amur common carp can be used along with normal strains at 50%. Mola can be used in small quanutites-5% along with major carps			

Table 11: Different species combination and ratio

3.3. Transportation of fish seed

Transport of fingerling is a critical aspect for the survival of fish to be stocked. Fingerlings require proper care during transportation to minimize transportation loss. If fish are roughly handled, they will lose their scales and/or mucus covering their body. Their organs also will be injured. These wounds can easily be infected and will cause slower growth, retardation, or later, even death. Finding good quality fingerlings, transporting and proper stocking procedures are necessary for ensuring good production. The farmer and hatchery/nursery operator must make all materials and equipment readily available on site prior to transportation.

3.3.1 Preparations for transportation:

Proper preparations are required for transportation both at the packing place (hatcheries/seed rearing farms) and receiving place (fish ponds to be stocked) and these apply for both short distance and long distance transportation.

Before packing: Assess current condition of fish. If fish are already stressed before, Transportation might be lethal. Visual inspection of fish a few days prior to transport to decide if they are fit for transport --> fish behaviour, presence of dead fish, condition of fins and body.

The preparation at packing place:

- Stop feeding fingerlings 24 -48 hours prior to transportation
- Keep all the materials required ready for packing - Oxygen cylinder, packing bags/containers and other accessories
- Collect the fingerlings from the pond during cool hours (very early

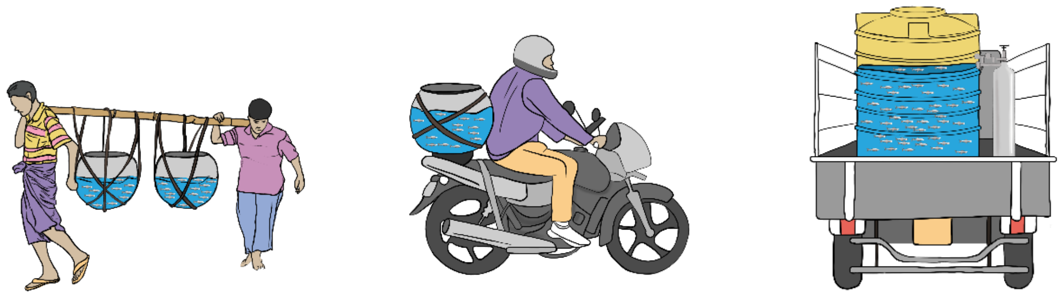
morning or late evening) condition them either in hapas or small cement tanks With clear well aerated water free of plankton
- Condition the fingerlings minimum of two hours before packing to minimize the metabolic rate and oxygen consumption during transportation
- Observe the seed and remove any dead fish and week ones
- Pack during cool hours (very early morning or late evening)
- Count the fingerlings using pre measured scoops 3 or 4 and take the average numbers/weight per scoop and this will be base for calculating number or weight of the fingerling for packing purpose

3.3.2 Methods of transportation

Transport carriers are of two types:
(1) Open system comprising open carriers, with or without artificial aeration/oxygenation/water circulation and
(2) Closed system having sealed airtight carriers with oxygen.

3.3.2.1 Open system:

Fish is transported in open container fitted in a vehicle and provided with equipment for continuous oxygen supply during transport and normally used for short distance that can be covered in few hours and when large quantities of seed are to be transported.
Sanitize the vehicle/container & the materials used for transporting using $KMnO_4$.
Normally syntax tanks of 1000 L capacity are used for large sized fingerlings transportation
In this tank 1000-1500 fish of large fingerlings (50-100g) are transported for 12-18hr duration.



on foot　　　　with Vehicle

Open system of fish seed transportation

Partial sedation is preferred to avoid jumping and stress during transportation-MS222 5ppm Sodium amatol 50-100 ppm.
Cover the top of the vehicle/container to avoid fish jumping out
During long travel, exchange water partially for every 200km is desired.

3.3.2.2 Closed system:

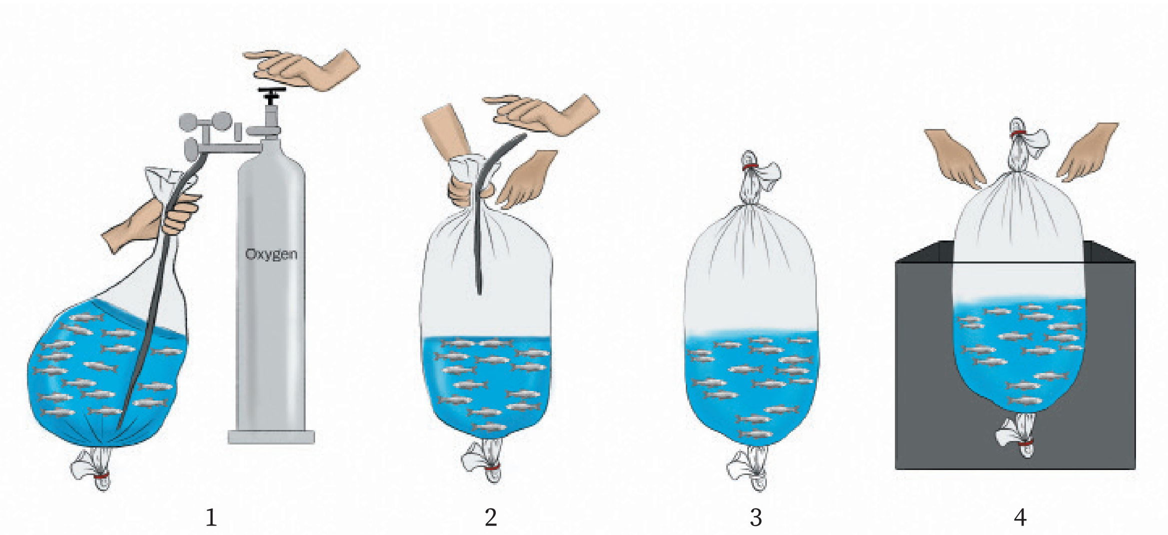
In this system fingerlings are transported in polythene bags filled with water & pure oxygen made leak proof (either sealed or using rubber band & tied) & put in a container (Packing boxes with Xylofoam insulation) to insulate from heat during transport & used mainly for transporting to long distances.
This method is safe for transporting fingerlings up to 24 hours in healthy condition with no or minimal death (< 5%).
Polythene Bags of size used 65-75 cm L X 40-50cm holding 16-18 Ltr. water are used Temperature of water should be dropped gradually (1,5°C/h) to reduce fish swimming speed.
Bags are filled with 1/3 of water and remaining 2/3 space is filled with medical oxygen with sufficient space for sealing the bag.
Counting is done cups with perforation or Tea strainers and the capacity of cups is done by manual counts.
The number of fingerlings (range /bag is given below and the actual number is to be determined based on the duration of transport.
Suggested quantities of different sized fish that can be transported in sealed plastic bags (16-18 Ltr capacity) with approximately 5-6 litres of water and pure oxygen given below.

Size of the fish	Number per bag	Transport duration
8-15 mm	1000-15000	Up to 24 hours and the number packed is determined by the size distance and also the number of travel hours
15-25mm	300- 500	
25-50mm	250-400	
50-100mm	100-250	

Table 12: Suggested Density of Fish seed per bag based on fish length

Seedling weight in grams	Number per bag	Transport duration
1-5	2000	12 hours
1-5	1000	24 hours
5-30	500	12 hours
30-60	20-30	8 hours
60-100	8-10	8 hours

Table 13: Suggested density of fingerlings based on weight



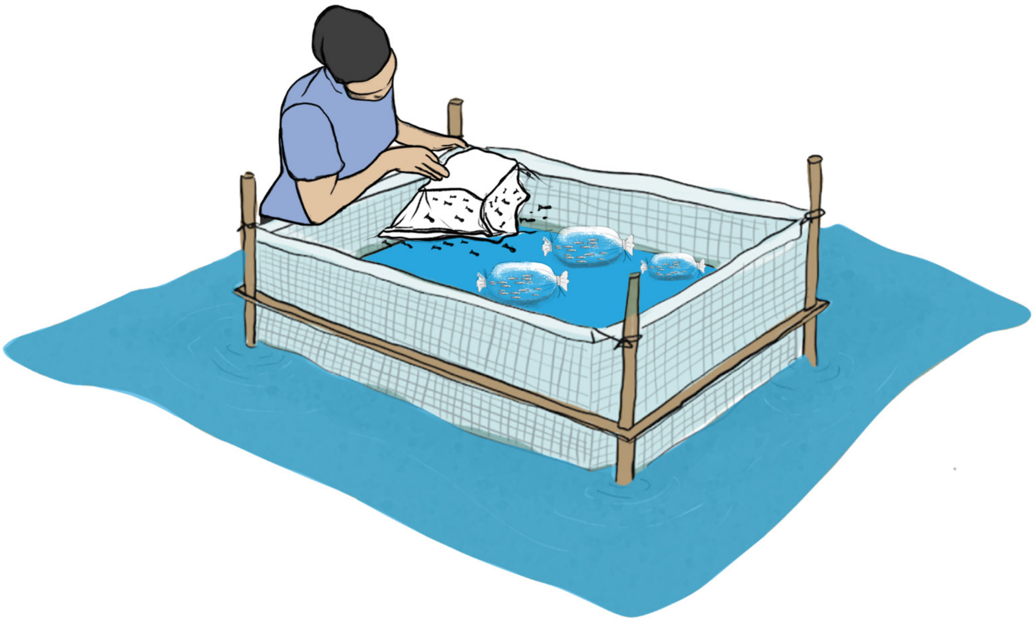
Fish seed packaging for closed system transportation

3.3.3 Timing of transport

Best time for transportation during early morning or late evening hours for transportation around 5-6 hours. If it is more than 6 hours evening and night hours are most desirable timings.

3.4 Release of fish seed

Upon arrival at their new home, adjust fish to their new surroundings:
Make sure pond is ready with good quality water and sufficient plankton for stocking fingerlings by checking water quality and corrections if required
Lower the closed polythene bags floating in the water to get acclimatized to new pond water temperature.
When the temperature difference between the pond water and water inside (1-2 oC difference), Open the bags to make a ring, add cup by cup of water pond to the bag to fill up to 50%.
Observe for their movement/activeness.
Remove if any fish dead or inactive or weak.
Count the number of fingerlings before releasing using pre measured scoops.
Disinfect the seed by dipping in KMnO4 solution 5ppm (light pink coloured water).
It is done by pouring the fingerlings to a hand net (strainer net) and dip the hand net in the Tub/bucket with disinfection solution for about 2 minutes.
Slowly allow the fish to move out to the pond.
Best time releasing fish in to ponds is cool hours (early morning or late evening hours).



Releasing fish in hapa net

3.5 On stocking economics

Recurring or operating costs	Component	Units	Cost per unit*	Cost
A. Pond Preparation Cost				
Liming	Agriculture Lime	100 kg	Rs. 7.00/kg	Rs. 700.00
	Ag lime application cost	1 X 1 hour time	Rs. 200.00/hour	Rs. 200.00
Pumping Cost	5 Hp pumping cost to fill the pond (8 days' time)	716 units	Rs. 3.00	Rs. 2,148.00
Manuring	Manure purchase cost	1200 Kg	Rs. 5.00/kg	Rs. 6,000.00
	Manure application cost	2 X 2 Hours	Rs. 200.00/hour	Rs. 800.00
		A	**Total**	**Rs. 9,848.00**
Recurring or operating costs	**Component**	**Units**	**Cost per unit***	**Cost**
B. Seed stocking cost	Seed purchase cost	1500 fish	Rs. 2.00	Rs. 3,000.00
	Seed transportation cost	1 vehicle	Rs. 3000.00	Rs. 3,000.00
	Seed stocking cost (Resources)	2 vehicle	Rs. 300.00	Rs. 600.00
	Farmer's work-hours cost	6 hours	Rs. 200.00/hour	Rs. 1,200.00
B. Sum of all expenses incurred for the stocking of fish seed in the pond				**Rs. 7,800.00**

On-Stocking recurring expenses total (A + B) = Rs. 9,848.00 + Rs. 7,800.00 = Rs. 17,648.00

Risk Factors:

- Sourcing the fish seed from unreliable source (lack of information on breed) and poor quality may result in low survival and poor growth
- Presence of wild fish (predatory and weed fishes) specially in non-drainable pond specially if water directly (unscreened) received from natural sources(River/canal)
- Wrong identification of species. Identification of species at spawn level is almost impossible
- Sourcing fish seed from mixed breeding –purity of species is in question
- Using fish seed with high mortality during transportation (long transportation) – weak and easily susceptible for diseases and may not tolerate fluctuation in pond environment
- Improper acclimatization/conditioning and not treating fish seeds before stocking. The infectious disease incidence was 12% in farms that treated the fish seeds before stocking; while it was 45.33% in other farms
- Stocking fishes more than recommended (over stocking), improper species combination and size of fish at stocking (poor quality) may serve as putative factor infectious diseases

FAQs

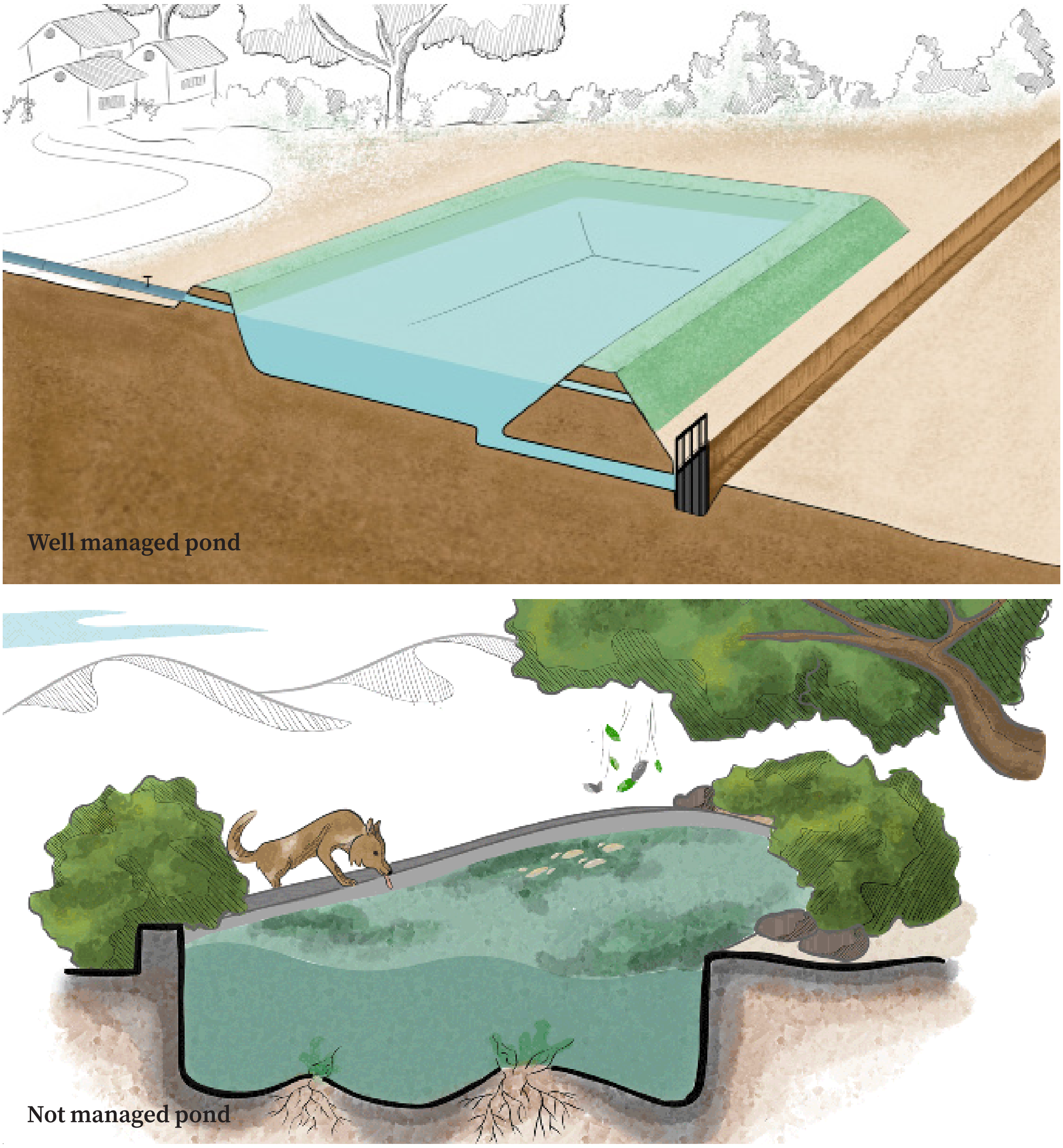
- How to decide the best fish species for aquaculture?
- How many fish can be put in to a pond of one-acre water area?
- What is the best species combination to be stocked in to aquaculture pond to get maximum production?
- How to transport baby fish(fingerlings) from nursery to pond location?
- What is the most suitable culture system for efficient utilization of resources?
- How do you check whether the pond is ready to receive baby fish?
- What are the precautions to be taken before releasing baby fish in to fish pond?

Chapter 4

Post stocking

4.0 Post stocking

Post stocking includes the activities to be undertaken from stocking of fingerlings up to the final harvesting of fish from the pond. The activities



Well managed and not managed pond

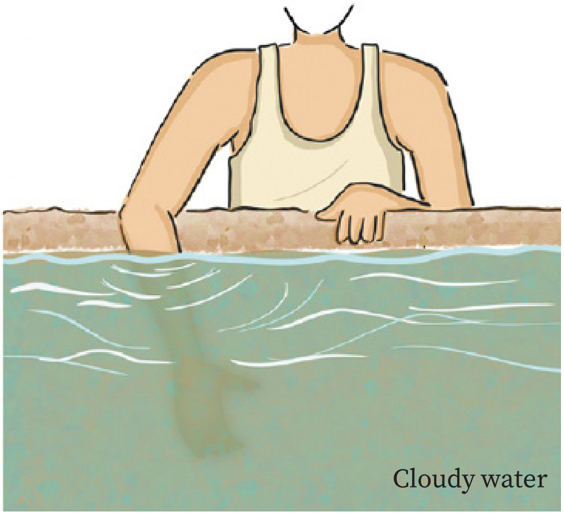
are pond hygiene, water quality monitoring & management, manuring and/ or feeding, growth and health monitoring & management, and harvesting at right time are the key steps of post stocking management.

4.1 Water quality management

A pond with "good" water quality will produce more and healthier fish than a pond with "poor" water quality. How to define "good" water quality for fish culture is highlighted below .

4.1.1 Physical parameters

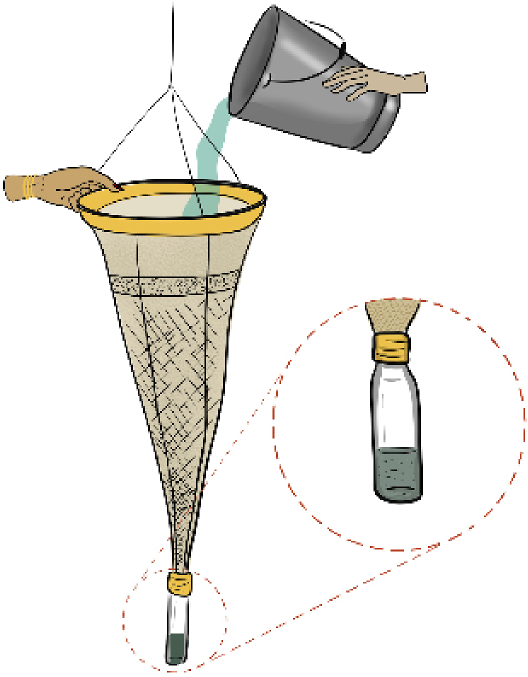
Parameter	Suitable Range/ Conditions	Remarks
Water depth	1.5 m	This depth will help to grow healthy fish as sun light will penetrate and help in plankton production Shallow pond less than 1.5 m will get heated up during summer resulting in algal blooms and reduce the oxygen level causing fish death. Deeper pods >2.5m will reduce plankton production and productivity. Also increase water requirement and cost of production
Water Temperature	26 to 32°C	For good growth and health of fish. This temperature will help in better food consumption and good growth and keep the fish active and healthy). In case of high temperature use shower, use orchid net, use water hyacinth or replenish with fresh water
Watercolor	Light green brown	Indicates a good mixture of phyto plankton and zooplankton Dark green- indicates algal blooms not good for production Dark brown indicate excess organic matter –not desirable
Water Transparency	30 cm from surface	Indicates good productivity –measure of alkalinity High transparency indicates low alkalinity
Light	Keep the surroundings clear of trees for light penetration to pond	Facilitate good photosynthesis stimulating good plankton production
Odour	No fouling smell from the pond	Any fouling smell indicates deterioration of water quality. Reasons for this may be due to accumulation of organic matter, fall of leaves etc,. In such cases periodic removal of leaves, dead fish and removal of left over feed should be attended immediately



Measuring transperency using hand

4.1.2 Biological parameters

Maintaining good plankton density of phytoplankton and zooplankton is essential for good growth of Fish. Plankton type and density is to be checked once in two weeks to decide the manuring schedule. This can be done by using plankton net made of bolting silk cloth of 60-micron mesh (readily available in market) by filtering known quantity of water (50 ltr. using buckets with measurements).



Plankton collection using plankton net

If it is equivalent to at least 3 ml/100 I water, there is enough zooplankton available to feed your fish. If you have sampled, for example 50 l of water, you should then have a settled volume of at least 1.5 ml.
Optimum plankton density for good growth should be 4-5 ml of plankton /100ltr of water filtered & contain zooplankton @ 5-6 zooplankton/ml.
Traditionally, Sechi disc reading of 30 cm(transparency) is considered as indicator of required plankton in the pond. If the plankton density is not in the range the growth of the fish will reduce. If plankton density not good, then go for additional manuring.
Prevent excess growth of aquatic weeds specially floating aquatic weeds. Excess growth will form a mat preventing penetration of sunlight & affecting plankton production. Roots of these plants will harbor harmful insects
Remove snails or other animals attached to inner side of the pond by scraping or using net. Snails may act as hosts for pathogens.

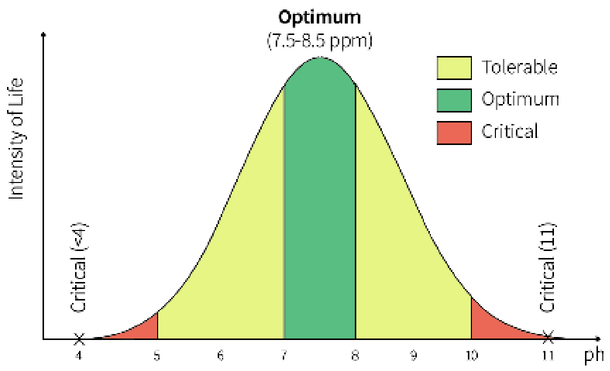
4.1.3 Chemical parameters

The most important chemical parameters determining the water quality are Dissolved Oxygen(DO). pH, Alkalinity and Ammonia. The farmers should check for DO in the morning and for pH in the afternoon to get the critical levels and accordingly take corrective measures. DO and pH should be checked twice a day. The diurnal fluctuations, optimum ranges, upper and lower critical level and their effects are summarized in the table below.

Parameter	Optimum range	Effects
pH Increases during daylight; decreases at night due to respiration and increasing carbon dioxide levels	7.5-8.5 (3 is critical)	< 4 lethal 4- 7.5- slow growth 7.5-8.5- desirable range 8.5- 10 slow growth > 11 alkaline death point Low pH results more mucus and body becomes soft and rough in high pH
Dissolved oxygen(DO) Minimum before sun rise and increases during mid-day and reduces by evening	4-6 ppm (not less than 3ppm)	2.4 and below Lethal-fish kills 3.0-4.0 causes suffocation and slow growth rate 4.0-6.0 desirable range >8 super saturation-creates dropsy
Alkalinity Alaklinity and pH are inter- related. Low alkalinity more fluctuation in pH	80-200 (critical 25ppm)	Low alkalinity(<20ppm) more fluctuation and this creates stress in fish. Exposure of fish to high alkaline conditions inhibits the rate of ammonia excretion, leading to ammonia accumulation and toxicity.
Ammonia	<0.2 ppm	Any higher level is lethal to fish

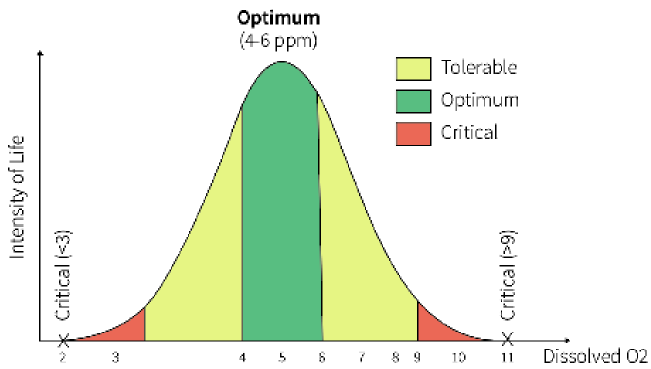
Table 14: Suggested density of fingerlings based on weight

Optimum levels of chemical parameters



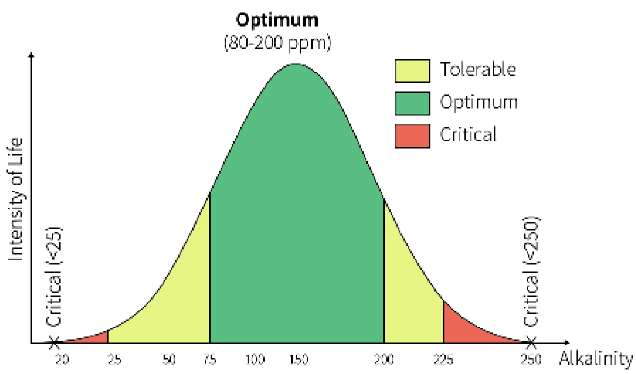
Optimum level of pH

Optimum and critical levels of pH in fish pond



Optimum level of Dissolved O2

Optimum and critical levels of dissolved oxygen (ppm) in fish pond



Optimum level of Alkalinity

Optimum and critical levels of alkalinity in fish pond

4.2 Liming

Application of agricultural limestone and/or dolomite to improve pH and alkalinity in aquaculture ponds is a widely used practice. However, there is considerable use of lime in aquaculture to disinfect pond bottoms and water, to attempt to control pH and various other reasons.

4.2.1 Types of limes used

Normally agriculture lime and dolomite are used during post stocking operations. Dolomite is better as it stabilises the pH of water.

4.2.2 Liming dosage and mode of application

Liming is practiced during post stocking management for maintaining desired pH level. In case of low pH add lime @ 50-100 Kg/ha once in two weeks until stabilises.
pH should be measured in the afternoon to know the actual pH of the water and take corrective measures.
In case of low alkalinity (high transparent water) and hardness use lime and dolomite. Add lime and dolomite @ lime 20 kg and dolomite 40 kg per week until the alkalinity reaches around 80 ppm above and become stable.

As a preventive measures of low alkalinity use salt @ 100kg and lime 50 kg /ha per month at the starting of winter and continue to end of winter to maintain good water quality during winter.
Lime is spread across the pond and take precaution measures mentioned under pond preparation chapter.

4.3 Manuring

Manuring during post stocking operation is done to maintain sustained production of zooplankton during the entire culture period.
General guidelines.
During pond preparation only 25-30% of the recommended dose is used (see pond preparation).
The balance is to be used in equal monthly instalments for the rest of the culture period to maintain continuous plankton production as a post stocking management practice.
The balance is to be used in equal monthly instalments for the rest of

the culture period to maintain continuous plankton production as a post stocking management practice.
Example is illustrated in tabular form for recommended manuring of cattle dung @10,000kg/ha/year for a crop of 10-11 months.

Recommended dosage(Total)kg/ha/ year	Initial dose@25-30% Kg/ha	Monthly dosage of manuring kg/month
10,000	2500-3000	700-750

High transparency (> 30 cm) indicates low productivity (low alkalinity <20 ppm)) and requires one additional dose of manuring.
Apply manure in the corners of pond in heaps for slow mixing and release of nutrients for phytoplankton.
Apply organic fertilizers regularly, avoiding overloading the pond with several weeks’ supply. Check the water quality to control the quantities used.

Note: wastes such as rice hulls, sugar-cane stalks and sawdust are rich in cellulose.

4.4 Feed management

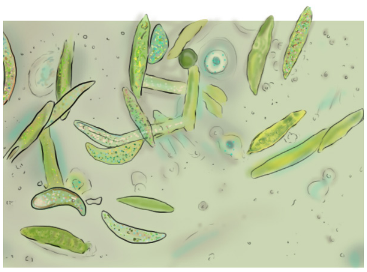
To survive, grow and reproduce, fish need to feed on organic materials such as plants, other animals, or prepared feeds containing plant and/or animal material. It is therefore most important for you to ensure that your fish get the food they require, both in quality and in quantity.
The highest recurring cost in aquaculture is that of feed. Feed alone accounts for about 60-80 percent of operational costs in intensive aquaculture, while feed and fertilizers represent about 30-60 percent of the total cost of aquaculture production in semi-intensive aquaculture system. Carps in addition to consuming natural food also require l supplementary feed to meet extra energy required for somatic growth. Supplementary feed is given to meet additional requirement of energy and thereby increase their growth. More often than not, cultured fish are often overfed because of farmers’ perception that more feed will result in increased production without looking at its proper utilization. Better feed management can reduce the feed cost to the extent of 15-20 percent. Hence, feed management both of natural food and supplementary(external) feed assumes significance in post stock management of carp ponds.

4.4.1 Natural food

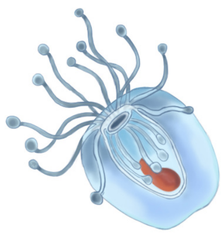
Phytoplankton & Zooplankton form the main food for carps. Continued production of plankton is required for good growth, survival & health of fish. Plankton density need to be assessed once in two weeks either by water colour or more precisely by collecting plankton using net
Check on quantity by filtering through your plankton net a known volume of pond water taken at several sampling points throughout the pond.
Example

- Use a 10-l bucket for and, take five water samples to obtain a total volume of 50 liters
- Filter them through plankton net made of bolting silk cloth with a mesh size of 65 microns to concentrate the phyto and zooplankton within its bottom container
- Transfer this zooplankton into a graduated glass tube
- Kill the Plankton by adding a pinch of table salt or a few drops of formalin
- Let them settle for about one hour at the bottom of the tube
- Measure the settled volume of zooplankton
- If it is equivalent to at least 3 ml/100 I water, there is enough plankton available to feed your fish
- If you have sampled, for example 50 l of water, you should then have a settled volume of at least 1.5 ml

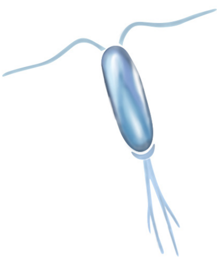
Accordingly, manure is to applied as explained under manuring to sustain plankton production throughout the growing period.
If grass carp is used as a component in culture, provision for providing its natural food (Floating aquatic plants- Lemna, Azolla or grass like Napier) should be made.



Phytoplankton



Zooplankton

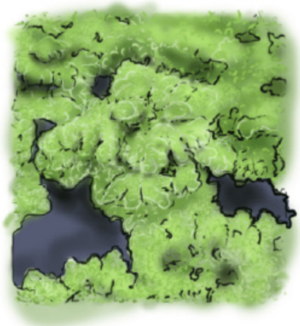


Corepod

Rotifer

Cladoceron

Lemna



Azolla

Napier grass

Natural food

4.4.2 Supplementary feeding

In pond polyculture, the role of natural fish food is outstanding because it is the source of protein in the diet of fish which otherwise would only be supplied by expensive animal or plant protein meal. As the name indicates, feeding in pond fish culture is practiced mainly as a supplement to the natural fish food. Natural fish food organisms are rich in proteins but poor in carbohydrate. Widely applied supplementary feeds are the different cereals. They are relatively poor in protein but rich in energy. More protein-rich feeds, together with cereals, are also used to supplement the natural fish food when the standing stock of fish increases by the end of the production season.

In semi intensive culture with manuring a good portion (50%) of protein and other nutrients will be met by plankton and needs to supplemented with carbohydrate rich feed containing protein around 24% crude protein.
Types of supplementary feeds
Supplementary feed are three types:
Conventional feed
Farm made feed
Commercial feeds

Conventional feed: A mixture of oil cake and rice bran in equal quantity to meet a protein requirement of 24-26%. Conventional feed meets the protein and energy requirement of grow out fish but lack in vitamins and minerals. Oil cake is soaked for few hours and mixed with dry rice polish, cooked and fed in dough farm.

Farm made feed:
Farm made food can be prepared using ingredients like Oil cake, rice bran, Fish meal/ soybean, pulses and to make it a balanced diet. This can be prepared by farmers.

Ingredient	% composition	Feed preparation method
Oil cake(GNC or Mustard oil cake)	25	All the ingredients are mixed and powdered. Mix with in water and cook for about 20 min and make in to dough/balls
Rice bran	25	
Fish meal	10	
Pulses(Horse gram, black gram)	20	
Maize	10	
Broken rice	10	

Table 15: Feed ingredient and their proportions for preparing farm made feed

Complete feeds

In Semi intensive farming where is ponds are fertilized, a good portion of protein requirement is met from natural food but needs to be supplemented with energy, vitamins and minerals to make it a complete diet. Commercial feeds are complete diets containing all the requirements of fish. A number of commercial fish feeds (floating and sinking) are available in the market and these can also be used based on the availability, quality, accessibility and affordability of the farmer.

Commercial feeds are quite expensive (around Rs50-55/Kg) compared to farm made or conventional feed (Rs30-35/ kg)

4.4.3 Feeding rate, methods, feeding frequency & schedule

The amount of feed given to carp depends upon several factors such as species, size, biomass (spawn, fry, fingerling, adult/brood), natural food present in pond, water quality parameters etc. To reduce feed wastage, feeding should be monitored regularly otherwise it will lead towards deterioration of water quality, which in turn causes stress, disease and/ or mortality in fish. The proper feeding schedule should be followed throughout the carp culture.

Feeding quantity is to be regulated based on the fish biomass in the pond. This needs to be assessed preferably once in two weeks by sample netting and weighing the fish.

Feed required = Estimated fish biomass in pond x feeding rate %, where biomass is, average body weight of fish x total number stocked x expected survival.

In grow out pond survival usually reduces to 80%. Hence a survival of 70-80% can be considered for estimating fish biomass.

Fish require more feeding in the initial stages as the growth rate is faster and as they feeding consumption reduces and we need to give less feed.

Supplementary feed is recommended @3-5 % of the fish biomass for initial 2 months and gradually reduced to 2, and 1.5% at the end of the growing period.
In addition to biomass, water temperature and weather conditions also be looked and accordingly adjust the feeding rate.
If it is too cloudy avoid feeding and in the winter months reduce the feed because of low metabolic activity due to low temperature.
To avoid wastage of feed and reduce the feed cost, feed consumption should be monitored.

Feeding methods

Direct pond feeding should be avoided as we will not be able to assess the consumption of feed by fish and unconsumed and gets accumulated in the pond bottom. Continued accumulation of feed at the pond bottom may lead to increase in the organic load resulting in water quality deterioration and affect the fish growth and health also.

Different feeding methods like tray feeding and bag feeding are suggested
In Tray feeding the feed is kept in the tray and the tray is hanged inside pond 1-2 ft below the water level and observed one hour after feeding to see the quantity consumed and accordingly feeding quantity.
Bag feeding with perforated bag is a better practice as fish will find more time to feed and wastage will be minimum.
About 20- 30 bags are kept per hectare tied over the pond using rope from one end to other end of the pond.
The bags will be checked and refilled once in two or days depending on feed consumption.
Feed may be given once (in the morning hours) or twice (morning and evening) in a day based on the consumption by fish – This is done in tray feeding.
Avoid very late evening feeding.

Feeding frequency

Increasing the frequency of supplementary feeding has several advantages

- Reducing food wastage
- Reducing dissolved oxygen consumption and improving water quality
- Reducing nutrient losses attributable to leaching, thereby improving food quality
- Improving uniformity of fish sizes, giving more possibility for the less aggressive fish to feed
- improving fish growth and feed utilization

Before deciding on how frequently you should feed your fish, note the following points.

The smaller the fish, the more frequently they should be fed.
Dry feeds need to be distributed more often than moist feeds.
The feeding frequency should be reduced as the water temperature cools down, or if it exceeds optimum levels.
The frequency should be adapted to the fish species. For carps feeding twice in day-once in the morning(9am) and once in the late afternoons(4pm) is better. Avoid late evening feeding.
The feeding cost should be checked to make sure it is not excessive compared to the yields obtained.

4.5 Diseases

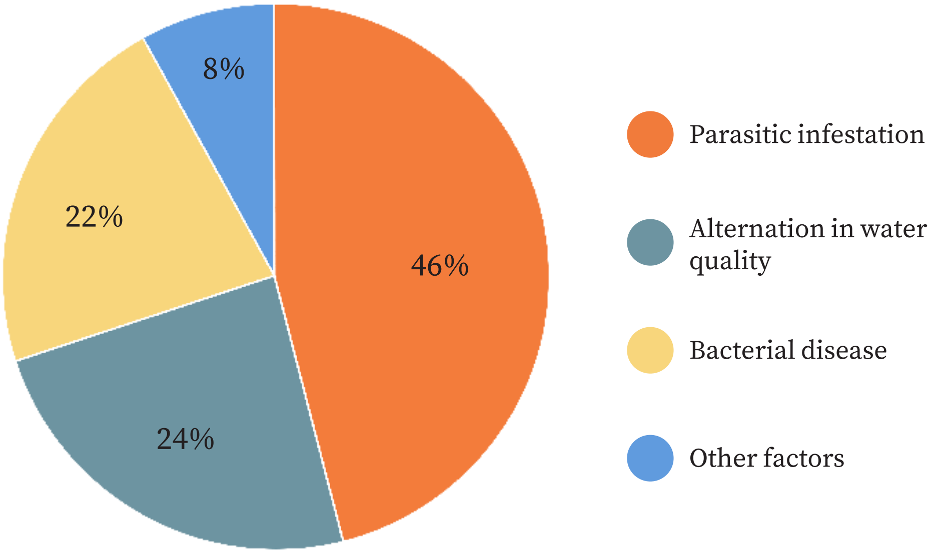
Occurrence of diseases in carp farming is very scarce specially so in case of extensive and semi intensive culture systems. There are no reported incidences of fish diseases causing heavy economic loss. Diseases are often seen only in very high intensive culture systems but there are no reported high losses due to diseases. Estimated loss of fish production (as percentage of total production) and total economic loss (in INR) were estimated to be in the range of 5- 10% (14,900.00- per ha to 30,770.0 per ha).

Unlike Land animals it is difficult to isolate and treat infected fish in a pond hence entire water body is to be treated which may not only be effective but also not economical. prevention of occurrence and further spread of diseases through good biosecurity, pond preparation Good water quality and feed management practices are the key for successful aquaculture.

4.5.1 Causes

There are several causes of disease that may affect the fish directly or may continue to cause disease problems. Basically, any factor which causes stress or difficulty to the fish decreases its resistance to disease and increases the chance of disease problems occurring.
Some of the causes for disease are:
Fish seed with low genetic immunity.
Under feeding leading to malnutrition resulting in growth retardation and low resistance to diseases.
Deteriorated water and sediment conditions favouring fast spread of pathogens.
Overcrowding pond with very high stocking density causing physical injuries leading to secondary infection.
External source through Infected fish seed, equipment, feed, birds and such other sources.
Incidences of occurrence of parasitic infestations in freshwater aquaculture

are maximum (46%), followed by loss due to alternation in water quality parameters (24%) leading to production loss. Infection of fish with bacterial pathogens are in the range of 22% and in only 8% cases the mortality are due to other factors.



Different causative factors responsible for mortality & production loss in freshwater aquaculture

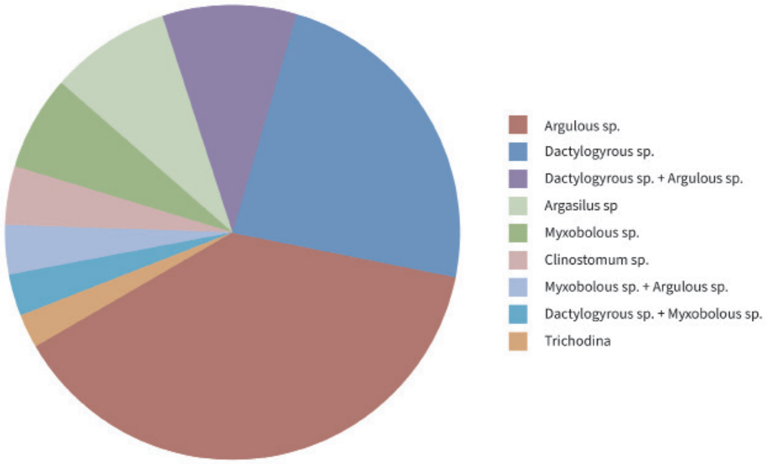
4.5.2 Types of diseases

Common diseases, causative agent, symptoms and control measures in carps

Name of the disease	Causative Agent	Symptoms	Stages of Infection	Treatment/ Management Protocols
Infectious diseases				
Ichthyophthiria-sis *(Itching disease)*	*Protozoa (Ichthypthiriasis multifilis)*	White nodular spots on skin, gills, fins and restlessness	Fingerlings and adults	Daily bath treatments in 2-3%salt solution for one hour for 7 days or 0.15 ppm of malachite green for pond treatment
Trchodiniasis	*Trichodina*	Attached to Gills	All stages	Improve water quality and bath treatment
Costiasis	*Parasites of Genus Costia*	Bluish –white shade on the body	All stages	Bath treatment with 2-3% NaCl or 50mg/ litre of KMn)$_4$ or pond treatment with 5mg/ltr of $KMnO_4$

Whitespot Disease	*Myxobolus Species*	White creamish cysts on gill	All stages, more in fingerlings	Only prophylactic measures. Segregation of infected fish and disinfection of pond after drying
Dactylogyrosis & Gyrodactylosis	*Helminth*	Gills and body get faded	All stages	Bath treatment 25mg/l of formalin with 3-5%NaCl for 15 min or pond treatment with 5mg/ltr of $KMnO_4$
Block Spot Diseases	*Larvae of Diplostomum sp.*	Block spots on the body	Adults	Removal of intermedi-ate(mollusks) and final hosts(birds)
Crustacean diseases(External parasite)				
Fish lice	*Argulus sp*	Ulcers on the body and visible movement of the parasite	Adults	Bath treatment with 25mg/l of formalin 3-5%NaCl for 15 min or 100ppm KMnO4 pond treatment with 5mg/ltr of KMnO4 for 5-10 seconds or Pond treatment with 5mg/ltr of KMnO4 & removal of parasites
Lernaeosis	*Lernaea sp.*	External attachment to body	Adult stage	Bath treatment with 25mg/l of formalin or 2-3%NaCl for 15 min or 100ppm KMnO4 pond treatment with 5mg/ltr of KMnO4
Non infectious diseases				
Gill disease	*Water born irritants, low oxygen level*	Respiration problems	All stages	No specific treatment. improve the water quality
Algal toxicosis	*Algal blooms*	Surfacing of fish with erratic movement	All stages	Sprinkling of cow dung @200kg/ha over surface and covering to reduce sunlight intensity
Nutritional diseases/disorders				
Starvation	*Complete deprivation of feed/ not acceptance of feed*	Enlarged head and slender body and retarded growth	All stages	Provide nutritionally balanced diet
Scoliosis	*Irregular development of skeleton*	Spinal deformity		Removal of deformed individuals

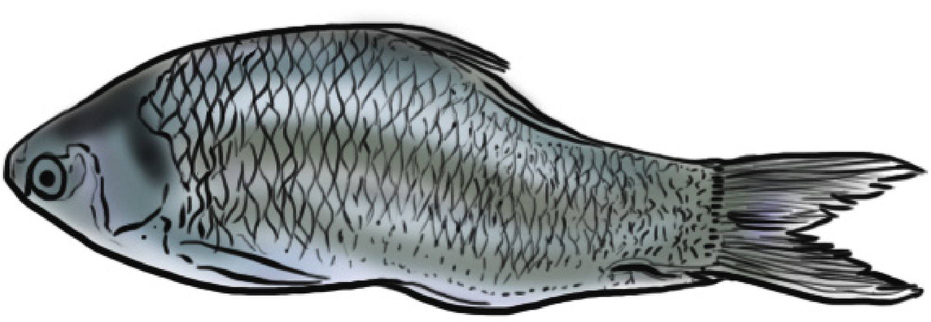
Among all fish parasitic infestations, disease with Argulous is most common (29%), followed by infestation with Dactylogyrous (25%) and Myxobolous (9%) (Figure below). However, no incidences of viral disease reported in freshwater aquaculture in India, causing huge mortality. May be that Indian Major Carps (IMCS) are not susceptible to fish viral pathogens or the culture environment is not conducive for the viral pathogens to multiply and cause disease.



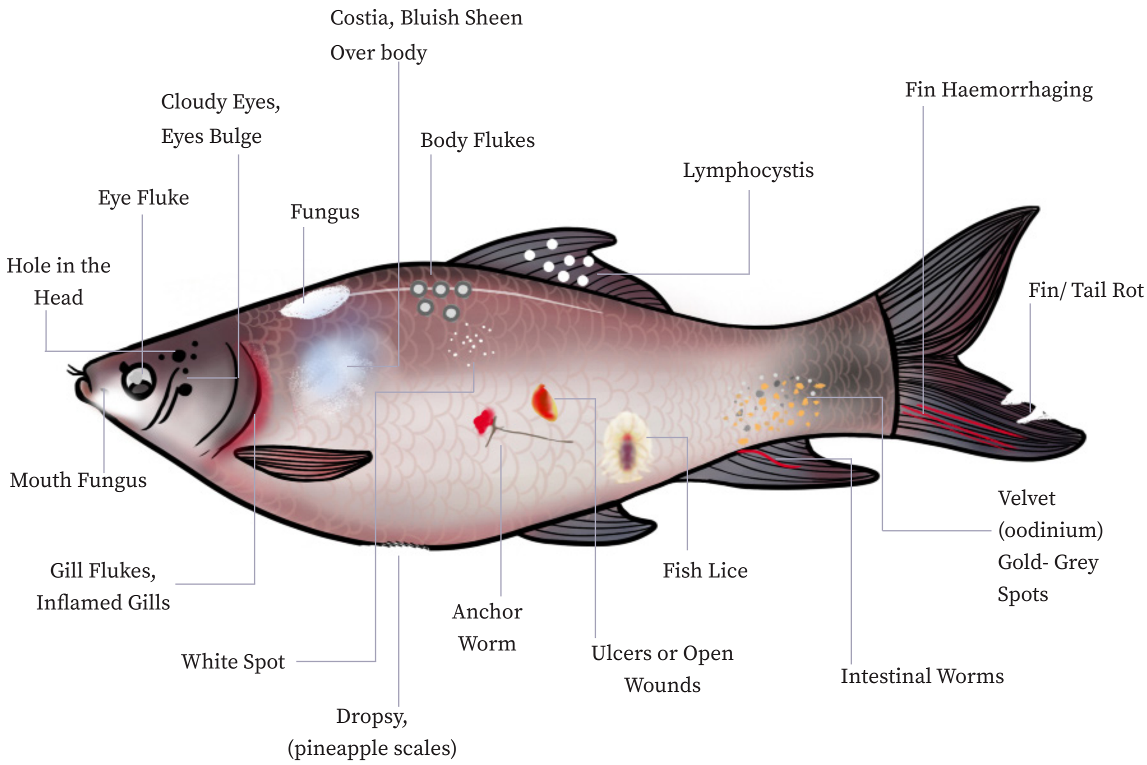
Different fish diseases and their contribution

Lernea Argulus Tapeworm

Disease causing parasites



Deformed fish



Disease infected fish

4.5.3 Management of diseases

Treating a diseased fish is difficult when compared to land animals, as individual treatment is difficult/ not possible in aquaculture there by requiring mass treatment of the entire mass or the pond itself. Prevention, therefore, is always the best approach in aquaculture to control the disease outbreak than treating the disease.

- Control wild fish by using filters and screens and regularly eradicate them from canals and ponds.
- Disinfect all fish stocks imported from outside as eggs, juveniles or adults

Management practices like good pond preparation practices, optimum stocking density, water quality monitoring, proper feeding and periodic liming are some of the key factors to avoid occurrence of diseases in fish Prophylactic measures specially during winter months like maintaining proper water depth, avoiding over feeding will help in managing of fish health.
In case of sudden death in fish, dead fishes should be removed from pond and check for oxygen level in the early morning hours (sun rise time – the

DO level will be minimum and critical) and send the dead fish and pond water for analysis for any possible hazardous chemicals/ poison in the water and detection of causes for fish kills.

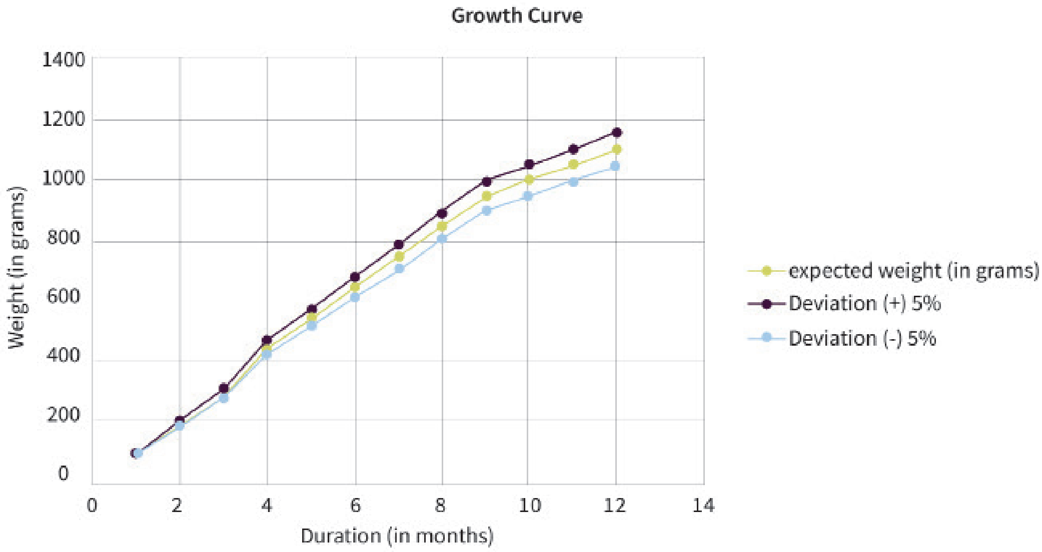
4.5.4 Management of pond hygiene

Maintain required water depth all through the growing period.
Clear excess growth of aquatic weeds & plants on the margins (inside pond).
Stop feeding during excessive rainfall and heavy winter time.
Clear algal blooms (brown algae) when starts appearing to avoid further spread and creating mat/bloom.
Clear branches of big trees that covering the pond to avoid drooping of leaves in to the pond.

4.6 Sampling

Sample netting of pond at regular intervals will help in assessing growth and health of fish and also in regulating feeding quantity. Cast net is one of the easiest ways to take a sample. However, for larger ponds a seine net can be used to sample a corner of the pond.
A fish sample should be at least 15 fish. If 1 cast is not enough to catch this number of fish cast again until enough fish are caught. If more than 15 fish are caught, don't throw the extra fish back. Collect all the fish caught, weigh them, & count them & record the information in the pond record book
Sampling at two weeks' interval is preferred. Once in a month is a must
During sampling take out all unwanted weed fishes/predatory fishes if found entry unintentionally.
Steps to be taken while sampling of fish

- Don't feed fish previous day to sampling
- Keep fish in water at all times or as much as possible in wet condition whilehandling fish
- Wear gloves when handling fish
- While sampling, check their general body condition for activeness, any external injuries, disease, deformations, discolorations etc
- Measure fish both for weight(g/kg) and length(cm). Measuring weight of the fish at sampling is very important.
- Note the results in record book for monitoring system
- After sampling disinfect the fish by dipping in them in 5ppm $KMnO4$ solution followed by 2% salt solution before releasing back to pond



4.7 Harvest

The decision to harvest the fish from a pond is made for two main reasons:
A. The fish has attained the right size at which it gives maximum profit in the market and any further waiting may reduce the profit.
B. When the prevailing market opportunities offer the highest profit and the opportunity may be lost with delay.
In order for the farmer to decide that the fish has attained optimum size for harvest, the farmer must conduct regular sampling and weighing the fish and recording the data. If The data shows that the monthly increase in fish weigh rises until it attains marketable size. After attaining marketable size, it is advisable to harvest the fish.

4.7.1 General comments

Stop feeding before 2 days before harvest.
Early morning or late evening hours are the best time for harvesting. If the fish is to be transported for long distance evening harvest is the best time as fish can be transported in the night cool hours. For long term transportation, fish must be washed/dipped in water put in a container with ice packing.
Harvesting using big meshed size (> 2 inches) drag net is better to avoid smaller fish getting caught. The net is dragged from one end to other end manually.
Other option - if there is a workforce scarcity, cast net can also be used for sampling fish. Cast net can be operated in different parts of the pond to get required number for sampling. This can be operated by one person.

4.7.2 Types of Harvest

There are 2 type of harvest One is partial and other is complete harvesting. In addition, multiple harvesting multiple stocking and also can be practiced in perennial ponds to make fish available throughout the year but this demands availability of seed around the year.

Partial harvesting:

Partial harvesting can be done 4-5 months after stocking and fish of marketing size, around 750 g (varies from place to place) and allowing the smaller fish to grow fast.
Partial harvesting can be done using drag net of bigger mesh size (> 2 inches) to avoid small fish getting caught. The number harvested may replenished with equal number of fresh from the rearing pond if available.

Complete harvesting:

Full harvesting may be done once all the fish attain marketable size (8-10 months after stocking). depending on the market demand
It is preferable to harvest completely during summer months (April-may) by repeated netting and dewatering the pond. Dewatering will also enable preparing the pond for the next crop.
Completing harvesting during summer months will also help in avoiding risk of flooding and fish loss during monsoon months.

Post stocking economics:

Recurring or operating costs	Component	Units	Cost per unit*	Cost
C. Water quality assessment kit cost	Water quality test kits (pH, Ammonia, Nitrite, nitrate, alkalinity)	1 (100 tests each)	Rs. 3500.00	Rs. 3500.00
D. Periodic Liming cost	Ag lime purchase cost	20 kg X 8=160 Kg*2	Rs. 7.00/kg	Rs.1120.00
	Ag lime application cost	8 X 1 hour time	Rs. 200.00/ hour	Rs. 1600.00
E. Periodic manuring cost	Manure purchase cost	200 kg X 16 applications =3200 kg*3	Rs. 5.00/kg*3	Rs. 16,000.00
	Manure application cost	16 applications	Rs. 200.00/ hour	Rs. 3200.00
F. Supplementary feed cost*4	DORB purchase cost	480 Kg (32% of target biomass)	Rs. 14.00/kg	Rs. 6720.00
	Oil cakes purchase cost	120 Kg (8% of target biomass)	Rs. 35.00 /kg	Rs. 4200.00
	Used bags cost	25	Rs. 10.00/bag	Rs. 250.00

	Feed application cost	60days*5	Rs. 200.00/ hour	Rs. 12,000.00
G. Sampling cost	Monthly sampling cost	8 times	Rs. 500.00/ hour	Rs. 4000.00
H. Expert advice &/or lab assessment cost	Consultation cost	4 times	Rs. 1500.00/ visit	Rs. 6,000.00
I. Harvesting cost	harvesting gear rental	1 seine net	Rs. 1500.00/ Day	Rs. 1500.00
	Harvesting workforce	7 people	Rs. 600.00/ half day	Rs. 4200.00
J. Value for farmer's time	Work-hours spent by farmer on farm	@ 1 hour/day X 240 days =240 hours	Rs. 200.00/ hour	Rs.48,000.00
I) Total post stocking expenses (Sum of C+D+E+F+G+H+I+J)				**Rs. 1,12,290.00**
II) Total On-Stocking expenses (A+B)				**Rs. 17,648.00**
III) Sum of all operating expenses (A+B+C+D+E+F+G+H+I+J)				**Rs. 1,37,738.00**
IV) Land lease				**Rs. 15,000.00**
V) Sum of all investments made for the complete culture cycle				**Rs. 1,52,738.00**
VI) Harvested biomass value	**@ 1kg body weight with 100% survival estimate**	**1500 X1 Kg= 1500 Kg**	**Rs. 120/ Kg farmgate price**	**Rs. 1,80,000.00**
One culture cycle profit margin= (VI-V)				**Rs. 27,262.00**

*2 This is an estimation for demonstrating the economics part based on the need of your farm, application necessity and dosage needs to be decided. Estimated at the rate of 20 kg / Acre / month and an estimate of 8 months of culture period.
*3 Application volume, number of applications and unit price are indicative, considered for the purpose of calculation, actual manuring dose needs to be decided as per the individual pond requirement and price of the manure also needs to be amended as per your local cost.
*4 Total supplementary feed usage volume is estimated @ 40% of the total target biomass of 1500 kg and the DORB and Oil cake ratios are 80% and 20% respectively.
*5 While calculating the supplemental feed application cost, the total days of supplemental feed application was calculated only for 60 days considering its usage extensive farming system, in case of semi-intensive system it needs to be corrected as per the actual application days. If the productivity of the pond is good, there might be no need to use supplementary feeds and that cost component can be deducted from the expenses.
* In the case of leased ponds, land lease needs to be considered under recuring expenses.
* Expenses like disease treatment and other incidental expenses which are case specific are not mentioned in this estimate model, if such expenses are there, they need to be counted under recuring expenses.

4.8 Women in aquaculture

Participation of women in aquaculture is limited due to several factors right from social taboo to lack of technical knowhow on aquaculture practices. However, women support their menfolk in pond cleaning, pod preparation and feeding fish. They also take part in decision making in sourcing inputs like fish seed, feed and other inputs required for aquaculture. It is more of a family activity in small scale aquaculture than men alone doing the job. Women with literacy help men in keeping record books.

Women groups are now more involved in managing aquaculture ponds as seen in Bangladesh and Nepal. In India also women have started in aquaculture activities as exemplified by WSHGs (Women Self-Help Groups) being allotted GP ponds on priority in Odisha state where complete operations are managed by women.
Women involvement in fish trade is very negligible as they are ill suited due to security and domestic responsibilities at the same time.
Socio-cultural inhibitions in specific communities also debar women freely take marketing activities.

Risk Factors:

- The infectious disease incidences in farms that regularly not monitored water quality and fish health status were very high
- Presence of wild fish will have an impact on infectious disease outbreak. The infectious disease incidence was 41% in farms recorded the presence of weed fishes
- Improper feed and feed management –if not done properly it may affect growth and production
- Unhealthy pond may lead to water quality deterioration and subsequent disease breakout
- Excessive use of commercial inputs: Commercial inputs include, feed, growth promoters, probiotics, pond hygienic
- Algal blooms commonly noticed are Euglena (Brown/Red algae) and Dark green bloom caused by blue green algae –microcystis (filamentous algae)

FAQs

- What are the important steps in post stocking management?
- What are the major water quality parameters that require attention during post stock management practices?
- How does the water quality affects growth, survival and health of fish?
- Why should we apply lime and manure during culture period?
- What type of supplementary feed is best growth of fish?
- How do we calculate the feed quantity to be fed?
- What time is the best for feeding fish and how do we feed the fish?
- What are the common diseases of fish and how to control?
- How to control the spread of fish disease?
- What are the risks and mitigation measures?

Annexures:

Success stories: **Odisha**

1. An innovative technology in carp-prawn polyculture

Sri Nabakishore Pani of Village – Barakera, Block – Delanga has practiced Indian major carps in his 0.75 acre pond area. He was interested for prawn culture along with fish. He was trained about polyculture practice in a training conducted by the fishery scientist of KVK. During the training through feedback it was planned for a demonstration of polyculture practice in the Barakara village of Delang Block. In the demonstration pond instead of Mrigal freshwater prawn was introduced. Grass carp was stocked to utilize the aquatic vegetation of the pond. Instead of post larvae (PL) of fresh water prawn the PL was converted to juveniles by stocking the PL in a confined hapa within the same pond. In the hapa the PL to become juveniles sufficient hide outs in plastic pipe put in the hapa to avoid cannibalism. High protein pelleted commercial feed given to PL. After PL became juveniles the hapa was opened in the same pond so that the juveniles will come over to the main open pond.
Proper feeding management with GNOC and rice bran at equal proportion (1:1) for fishes and pellet feed for prawn @ 5-2 % body weight was suggested to practice. Sampling was done in every month and the growth (gm) and length (cm) were measured. From sample netting it was observed that the average growth rate of Catla is 0.5kg, Rohu is 0.4kg, grass carp is 0.6kg and prawn is 40gms after 4 months of stocking. The farmer is expecting a net profit of Rs.75,000/- from his 0.75 acre of pond area.

2. 'Composite Pisciculture- A Paying Enterprise'- Sri Sadasiba Jena proves it

Introduction:

Village: Sarbapada consisting of forty farm families is located 4 km away from Nimapara block and 25 km from KVK, Puri, Kakatpur. The KVK has adopted this village as it is a small one. Sri Sadasiba Jena of this village an educated farmer after his matriculation took up agriculture as his main occupation as he could not get any job of his own choice. He had done pisciculture in his 1 Acre of land in traditional method. He could not get much profit out of that due to lack of scientific knowledge on pisciculture.

Intervention/Methodology Process:

KVK intervened to conduct the FLD Programme on composite pisciculture in his pond during 2009-10. The advanced fingerlings of Indian major carp (Catla:Rahu:Mrigal 3:4:3) were released @ 10000 nos / ha during the month of August after preconditioning, Pre & post stocking management of water quality, recommended feeding practices, application of lime @ 200 kg/ha, use of turmeric powder along with lime at the ratio of 1:10 for twice at 30 days interval during the month of December and January as preventive measure for fish health were followed as per the guidelines of KVK Scientists.

Outcome in terms of production/productivity & net income:

Sri Sadasiba Jena could harvest an yield of 42.5 q/ha against 18q/ha in farmers practice with an %increase in yield 141% over farmers practice within a period of 10 months with a net return of Rs. 77,000/- over an expenditure of Rs. 25,000/ from his 1 Acre pond area.
Sri Sadasiba Jena now he becomes an example for the follow fish grower of the locality by proving himself successful entrepreneur in the field of pisciculture.

Outcome- Diffusion of technology in the similar area and their analysis:

During field day the said information along with the advanced technology spread to nearby farmers of Nimapara block. The villagers were very happy with the lucrative return from the pond. The villagers from nearby villages like sarbapada, Jageswarpur had a close look to this technological intervention for such profitable pisciculture.

Expenditure		Income
Item	**Cost**	
Fish fingerlings	Rs. 8000/-	All the ingredients are mixed and powdered. Mix with in water and cook for about 20 min and make in to dough/balls
Fertilizer (Cow dung + Urea + GNOC + SSP + Lime	Rs. 4000/-	
Feed (GNOC + Rice bran)	Rs. 12000/-	
Miscellaneous	Rs. 1000/-	
Total	**Rs. 25000/-**	
	Profit	Rs. 1,02,000 – 25,000 = Rs. 77,000
B:C ratio 4.08:1		

Impact:

Sri Sadasiba Jena now has become an example for the fellow fish growers of the locality by proving himself successful entrepreneur in the field of pisciculture. Now the composite fish farming is carried out in an area of 25 Acres in Nimapara block.

Release of fish fingerlings in the pond

Cast Netting / Sample Netting

Fish harvesting

Success stories: **Assam**

1. Ranjit Hazarika

Farmer:
Mr. Ranjit Hazarika
S/O Rupeshwar Hazarika
Village Chengmora Jarani
P.O. Kalabari
Dev. block. PUB-Chaiduar, Biswanath
Contact No.: 7399993980

Aquaculture activities :
In the year 2003 Mr. Hazarika started his business in Fishery Sector as a fish seed vendor. In the starting, Mr. Hazarika used to carry fish seeds from Barpeta, Nogaon and Rangia and distributed the same in Local areas. Then, he expanded his market areas and supplied the fish seeds to the entire Biswanath district and some of areas of Lakhimpur &Dhemaji District and as well as to Arunachal Pradesh. In the year 2007, he established his own farm with a 0.42 ha water area. Later on, Mr. Hazarika expanded his farm area. Now, his farm area is more than 3.50 ha with 3 nos. of Stocking tanks (1.2 ha), 10 nos. of rearing tanks(1.7 ha) and 4 nos. of nursery tanks (0.50 ha).At present, he practices Integrated Fish farming system i.e. Fish cum Goatery farming, fish cum Poultry/ducks, fish cum horticulture farming. Moreover, he encourages local youths to involve in Fish culture. As a result of this, today more than 20 hacter of water area ponds are available in his village. In addition to these, to acknowledge his effort towards fish farming and in order to produce quality fish seeds, an eco hatchery is in construction with 60% subsidy from the Deptt. Of Fisheries, Biswanath under Pradhan Mantri Matsya Sampada Yojana (PMMSY), 2021-22. The physical progress of the eco hatchery is 85% which will be operationalized in coming fish breeding season.

Nos./ Water area	Activities	Production	Cost of production	Sale	Income	Remarks
1.2 ha	Composite Fish Culture	6000 kg	2,00,000/-	@ 200.00/kg	12,00,000/-	
0.04 ha	Horticulture/ vegetables		8,000/-		20,000/-	
1.70 ha	Fish seed (Fry)	200 kg	15,000/-	@ 300/-kg	60,000/-	
0.70 ha	Fingerlings	2000 kg	1,00,000/-	@250/-kg	5,00,000/-	
10 nos.	Goatery	100 kg			40.000/-	
4 nos.	Diary	>10 liter/day			1,00,000/-	
	Poultry (Local variety)	Egg- 5000 Meat- 400 kg		5/egg 350/kg	25,000/- 1,40,000/-	
30 nos.	Duck	Egg-800 Meat- 30 Kg		7/egg 400/Kg	5600/- 12000/-	

Table: Resources, activities, production & income from farm


Fish farm Ranjit Hazarika

Eco-hatchery under PMMSY 2021-22

2. Bhargav Kr Bhagawati (Pabhoi Fish Farm)

Taking a right decision and working dedicatedly to achieve a dream make anyone to become a successful person. The perfect example is Bhargav Kr. Bhagawati, a youth from Pabhoi, Biswanath Chariali who has been doing exemplary work in the field of aquaculture. He is a perfect example of entrepreneurship development in rural Assam and is a role model for many youths aspiring to become a successful entrepreneur in the field of fisheries.

His journey before entering to this business was not smooth. Earlier after completing MBA in 1st class he worked for companies including MNCs for 5 years. But he has an entrepreneurial mindset and so didn’t find any spark in salaried job. His father is also a progressive fish farmer. So he decided to join his parental business in 2014. But taking this decision was not easy for him. By giving up a good salaried job and coming back to an interior place, from Delhi to Pabhoi to find his dream has never been easy. People made fun of him calling him mad and someone said that because of losing job he got back to home. But he already made up his mind to do something big and to prove everyone wrong. He visited many places and premier fishery institutes of India to gain knowledge about scientific fish farming and whole heartedly get involved in this business.

Mr. Bhagawati’s farm is known as “Pabhoi Fish Farm” that was established by his father Biren Bhagawati, a great personality and the most respected person among the fish farming fraternity. It is one of the leading fish farm in Assam in the present scenario. Bhagawati’s farm area including a lease land is around 19 hectares and he annually produces about 50crores fish spawn, about 100tons of fry-fingerling seed and about 20tons of marketable size fish. He is able to build up an ecosystem involving lots of farmers with his farm creating a profit making revenue earning model benefitting all the farmers. With his associate farmers their unit collectively produces 1000ton fish seed and 500 tons market size fish during this year. He has a strong distribution network. His farm produced seeds are sold to entire Assam and Arunachal Pradesh and some parts of Meghalaya and Nagaland.

Bhargav has been trying to commercially breed locally important high value fish like Magur, Pabda, Chital etc for last three years. He has recently established a large breeding unit of locally important fish species funded by NFDB and monitored by Dept. of Fisheries, Assam. He has achieved a tremendous success in breeding of Magur and Pabda. He has produced around 25000 nos magur seed and 30000 nos.pabda seed during this year. He targets to produce more than 100000 seeds of Magur and Pabda separately in the next year. He has also achieved a remarkable success in breeding of Chital fish in Biofloc Tank. Chital fish seeds are aggressive eater of flocs so survival of seeds is higher than that of traditional method. This year he is able to produce 25,000nos of Chital seed.

Pabhoi Fish Farm is known for quality seed, Training and Consultancy, Scientific management practices and Ethical business practices. He provides Residential and day long training. Bhargav has been invited to many institutes viz. Krishi Vigyan Kendras, Assam Agricultural University, College of Fisheries, AAU, Raha etc. Farmers, Students of College of Fisheries, Raha and other college students come to this farm for exposure visit and hands on training. Pabhoi Fish Farm has been doing many collaborative works with Dept. of Fisheries, Assam, Dept. of Fiheries, Arunachal Pradesh, DCFR, Bhimtal, Uttarakhand, KVKs located in Assam and Arunachal Pradesh, ICAR-IARI,Gogamukh,Assam, Assam Agricultural University (AAU), Jorhat, College of Fisheries (AAU), Raha, College of Fisheries (CAU),Tripura, NFDB-Regional Centre Guwahati, RARS(AAU), Shillongoni, Biswanath College, Rajiv Gandhi University(RGU), Arunachal Pradesh, Amity University, EDII(Entrepreneureship Development Institute of India), State institute of Rural Develoment (SIRD), Biswanath etc.

Bhargav is nourishing his farm so well that this Pabhoi Fish Farm is not simply a farm in present scenario, it becomes an institution known for working on societal development of people by the means of providing quality seed, imparting training and consultancy on scientific fish culture and creating new aquapreneurs in Assam and Northeast as well. Bhargav is perfectly doing what is ‘need of the hour’ i.e Rural Entrepreneurship development. For his remarkable work in the field of Aquaculture he was awarded as the best Fish Farmer of Assam on the occasion of the National Fish Farmer’s Day on 10th July 2022 at Tripura. The farm is always open for those who want to practice scientific fish farming as a profession thus helping rural economic development by the means of Fish Farming.

Magur breeding in newly constructed Magur hatchery

Pabda breeding and 22nd day raring seed

Officials of Dept. of Fisheries, Biswanath District visit to the place to see Chital breeding

Fish seed packing towards various destinations

Abbreviations

- L- Length
- B- Breadth
- m- meter
- Ha- hectare
- Kg- kilogram
- ppm- parts per million
- cm-centimetre
- Ltr- Litre
- °C- degree Celecious
- WSHG- Women Self Helf Groups
- GP- Gram Panchayat

Conversion table

1 inch	2.54 cm
1 m	3.3 feet
1 hectare	2.47 acre
1 degree celsius	33.8 fehrenheit
1 sq.m	10.76 sq. feet

Farmer Exercise Book

Farmer Exercise book

1. Which of the following is a sustainable fish farming approach?

a) No chemical & No antibiotic usage
b) Efficient usage of water resources
c) Careful and efficient approach in feed and nutrient usage
d) Create no harm to surrounding ecosystem
e) All the above

2. Which of the following soil type is best suited for an Aquaculture Pond?

a) Sandy soil
b) Clay Soil

3. Consequences of selecting a soil type with poor water holding capacity?

a) More pumping cost
b) Quick reduction in water depth
c) Unstable plankton levels
d) All the above

4. Select the Ideal water pH range from the below list suitable for fish farming.

a) 6.5-9
b) 9-11
c) 4-6
d) All the above

5. Select the ideal pond depth for fish farming from the following list.

a) 1.5 Meters
b) 0.6 to 0.8 Meters
c) 2 to 3 Meters
d) All the above

6. The basic qualities of a good pond dike

a) Resist the water pressure
b) Should be impervious
c) Should be high enough
d) All of the above

7. If the stocking density is 1 fish per m 2 , in 1 Acre (4047 m 2) the total number of fish required for stocking is 4047 number. If the stocking density is 2 fish per m 2, how many fish do you need to stock in 1 Acre pond?

a) 8094
b) 7022
c) 6054
d) 1500

8. If the seed cost per fingerling is Rs. 3.00, how much capital do you need to buy 3000 fish fingerlings?

a) Rs. 8,000.00
b) Rs. 9,000.00
c) Rs. 12,000.00
d) Rs. 6,000.00

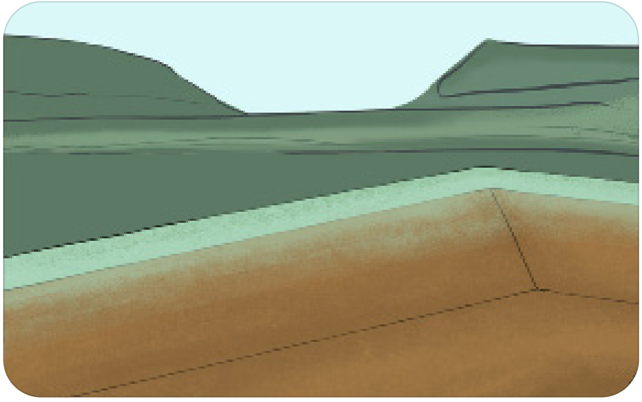
9. Identify Catla from the pictures below.

a)

b)

c)

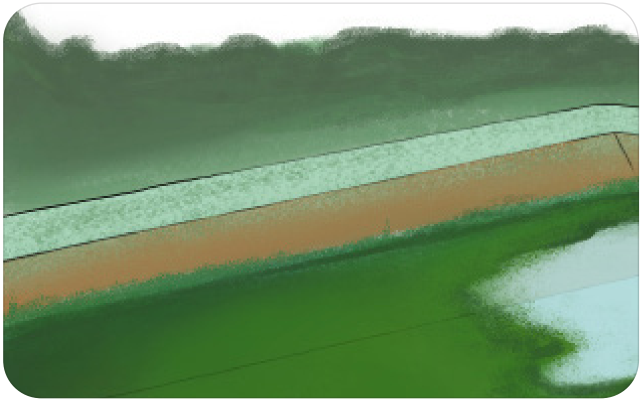
10. Which of the following picture shows a good fishpond plan?



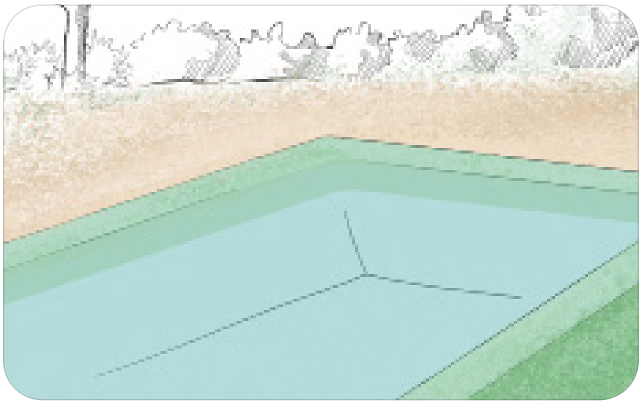
a)

b)

11. Identify the pond with poor water quality.



a)



b)

12. If you can stock 1500 fish per acre, how many fish do you need for stocking in 2.5 Acres?

a) 4000 Fish b) 3000 Fish c) 3750 Fish d) 2750 Fish

13. Identify the characteristics of good quality seed from the following.

a) Active movement, no physical damage, good pigmentation
b) Lethargic, injuries on the body, dull colour

14. If the average supplemental feed per day is 15 Kg, how much feed do you need for 200 days?

a) 2500 Kg b) 3000 Kg c) 3500Kg d) 1500 Kg

15. What will be the Feed Conversion Ratio if the cumulative supplemental feed volume is 4005 Kg and the harvested biomass is 1500 Kg?

a) 1:37 b) 1: 2.67 c) 1:1.75 d) 1: 2.77

16. If the operational expenditure for one culture cycle is Rs. 80,000 and the revenue generated after harvest and sale is Rs. 1,55,000, what is the profit margin?

a) Rs. 65,500 b) Rs. 75,000 c) Rs. 80,000 d) Rs. 1,05,000

17. If you spend Rs. 2,20,000 for pond construction, Rs. 50,000 for water pumping equipment, and Rs. 30,000 for manual labour for pond construction work like water lines, outlet and other infrastructure, what is your total capital investment cost?

a) Rs. 4,75,000 b) Rs. 3,00,000 c) Rs. 2,70,000 d) Rs. 2,50,000

18. If the total Capital expenditure for starting a fish new farm is Rs. 300,000, the average operational expenditure per cycle is Rs. 80,000 and the average profit per cycle is Rs. 75,000, how many culture cycles will it take to attain the ROI?

a) 3 Culture cycles b) 4 Culture cycles c) 2.5 Culture cycles d) 5 Culture cycles

19. If the prescribed Agriculture lime dose per 1 Acre per 3 feet water depth is 20 kg, how much lime do you need for a 2-acre pond with 6 feet water depth?

a) 90 Kg b) 80 Kg c) 120 Kg d) 40 Kg

20. The water transparency level of an aquaculture pond can be measured by

a) Secchi Disc b) Refractometer c) Plankton net d) Colour comparator

21. Which of the following Agri-byproduct can be used as a supplemental diet in fish farming

a) Paddy husk b) Dry Grass c) Rice bran d) Peanut hulls

22. If the water transparency level in a fish pond is less than 25 cm, how much fresh poultry manure can be applied per week?

a) 0 kg/Acre b) 4.5 kg/ Acre c) 10 kg/ Acre d) 6 kg/ Acre

Key: E. 2. B. 3. D. 4. A. 5. A. 6. D. 7. A. 8. B. 9. B. 10. A. 11. A. 12. C. 13. A. 14. B. 15. B. 16. B. 17. B. 18. D. 19. B. 20. A. 21. C. 22. A.

Sustainable Aquaculture

Grow Out Economics

Sustainable Aquaculture- Grow out Economics

Economical assessment before the investment is vital for the success of any business operation. The same principle applies to Aquaculture operations also.

- Study your market first, and identify the species which can fetch the best market price and more profit margin per kg fish production.
- The selected species should be able to grow well, giving the best possible production from the selected culture system which you want to adapt.
- Estimate the one-time capital investment cost for adapting the selected mode of the culture system. Look for ways to optimize the resources and investment costs.
- Estimate the running capital required for the selected fish species production from the selected mode of the culture system.
- Derive the net profit estimate.
- Estimate the Return On Investment (ROI) period, if the ROI value is amicable for you, it is a good choice to venture into aquaculture business operation.

Pre-Stocking Economics:

New pond construction cost:

Note: There is a considerable difference in construction cost between exclusive manual labour usage and manual & mechanical hybrid mode. In this economics estimate, we considered the hybrid mode. But for the convenience and knowledge of the user, we provided both details separately below. In some places, the possibility of using mechanical devices might not be possible, in those places manual mode is the only way.

Things to know- One-time investment or capital investment:

All the investments that need to be made to develop the infrastructure required for an aquaculture operation. Core components are,

1. If you want to purchase the required land, its acquisition cost needs to be considered as a capital investment cost. In the case of both own property or lease property, lease cost needs to be considered under operational expenses.

2. Pond construction cost.

3. Other infrastructure development costs like, warehouse, roads, power sourcing etc.

4. Equipment and tools purchase cost like, boat, nets, electrical motors, standby power generation systems, weighing scales, Secchi disk etc.

5. Don't try to keep every piece of information and every detail in your memory, you tend to forget a lot of information as time progresses.

Please maintain a pond record book, and update it regularly and promptly so that you don't lose any vital information. It will be helpful for you to assess past events and improvise your future deeds.

The following table was provided as an example of how a one-time capital investment cost can be calculated.

For example, calculations purpose the pond size and other dimensions are considered as follows:

Area: 1 Acre (4080 M^2)
Length: 65 Meter
width: 62.77 Meters
Total dike hight: 2 Meter
After compaction dike height: 1.8 Meters
Dike crust width: 2 Meters
Wet side dike slope: 2:1
Dry side Dike slope: 1.5:1
Water filling depth: 1.5 Meters

Sample Calculations					Your Farm's Economic Workings				
One time capital investment costs	**Component**	**Units**	**Cost per unit***	**Cost***	**One time capital investment costs**	**Component**	**Units**	**Cost per unit***	**Cost***
Asset acquisition cost	Land purchase cost	1 Acre	₹ 1,00,000.00	₹ 1,00,000.00					
	Lease cost	1 Acre	₹ 15,000.00	₹ 15,000.00					
	Soil quality & suit-ability assessment test	1 Acre	₹ 2,000.00	Rs. 2,000.00					
	Survey, drawing & topographical work plan	1 Acre	₹ 5,000.00	Rs. 5,000.00					
		A	**Total if purchased the land**	**₹ 1,07,000.00**					
		B	**Total if it is a lease the land**	**₹ 22,000.00**					
Construction cost for new pond	Clear vegetation in the site with bulldozer	1 Acre	₹ 2000.00/ hour x 4 hours	₹ 8000.00					
	Remove topsoil with bulldozer	816 M^3	₹ 2000.00/ hour x 12 hours	₹ 24,000.00					
	Build inlet pipe manually	1 M	₹ 600.00/M	₹ 600.00					
	Dig drainage canal	1.5 M^3	₹ 600.00/M	₹ 900.00					
	Drainage pipeline installation	15 M	₹ 300.00/M	₹ 4500.00					
	Build dikes	2500 M^3	₹ 2000.00/ hour x 30 hours	₹ 60,000.00					
		C	**Total**	**₹ 98,000.00**					

Sample Calculations					Your Farm's Economic Workings				
One time capital investment costs	**Component**	**Units**	**Cost per unit***	**Cost***	**One time capital investment costs**	**Component**	**Units**	**Cost per unit***	**Cost***
Infrastructure Development cost and others	Warehouse	100 M^2	₹ 300.00/ M^2	₹ 30,000.00					
Pumping system	5 Hp submersible pump cost	1	₹ 45,000.00	₹ 45,000.00					
Boat	1 M.T volume boat	1	₹ 10,000.00	₹ 10,000.00					
Others	Drainage pipes, cement, gravel etc	---	₹ 25,000.00	₹ 25,000.00					
		D	**Total**	**₹ 1,10,000**					
Value for farmer's time spent on the site	Farmer's time for planning and execution supervision	(96 hours) 15 days	₹ 1000.00/ 8hours	₹ 15,000.00					
		E	**Total**	**₹ 15,000.00**					
Total capital investment (For lease pond) B+C+D+E				**₹ 2,45,000.00**					
Total capital investment (For purchased pond) A+C+D+E				**₹ 3,30,000.00**					

*** Indicative values, need to be verified and replaced with local cost.**

Cost Variation between Manual Labour & Machinery:

With manual workforce:

Component	Units	Cost per unit	Workforce required	Time	Estimated units for calculation	Cost
Clear vegetation in the site	M^2	₹ 2.00/ M^2	4 people	4 people x 72 hours	4080 M^2	₹ 8160.00
Topsoil removal/storage (0.20 m)	M^3	₹ 36 / M^3	12 people	12 people x 68 hours = 816 hours (1M^3 /hour excavation & moving)	816 M^3 (for 4080 M^2 area)	₹ 29,376.00
Build inlet pipe	M	₹ 600.00/M	2 people	2 x 2 hours	1 M	₹ 600.00
Dig drainage canal digging 15 M long & 0.1 M^2 deep	M^3	₹ 600.00/M	2 people	2 people x 2 hours = 4 hours (0.75M^3 /hour excavation & moving)	1.5 M^3	₹ 900.00
Drainage pipeline installation	M	₹ 300.00/M	4 people	4 people x 8 hours = 32 hours	15 M	₹ 4500.00
Build dikes (65 M length x 62.77 M width x 2- meter hight and 2-meter crust)	M^3	₹ 36/M^3	36 people	36 people x 70 hours (1M^3/hour excavation & moving)	2500 M^3	₹ 90,000.00
					Total	**₹ 1,33,536.00**

With machinery & manual combination work:

Clear vegetation in the site	M^2	₹ 2000.00/ hour	1 Bulldozer	4 hourst	4080 M^2	₹ 8000.00
Topsoil removal/storage (0.20 m)	M^3	₹ 2000 / hour	1 Bulldozer	12 Hours (excavation & moving)	816 M^3 (for 4080 M^2 area)	₹ 24,000.00
Build inlet pipe	M	₹ 600.00/M	2 people	2 x 2 hours	1 M	₹ 600.00
Dig drainage canal digging 15 M long & 0.1 M^2 deep	M^3	₹ 600.00/M	2 people	2 people x 2 hours = 4 hours (0.75M^3 /hour excavation & moving)	1.5 M^3	₹ 900.00
Drainage pipeline installation	M	₹ 300.00/M	4 people	4 people x 8 hours = 32 hours	15 M	₹ 4500.00
Build dikes (65 M length x 62.77 M width x 2- meter hight and 2-meter crust)	M^3	₹ 2000/hour	1 Bulldozer	30 hours (excavation & moving & compaction)	2500 M^3	₹ 60,000.00
					Total	**₹ 98,000.00**

On-Stocking Economics:

On-stocking economics involves the recurring or operational expenses involved in pond preparation like liming, water filling, manuring, seed purchasing and stocking cost. These expenses get repeated for every culture cycle.

Sample Calculations					Your Farm's Economic Workings				
Recurring or operating costs	**Component**	**Units**	**Cost per unit***	**Cost**	**One time capital investment costs**	**Component**	**Units**	**Cost per unit***	**Cost***
A. Pond Preparation Cost									
Liming	Agriculture Lime	100 kg	₹ 7.00/kg	₹ 700.00					
	Ag lime application cost	1 X 1 hour time	₹. 200.00/hour	₹ 200.00					
Pumping Cost	5 Hp pumping cost to fill the pond (8 days' time)	716 units	₹ 3.00	₹ 2,148.00					
Manuring	Manure purchase cost	1200 Kg	₹ 5.00/kg	₹ 6,000.00					
	Manure application cost	2 X 2 Hours	₹ 200.00/hour	₹ 800.00					
		A	**Total**	**₹ 9,848.00**					

Sample Calculations					Your Farm's Economic Workings				
Recurring or operating costs	**Component**	**Units**	**Cost per unit***	**Cost**	**One time capital investment costs**	**Component**	**Units**	**Cost per unit***	**Cost***
B. Seed stocking cost	Seed purchase cost	1500 fish	₹ 2.00	₹ 3,000.00					
	Seed transportation cost	1 vehicle	₹ 3000.00	₹ 3,000.00					
	Seed stocking cost (Resources)	2 vehicle	₹ 300.00	₹ 600.00					
	Farmer's work-hour cost	6 hours	₹ 200.00/hour	₹ 1,200.00					
B.	**Sum of all expenses incurred for the stocking of fish seed in the pond**			**₹ 7,800.00**					

On-Stocking recurring expenses total (A + B) = ₹ 9,848.00 + ₹ 7,800.00 = ₹ 17,648.00

Post-Stocking Economics:

Post stocking expenses involves all the expenditure that you make to grow your fish after stocking the seed until they are being harvested and sold.

Sample Calculations					Your Farm's Economic Workings				
Recurring or operating costs	**Component**	**Units**	**Cost per unit***	**Cost**	**One time capital investment costs**	**Component**	**Units**	**Cost per unit***	**Cost***
C. Water quality assessment kit cost	Water quality test kits (pH, Ammonia, Nitrite, nitrate, alkalinity)	1 (100 tests each)	₹ 3500.00	₹ 3500.00					
D. Periodic Liming cost	Ag lime purchase cost	20 kg x 8=160 Kg*[2]	₹ 7.00/kg	₹ 1120.00					
	Ag lime application cost	8 x 1 hour time	₹ 200.00/hour	₹ 1600.00					
E. Periodic manuring cost	Manure purchase cost	200 kg x 16 applications =3200 kg*[3]	₹ 5.00/kg*3	₹ 16,000.00					
	Manure application cost	16 applications	₹ 200.00/hour	₹ 3200.00					
F.Supplementary feed cost*[4]	DORB purchase cost	480 Kg (32% of target biomass)	₹ 14.00/kg	₹ 6720.00					
	Oil cakes purchase cost	120 Kg (8% of target biomass)	₹ 35.00 /kg	₹ 4200.00					
	Used bags cost	25	₹ 10.00/bag	₹ 250.00					
	Feed application cost	60days*[5]	₹ 200.00/hour	₹ 12,000.00					
G. Sampling cost	Monthly sampling cost	8 times	₹ 500.00/hour	₹ 4000.00					

Sample Calculations					Your Farm's Economic Workings				
Recurring or operating costs	**Component**	**Units**	**Cost per unit***	**Cost**	**One time capital investment costs**	**Component**	**Units**	**Cost per unit***	**Cost***
H. Expert advice &/or lab assessment cost	Consultation cost	4 times	₹ 1500.00/visit	₹ 6,000.00					
I. Harvesting cost	Harvesting gear rental	1 seine net	₹ 1500.00/ Day	₹ 1500.00					
	Harvesting workforce	7 people	₹ 600.00/ half day	₹ 4200.00					
J. Value for farmer's time	Work-hour spent by farmer on farm	@ 1 hour/day x 240 days =240 hours	₹ 200.00/hour	₹ 48,000.00					
i) Total post stocking expenses (Sum of C+D+E+F+G+H+I+J)				**₹ 1,12,290.00**					
ii) Total On-Stocking expenses (A+B)				**₹ 17,648.00**					
iii) Sum of all operating expenses (A+B+C+D+E+F+G+H+I+J)				**₹ 1,37,738.00**					
iv) Land lease				**₹ 15,000.00**					
v) Sum of all investments made for the complete culture cycle				**₹ 1,52,738.00**					
vi) Harvested biomass value	@ 1 kg body weight with 100% survival estimate	1500 x 1 Kg= 1500 Kg	₹ 120/ Kg farmgate price	₹1,80,000.00					
One culture cycle profit margin = (VI-V)				**₹ 27,262.00**					

*[2] This is an estimation for demonstrating the economics part based on the need of your farm, application necessity and dosage needs to be decided. Estimated at the rate of 20 kg / Acre / month and an estimate of 8 months of culture period.

*[3] Application volume, number of applications and unit price are indicative, considered for the purpose of calculation, actual manuring dose needs to be decided as per the individual pond requirement and price of the manure also needs to be amended as per your local cost.

*[4] Total supplementary feed usage volume is estimated @ 40% of the total target biomass of 1500 kg and the DORB and Oil cake ratios are 80% and 20% respectively.

*[5] While calculating the supplemental feed application cost, the total days of supplemental feed application was calculated only for 60 days considering its usage extensive farming system, in case of semi-intensive system it needs to be corrected as per the actual application days. If the productivity of the pond is good, there might be no need to use supplementary feeds and that cost component can be deducted from the expenses.

* In the case of leased ponds, land lease needs to be considered under recuring expenses.

* Expenses like disease treatment and other incidental expenses which are case specific are not mentioned in this estimate model, if such expenses are there, they need to be counted under recuring expenses.

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