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Training Manual on Improved Carp/Carp-Shing Poly Culture in Pond and Dyke Cropping

September 2011

Cereal Systems Initiative for South Asia in Bangladesh (CSISA-Bangladesh), WorldFish Center

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Training Manual on Improved Carp/Carp-Shing Poly Culture in Pond and Dyke Cropping

A Course Manual for Fish Farmers

Preface

Due to inadequate technical knowledge and training in advanced methods of gradually growing carp poly culture, framers are not getting expected yield. From the very beginning of the CSISA-BD project, WoldFish Center has taken initiative to introduce advanced methods in carp poly culture. To do this, the shortage of skilled trainers and training materials, has, particularly, been realized. Presently, a number of manuals on carp poly culture from Department of Fisheries, Bangladesh Fisheries Research Institute, WorldFish Center and different GOs and NGOs are available. The training manual on 'Improved Carp/Carp-Shing Poly culture in Pond and Dyke Cropping' has been developed by the World Fish Center based on practical experiences from field level and with the help of other published manuals and taking into account various environmental and socioeconomic challenges the fish farmers may have to cope with.

The manual 'Improved Carp/Carp-Shing Poly Culture in Pond and Dyke Cropping' is well-suited to the training need of extension workers and fish farmers. Extension workers and fish farmers would be benefited from the manual during project period. The manual can further be enriched in the light of outcomes and experience from filed. It is hoped that different GOs, NGOs and individual would be able to play active role in manpower development and boost up fish production of the country by effective use of the manual.

We are indebted to all the people and organizations associated directly or indirectly with the preparation and publication of the manual.

Subject Contents

Training Manual on Improved Carp/Carp-Shing Poly Culture in Pond and Dyke Cropping

Introduction to the Manual and its Application

Carp poly culture in the ponds allover the country and ghers in the south-west is getting highly popular. However, due to lack of technical knowledge and ambiguous ideas most of the farmers are not getting expected yield. Even many are loosing money in carp farming. With particular emphasis on this, the training manual 'Improved Carp/Carp-Shing Poly Culture in Pond and Dyke Cropping' has been prepared by CSISA-BD Project. We are hopeful that the manual would play a unique supporting role in the improvement of the carp / carp-shing farming management in ponds and ghers of the farmers.

Duration of the Training

The manual has been developed for a 2-day fundamental training course. However depending on the actual need of the trainees, timetable can be modified within training duration of the two days. In general the daily programme should be continued from 10 am to 14 pm. The venue of the training should be in an area where farmer live or near to the tilapia pond or gher.

Training Methodology

Most of the learning matters should be accomplished using participatory approach. Here, ample opportunities would be given to farmers to exchange their own experience, so farmers can easily take part and achieve effective learning. The following experience-based participatory approaches will be used in each of the sessions -

1. Brain-storming,
2. Group Discussion,
3. Open Discussion,
4. Event Analysis,
5. Real Objects and Practical Demonstration,
6. Speech-Discussion, and
7. Question and Answer

Number of Trainees

Maximum 25 trainees can take part in the training. Because, the way the participatory techniques have been designed, if the number of trainees are more than 25, the problems may arise in effective communication between trainers and trainees. Mainly the manual has been designed for target farmers under CSISA-BD project.

Role of trainers in training

The role of trainers in participatory training is mainly creating learning environment so the trainees can learn by spontaneous participation. A trainer is a facilitator and at the same time a learner. In the process of blending learning maters with the knowledge and experience of the trainees, trainers will learn many things and at the same time will assist to provide right knowledge by amending many ideas. This way, the trainees and trainers will augment the training process as complementary of each other and assist in achieving learning goals.

Training Theme and useful instruction

The topics of the training have been determined in the light of practical need of the farmers at the field level and on the basis of evaluation and recommendation from the experts. In the different session planning, subject-oriented handouts are given in this manual. By reading the handouts, the trainers will enrich themselves, which in turn assist the trainees in participating in thematic discussion. Different subject matters are arranged chronologically. Running the session becomes easy if the trainers prepare themselves by assessing the session planning thoroughly well-ahead the training commences.

Using the Training Manual

To implement a successful dynamic programme, crafting individual with necessary knowledge and skill is crucial. Precondition of this is training. Traditional training is just the wastage of time in improving the knowledge and skill of the trainees. To maintain the quality of training, the apposite use of the training manual is essential.

All the direction on the use of the manual properly and effectively by the trainers and the trainees have been described. Following duties and responsibilities need to be undertaken to achieve the objectives of the manual.

1. Before the start of the session, the trainer should read through the session plan carefully. This will help the trainer to run the session properly
2. Handout given with each session needs to be thoroughly studied. To maintain the sequence of subject matter and discussion, pre- arranged flip-chart should be used.
3. Needless to say that the manual is only an instruction device. Therefore, trainer should run the session with necessary adjustment based on the knowledge and experience of the trainees.
4. Training methodologies and technicality of each session are described in detail. These have been selected to ensure active participation of the trainees in the training. Following the methods will be ensure the participation and expected outcomes of the session will be achieved.
5. The training sessions are arranged in sequence. Necessary information will be discussed within fixed time in each session. If necessary the trainer, in light of his/her own experience, can change or modify the session keeping main topic as it is. However timely starting and ending the session is good both for trainers and trainees.
6. Assessing the success of the training programme is important for both trainers and trainees. Therefore learning of the trainees should be evaluated during the training.
7. The manual is a valuable resource. Please preserve it carefully. At present and in future the manual will act as a reference.

Learning Environment

A primary object of the training is to create lively environment. The issue of learning environment is even more important as a supporting tool. Lively learning environment is such an environment where every trainee will actively take part in discussion and comment on. Facilitator will take the responsibility to ensure this. The trainer will be keen to know the expectation, thinking and reaction of the trainees. The active participation of the trainees should be ensured and their experience and comment should be given priority. This way, a lively atmosphere will be created in the training. The following guidelines can be followed to ensure a good learning environment and to make it bubbly.

Training guidelines:

1. To be respectful to all others
2. To maintain gentle manner and impartiality
3. To give due priority to comments made by other, because something really good can come out from the discussion
4. To ensure the participation of each and every one particularly the silent ones
5. To be good listener i.e., more listening and less uttering
6. To be careful about talking (side-talking, whispering) each other by the participants during discussion
7. To create environment so the trainees can talk one by one. If everyone speaks at the same time, nothing can be heard / understood.
8. To be patient and sympathetic.
9. To be careful about sensitive issues.
10. To keep faith / confidence on the knowledge and experience of the trainees
11. To become fellow / coworker so the trainees do not hesitate to speak out
12. To confess frankly if something is not known

Improved Carp/Carp-Shing Poly Culture in Pond and Dyke ropping Training Course

Timetable

Duration: 2 days

Day	Time	Subject matter/Theme
1	10.00-10.30	Inauguration-Registration and Course Introduction
	10.30-11.15	Basic Problems of Fish Culture
	11.15-12.00	Fish Culture Management and Preliminary Activities
	12.00-12.15	Tea Beak
	12.15-13.00	Cultivable Fishes in Carp/Carp-Shing Poly Culture and Management during Stocking
2	13.30-14.00	Post-stocking Management
	10.00-10.30	Repeat Discussion of the Day Before
	10.30-11.15	Sampling, Harvesting-Restocking and Marketing
	11.15-11.45	Vegetable Culture on Pond Dyke (to be continued)
	11.45-12.00	Tea Break
	12.00-13.30	Vegetable Culture on Pond Dyke
	13.30-14.00	Economic Analyses of Fish and Vegetable Farming and Data Keeping

Group Session Planning

Day – 01	Time – 10.00	Duration – 30 min

Target Group : Carp/Carp-Shing Farmers
Title of the Session : Inauguration-Registration and Course Introduction
Goal : To inaugurate training course on Carp/Carp-Shing poly culture and management so trainees and trainers will be known to each other and they will get a positive idea about the course

Objectives : **At the end of the session**
- Trainers will be introduced with trainees and trainees will have optimistic notion about the course
- Trainees will register their names in the particular forms of the course
- Trainees will be able to speak their expectation from the course timetable and course
- They will be able to speak about course regulation, different activities and their effectiveness
- They will be able to speak overall goal and objectives of the course

Subjects to be discussed in the session	Training method	Time
Welcome: Welcoming the participants, exchange of greetings and sitting arrangement	Speech	
Subject matter		25 min
Distribution of training materials and registration • Notebooks, pens etc. should be distributed among the participants • Registration of the name of participants in particular form **Knowing each other** • Trainer will introduce himself/herself to the trainees through chatting and discussion **Inauguration of the training course** • One of the participants will recite from the Holy Quran and/or narrate from the Gita/Bible • Welcome address from the participants • Welcome address from the trainer and inauguration of the course **Determination of the training expectations** • Trainer will know the training expectation of the trainees **Course timetable** • Trainer will distribute the timetable and explain queries (if any) about timetable • Course guideline • Trainer will explain the importance of course guideline and rules of writing guideline, and fix the VIP card written by the trainees after compiling or guideline written on poster paper on the board **Overall goal and objectives of the course** • Trainer will read out the handout with course goal and objectives and will explain	Speech Discussion Individual activities VIP card	
Summary		3 min
Vote of thanks by the trainer to the invited participants	Question answer	

Linking with next session:

Training materials Banner, registration form, training materials for distribution, timetable

Improved Carp/Carp-Shing Poly Culture in Pond and Dyke Cropping

Training Course

Goal and Objectives of the Training

Training goal

To improve the knowledge and skill of participants on carp/carp-shing poly culture in pond and dyke cropping so they can get more yields from carp/carp-shing poly culture in pond and dyke cropping

Overall objectives

- At the end of the course the trainees will be able to explain the following aspects –
- Basic fish culture concept
- Biology of the cultivable species in carp poly culture
- Carp poly culture management
- Different fish culture methods
- Carp poly culture planning and data keeping
- Economic analyses of carp poly culture
- Vegetable farming in pond dyke and economic analyses

Group Session Planning

Day – 01	Time – 10.30	Duration – 45 min

Target Group : Carp/Carp-Shing Farmers
Title of the Session : Basic aspects of fish culture
Goal : The trainees will get clear ideas on types of fish culture, methodologies, ponds, soil and water quality, good fry, investment in fish culture etc. so realizing the importance of the said aspects they will be able to increase fish production in their ponds using advanced technology

Objectives : **At the end of the session**

- Trainees will be able to speak on the types and methods of fish culture
- Trainees will be able to explain the classification of ponds and the features of a good pond
- Trainees will be able to explain the role of soil and water quality in fish culture
- Trainees will be able to speak on the aspects need to be considered in new pond excavation
- They will be able to identify and stock the good and improved quality fish fry
- They will be able to determine the investment necessary for fish culture

Subjects to be discussed in the session	Training method	Time
Introduction		2 min
1. Welcome: Welcoming the participants and exchange of greetings 2. Repeat discussion of earlier session 3. Linking with present session 4. Explaining the objectives of present session and worlds of encouragement	Discussion Question answer	
Subject matter		40 min
1. Fish culture, culture types and methods 2. The classification of the ponds and features of a standard pond 3. The role of soil and water quality in the fish culture and the merits and demerits 4. The excavation of the planned new pond to ensure the environment for fish culture 5. Identification of good quality fry 6. The availability and amount of funding in fish culture	Question answer Speech Flip chart	
Summary		3 min
1. Review of the major points 2. Verification of the Objective • What do you understand by fish culture? • What are the features of a standard fish pond? • What are the roles of the soil and water in the fish culture? • What are the ways to identify good fry? 3. Distribution of the handouts	Question answer	

Linking with next session:

Training materials Flip cart, white board, marker and handout

Planning of the flip chart

(Please follow the handout for detailed description)

<table>
<tr>
<td>Basic aspects of fish culture</td>
<td>Comparative discussion of the different fish culture system:
<table>
<tr><th>Culture management systems</th><th>Requirement of natural food (%)</th><th>Requirement of supplementary food (%)</th></tr>
<tr><td>Extensive system</td><td>100</td><td>0</td></tr>
<tr><td>Improved extensive system</td><td>70</td><td>30</td></tr>
<tr><td>Semi intensive system</td><td>50</td><td>50</td></tr>
<tr><td>Intensive system</td><td>0</td><td>100</td></tr>
</table></td>
</tr>
<tr>
<td>Five aspects pertinent to fish culture :
• Pond
• Water
• Environment
• Fish seed
• Investment</td>
<td>A. Classification of the ponds based on use
1. Fish fry pond
1.1. Nursery pond
1.2. Rearing pond
2. Stocking (grow out) pond
B. Classification of the ponds based on water retention capacity
1. Perennial pond
2. Seasonal pond</td>
</tr>
<tr>
<td>What is fish culture ?
Fish culture is the production of more fish than the normal through gradual application of different techniques to produce natural food for fish in the water and/or through the application of supplementary feed from external sources.</td>
<td>Things should be considered in the site selection of ponds
1. Location 2. Type of soil
3. Area 4. Depth
5. Pond slope 6. Dyke
7. Free of Aquatic weed 8. Openness
9. Free of pollutant from industries and factories</td>
</tr>
<tr>
<td>Types of fish culture :
Monoculture Poly culture
Cage culture Integrated fish culture
Floodplain fish culture Pen culture</td>
<td>Pond slope based on soil type
<table>
<tr><th><u>Type of soil</u></th><th><u>Slope</u></th></tr>
<tr><td>Clay</td><td>1 : 1.5</td></tr>
<tr><td>Silt</td><td>1 : 1.5</td></tr>
<tr><td>Sand</td><td>1 : 2-3</td></tr>
<tr><td>Loam</td><td>1 : 2</td></tr>
</table></td>
</tr>
<tr>
<td>Fish culture methods
Extensive culture method
Improved extensive culture method
Semi intensive culture method
Intensive culture method</td>
<td>If soil and water quality of ponds are not optimum :
• Natural food of fish will not be produced in sufficient quantity
• Supplementary feed will be wasted
• Fish growth will not be as expected
• Fish may die from diseases
• Fish production will be less than normal</td>
</tr>
</table>

Basic Aspects of Fish Culture

There are five aspects – 'Pond', 'Water', 'Environment', 'Fish seed' and 'Investment' very closely related with fish culture. Only the integrated and proper management of the said aspects can ensure advanced and profitable fish culture. To understand the importance of the five aspects, first we have to know what fish culture is – which is described here.

Fish culture, culture types and methods

Fish culture

• Generally it can be said that the fish culture is the application of the different techniques to produce more fish from a unit area of water body than what is normally obtained. The techniques are nothing but proper management of Pond', 'Water', 'Environment', 'Fish seed' and 'Investment' for profitable fish culture.
• Again according to environmental scientist and Food and Agricultural Organization (FAO), fish culture is the gradual application of different techniques to produce natural food for fish in the water. In this case, the major aspects of producing natural food for fish are the proper management of pond and water. As a result the environment of natural food production for fish and maximum use of fish seed and investment will be ensured.
• Fish culture is the production of more fish than the normal through gradual application of different techniques to produce natural food for fish in the water and/or through the application of supplementary feed from external sources. In this case, proper management of' Pond', 'Water', 'Environment', 'Fish seed' and 'Investment' can be noted.

Type of fish culture: Some of the traditional and profitable fish cultures are described here.

Monoculture: When only one species of fish or shrimp / prawn is cultured in a water body, the culture method is known as monoculture. e.g. only tilapia or golda prawn or magur or Thai pangus culture in a pond. In general, fish are cultured commercially following this method under intensive management system. In this case, fish farming is not much dependant on natural food. Through the application of well-balanced diet / food, fish with high market price are cultured. However, even under the commonly practiced management system, fish are farmed using monoculture method in the seasonal pond of our country.

Poly culture: When more than one species of fish are cultured in a water body, the culture method is known as poly culture. Considering the optimal use of the natural food items present in the water body, fish of different species are stocked in a water body. In this case, the stocked fish, generally are of different food habits. Under regular management system, higher yield is obtained from poly culture than that from monoculture. e.g. poly culture of rohu, mrigal and catla, silver carp, Thai sarpunti and common carp etc together.

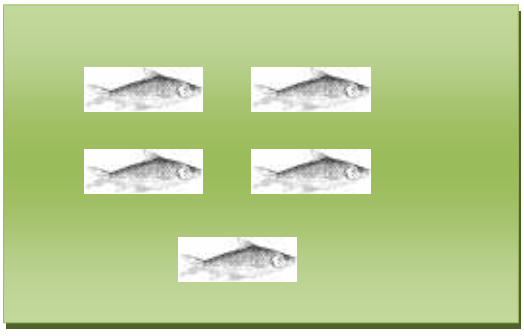


Figure: Monoculture

Figure: Poly culture

Fish culture in cages: Fish culture in cages is relatively a method of fish farming in Bangladesh. However, cage fish culture is an age-old practice in some countries of Asia such as Indonesia, China, Thailand, the Philippines, Vietnam and Nepal. Fish monoculture can be performed in the cages made from easily available materials found locally in any kind of open waters – beels, canals, rivers, streams and floodplain. In general, cage is suitable for monoculture of fish. However poly culture of some fish species can also be carried out in cages. Though this type of fish culture fully depends on the application of the balanced diet / feed, fish culture in cages may also be profitable using feeds available free of cost or very low cost feed. There is no need of huge investment in cage culture. Therefore, the future of cage culture in our country is very promising in many water bodies of our country.

Figure – Fish culture in cage

Integrated fish culture: Integrated fish culture is farming of more than one crop concurrently in a water body to ensure maximum production maintaining the balance of the environment. Such as fish culture in rice fields, Poultry cum fish culture, vegetable farming in the pond dyke, fish and livestock culture etc. Te basic principle of iterated fish culture is the incorporating different agro-farming like duck, chicken, livestock, vegetables and other crops with fish culture. In this instance, the input cost of fish culture substantially decreases and on the other hand, one or more extra crops are obtained along with fish. Though recently integrated fish culture has been discussed a lot, the culture has traditionally been practiced more or less in Bangladesh and other Asian countries since a long time ago. Integrated fish culture should be expanded fast and made popular to boost up the agriculture dependant economy of our country.

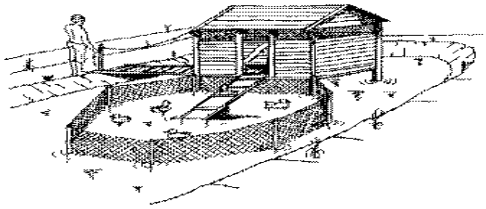


Figure – Integrated farming of fish and duck

Fish culture in pen in the floodplain: Fish culture in pen or gher is the management of stocked fish in an area of floodplain encircled from one or more sides by bamboo frame, other fencings or nets. The feature of this type of fish farming is the base of the fence is planted in the bottom mud of waterbody and the water of the pen is well-connected with the water outside (water flow between pen and floodplain). The fish culture in the pen is not a very old practice. The pen culture technology expands during the third decade of the last century, at first in Japan, later on in China and other Asian countries. Recently countries like the Philippines, Indonesia, Thailand and Malaysia have widely been using the pen culture technology for commercial fish production. The commercial fish culture in pens has huge potential even in Bangladesh.

Figure – Fish culture in pen

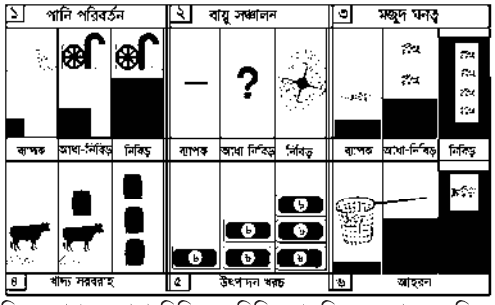
Multi species poly culture is more profitable in the pen as in ponds or other closed water bodies. Nevertheless, the fish production and profit solely depend on selecting right species composition and stocking density, survival rate and culture management. Per ha 2.96 tons and 5.4 tons of fish production have been yielded, respectively, in 1991 and 1992 by Bangladesh Fisheries Research Institute, Riverine Center, Chanpur from experimental poly culture of carps in irrigation canals using semi intensive fish culture method.

Fish culture methods

Fish culture method is to ensure fish growth using different tools and techniques properly in scientific way to produce fish at the maximum sustainable level. The main objective of the management is the profitable yield by integrating the basic features of aqua production 'pond', 'water', 'environment', 'fish seed', 'investment' and labour for profitable fish culture. Due to different type of integration of the required tools and techniques, fish culture is of four types. The types are described here –

a. Extensive fish culture system: Fish are cultured under this type of management with virtually no cost or very little cost. Only a few fish fry are released in the pond. No fertilizer or supplementary feed are used in the pond, fish fully depend on natural food present in the pond. Besides, neither any initiatives are taken nor any technological aspects of fish farming are considered in extensive fish culture method. As a result, only 1-2 kg fish per decimal are produced annually. Example can be given as releasing fish in the pond without any calculation and not following gradual stages of fish culture and harvesting fish irregularly.

b. Improved extensive culture system: A little improved culture management, where fish are stocked at relatively low density after removing aquatic weed and weed fish / predatory fish. In addition to irregular fertilizer and feed application, other activities of planned fish culture are also performed irregularly. Presently, this type of culture management is most common practiced. In the improved extensive culture method fish production is 5-12 kg / dec annually.



চিত্র- ব্যাপক, আধা-নিবিড় ও নিবিড় পদ্ধতির তুলনামূলক চিত্র

1. W ater exchange			2. Aeration			3. Stocking density		
Ext ensive	Semi intensive	Intensive	Extensive	Semi intensive	Intensive	Extensive	Semi intensive	Intensive
4. Food supply			5. Production cost			6. Harvesting		

c. Semi intensive culture system: In the semi intensive culture system, the necessary renovation of the water body, complete control of predatory and weed fish, medium stocking density, regular fertilizer and hand made feed application, partial harvesting and restocking after 3-4 months of fry stocking and if necessary water exchange and supply of oxygen (aeration) are performed. That is, some modern technologies of fish culture are followed under semi intensive culture system. Under this type of culture management, per decimal annual fish production may reach 15 – 30 kg or even more.

d. Intensive culture system: The culture of fish using very advanced technology after costly infrastructural restoration as necessary is known as intensive culture system. It requires high investment and rigorous labour. Although intensive culture system is highly profitable, however, it has high risk with potential negative impact on the environment.

A comparative scenario of feed application under four types of culture systems is given here:

Fish culture management system	Requirement of natural food (%)	Requirement of supplementary / balanced food (%)
Extensive system	100	0
Improved extensive system	70	30
Semi intensive system	50	50
Intensive system	0	100

Comparative illustration of different culture systems

Culture system	Different activities of fish culture					
	Pond praparation	Stocking density	Fertilizer application	Feed application	water / oxygen supply	Fish harvesting
Extensive system	Weed fish and aquatic weeds are not removed	Uncontrolled	No fertilizer are applied	No fish feed are applied from external resources	No oxygen is supplied	Irregular harvest
Improved extensive system	Weed fish and aquatic weeds are removed	Semi controlled	Fertilizers are applied irregularly	Fish feed are applied irregularly	No oxygen is supplied	Fish harvest several times a year
Semi intensive system	Weed fish and aquatic weeds are removed	Controlled	Fertilizers are applied regularly	Fish feed are applied regularly	Oxygen is supplied if necessary	Fish are partially harvested with irregular restocking several times a year
Intensive system	Complete removal of weed fish and aquatic weeds	Controlled with high stocking density	No fertilizer are applied	Balanced diet / feed are applied	Full time arrangement for oxygen supply	Fish are partially harvested with regular restocking several times a year

The classification of the fish ponds and features of a standard pond

Pond: Ponds are earthen container where water is available in a controlled or uncontrolled way. Fish are cultured in this very water using different technologies for fish farming. Based on the type of fish culture in the ponds and the water retention capacity ponds can be classified in to following types –

A. Classification of ponds based on use -

1. Fry pond: The ponds where spawn are cultured up to fingerling are knows as fry pond. Again fry ponds are of two types. Nursery pond and rearing pond

1.1. Nursery pond: The ponds where spawn are stocked at high density and reared up to more or less 1.5 inch fish fry are known as nursery ponds. The area of nursery pond should be 5 – 15 dec with a depth of 3 - 3.5 feet.

1.2. Rearing pond: The ponds where fry are reared up to fingerlings (4 – 6 inch) are known as rearing ponds. The area of rearing pond should be 10 – 35 dec with a depth not more than 4.5 – 5 feet.

2. Stocking or grow-out pond: The ponds where fry or fingerlings (4 – 6 inch) are released and reared up to food fish of marketable size large fish are known as stocking pond. The area of stocking pond should be 30 – 50 dec with a depth 6 – 7 feet.

B. Classification of ponds based on water retention capacity -

Ponds are divided in to two types based on how long ponds can retain water. Such as - 1. Seasonal pond and 2. Perennial pond.

1. Seasonal pond: The ponds that can retain water for fish culture for a minimum of five months are known as seasonal ponds. The ponds can be different types - shallow, deep, small, large and with or without dyke. Nilotica, sarpunti, golda, prawn, Chinese carps and fry of different fishes can be cultured in seasonal ponds.

2. Perennial pond: The ponds that can retain water for fish culture (minimum 3 feet) round the year are known as perennial ponds. All kinds of fish can be culture in this type of ponds, however, poly culture of carps is better.

Standard fish pond

Site selection for pond: The pond is the only habitat for cultured fish. Therefore pond should be suitable for living normal life of fish and their growing. The features of a standard fish pond are described here

চিত্রঃ আদর্শ পুকুর

1. Location: Connected to the homestead of the fish farmers or some place nearer

2. Type of soil: The soil suitable for carp poly culture should be brownish loam soil.

3. Area: 30 – 50 decimal and rectangular

4. Depth: 5-7 feet depth is anticipated

5. Pond slope: The slope of a standard pond should be from 1 : 1.5 to 1 : 1.2.

6. Dyke: Pond dyke should be complete and elevated to flood water can not enter in to the pond

7. Free of Aquatic weed: A standard pond should be free of aquatic weed and shadow producing large tree and tree branches

8. Openness: The ponds should be located in an open space so it gets the sun light round the day and pond water comes to the tough of enough air (oxygen)

9. Free of pollutant from Industries and factories: The pond should be located in such an area so pollutant from nearby or distant industries and factories.

Pond slope based on soil type

Type of soil	Slope
Clay	1 : 1.5
Silt	1 : 1.5
Sand	1 : 2-3
Loam	1 : 2

Pond selection technique in fish culture

Old ponds: Profitable fish culture mostly depends on pond selection. In this instance, the following check list might be helpful. You can decide your activities after filling the check list maintaining high impartiality.

Items need to be checked	10 marks	√ Tick mark	5 marks	√ Tick mark	Marks less than 5	√ Tick mark
Owner shi p of the pond	Single ownership		Owned by two		Multi ownership	
Duration of lease (if any)	More than 5 years		3 – 5 years		Less than 3 years	
Flood condition	Free of flood		Twice in 10 years		Flooded – under the flood level	
Average depth of water	1 – 2 m		0.5 – 1 m		Seasonal	
Types of soil	Loam		Silt		Sand	
Amount of bottom mud	Less than 10 cm		10 – 15 cm		More than 15 cm	
Large trees on the dyke	No trees		A few trees		Shady (dark)	
Daily sun light	7 – 8 hrs		5 – 6 hrs		3 – 4 hrs	
Area of pond	20 – 25 dec		10 – 20 dec		Less than 10 dec	
Slope of pond	1 : 2		1 : 1.5		1 : 1	
Availability of fish seed	Very easily available		Easily available		not easily available - inaccessible	
Location of the pond	Close to the homestead		Within 500 m of the omestead		Far from the homestead	

Based on the pond status tick mark and add the marks.

- If total marks within 95 - 120, carp culture will be profitable
- If total marks within 60 - 95, carp culture will be medium profitable
- If total marks within 95-120, carp culture will not be profitable

The role of soil and water quality in the fish culture and the merits and demerits

Every organism has its own environment. Fish is an aquatic organism. Proper aquatic environment is necessary for the fish. Every aspects of fish life happen in the water of ponds and other water bodies. Therefore, at first suitable culture environment for fish is needed which are influenced by organic, chemical and physical parameters of soil and water. To maintain the optimum degree of the said parameters of ponds and environment it is necessary to control and manage the different attributes of aquatic ecosystem properly.

If soil and water quality of ponds are not optimum :

- Natural food of fish will not be produced in sufficient quantity
- Supplementary feed will be wasted
- Fish growth will not be as expected
- Fish may die from diseases
- Fish production will be less than normal

Soil is the water containing pot of any water body. The productivity of a water body primarily depends on the type of soil. Healthy aquatic ecosystem and ample supply of natural food in the water are the preconditions of profitable fish culture.

Soil qualities: In general fish production is excellent in a pond excavated in fertile soil. Fertile land supplies natural fish food and plays role against water pollution. Generally soils are of 4 types – silt, sand, red (mud) and loam. Ponds with loamy soil are best suited for carp poly culture. Water retention capacity is very low for sandy soil and water is always turbid in a pond with muddy (red) soil. Therefore, ponds built in sandy and muddy soil have never been very suitable fish culture. Loam soil is the best considering water retention capacity, and holding and exchanging various nutrients. The suitability of water of the closed water body for fish culture depends on soil pH, phosphorus, nitrogen and organic matters etc. The parameters are described briefly here –

pH : The best pH of the soil for fish culture is 6.5 – 8. The availability of pH increases in optimum pH. pH less than 6 makes the soil acidic and presence of harmful substances are observed in the water. On the other hand, pH more than 9 reduces the supply of phosphorus.

Phosphorus: The presence of right amount of organic matter ensure the continuous supply of easily accessible phosphorus. 10 - 15 mg easily accessible phosphate per 100 g soil is required for fish.

Nitrogen: Arial nitrogen is the main source of soil nitrogen. 8 – 10 mg easily accessible nitrogen per 100 g soil is necessary.

Organic matter: Organic matters keep the sediment of pond bottom fresh and active. It also increases the water retention capacity of soil by blocking the water seepage. Organic matter is the major source of phosphorus and nitrogen. In aquatic ecosystem, organic matters directly soak up nitrogen from the air.

Excessive organic matters make the water polluted by reducing pH. Water becomes turbid due to floating organic particles. Generally 1 – 2 % organic matters present in the soil of ponds and water bodies increase the production capacity of water.

The physical, chemical and biological parameters of water

The only medium of fish existence is water. There are optimum degree of each of the physicochemical parameter for feeding, survival, growth, reproduction and other important activities to go on. The optimum ranges of the parameters in aquatic ecosystem are as follows –

Water quality parameters	Optimum range
pH	6.5 - 8
Organic carbon	1.5 – 2 (%)
Organic matters	2.5 – 4.3 (mg / 100 g)
Nitrogen	8 – 10 (mg / 100 g)
Phosphorus	10 – 15 (mg / 100 g)

The physical parameters of water

Water Colour: The light greenish water indicates high pond productivity. If water becomes yellowish, that indicate low nitrate in the water. When phosphorus is low, water turns blackish. Carbon-di-oxide is low in grey coloured water

Presence of natural food in water of various colours and their suitability of fish culture are described in the following table –

Water colour	Amount and type of natural food	Suitability of fish culture
Transparent	Phytoplankton absent	Not suitable
Greenish	Sufficient quantity of phytoplankton	Suitable
Dark greenish	Excessive phytoplankton present	harmful
Brownish green	Sufficient quantity of phyto - and zooplankton	Best suited
Yellowish green	Low phy toplankton and floating silt particles present	Little suited
Rusty	Phytoplankton but not fish food present	Not suitable

Water depth: Sun light is essential for the production of the natural food of fish – plankton and photo-synthesis. Water can be very hot if the pond is shallow. Harmful aquatic plants may grow at the pond bottom as well. If the pond is very deep, water temperature at the bottom can be very low. As a result the amount of dissolved oxygen at the pond bottom may drop. This may create harmful gasses at the bottom as well. To avoid this condition, the fish and other animals of the bottom come top the top layer of the water. The water depth of the fish pond should be 5 - 10 feet. The optimum depth range for carp poly culture pond is 6 – 7 feet.

Transparency and turbidity of pond water: The production of natural food for fish that is phytoplankton drops in turbid pond water. Again the excessive growth of phytoplankton at the upper lay of water may reduce the transparency of water. Resulting oxygen scarcity may hamper the normal living of fish. The 10 inches of transparency indicates sufficient amount of natural fish food in the water. The gill of fish may clog due to the accumulation of different substances dissolved in turbid water. As a result fish face difficulty in breathing, lose appetite and even die.

- The turbidity of water can be removed using gypsum (CaSO4 . 2H¬2O) at the rate of 1.5 – 2 kg per decimal water area
- Good results can be obtained by placing sacs of straw in the corners of pond.

Temperature: As the temperature increases so the tendency of feeding of fish. The growth rate of fish becomes faster. When the temperature crosses the optimum limit, the life of fish is hampered. On the other hand, when temperature drops, the rate of feeding of fish decreases as well. As a result fish growth slows down. That's why, the application of both fertilizer and food in fish ponds need to be reduced in the winter. For carp farming 28 – 31 oC temperature is optimum. The tolerance towards various temperature ranges by fish is described in the following table:

Species	Temperature range (°C)
Catla, Rohu and Mrigal	20 – 38 °C
Grass carp and Silver carp	25 – 35 °C
Common Carp	20 – 30 °C

Generally, good production is obtained at 28 – 31 oC in carp poly culture. However, fish feeding drops at temperature below 11 oC and fish stop feeding at temperature below 9 oC.

Sun light: If there are large trees at the pond dyke, the whole trees or their large branches should be cut down to allow sun light to enter in to the ponds freely. Turbid pond water seriously affects the entrance of sun light into the water. As a result the production of phytoplankton becomes limited only at the little upper layer of the pond. Different type of floating aquatic weeds also create obstacle for sun light to enter in to the pond. The phytoplankton production drops when the sun light can not enter freely in to the pond.

Chemical properties of pond water

Dissolved oxygen: Oxygen is essential for life. The oxygen produced in photosynthesis by phytoplanktons and aquatic weeds are dissolved in water. Water also absorbs some amount of oxygen directly from air. The pond fish including other aquatic animals and plants breathe using oxygen. The oxygen is not produced at night as there is no sun light. Oxygen is also used in the decomposition of organic matter at the bottom of the pond as well. As a result, there is very low oxygen content in the pond water at the morning. The oxygen content reaches highest after the noontime. Carps can not continue their normal physiological activities, if dissolved oxygen content in pond water drops below 2.0 mg / L. High fish growth is obtained in pond water with dissolved oxygen content 5.0 mg / L.

Food conversion ratios of fish increase if appropriate oxygen content is present in the water. That is comparatively lower amount of food can produce higher amount of fish. Fish appetite increases when dissolved oxygen content increase and fish loose appetite when dissolved oxygen content drops.

The causes behind low dissolved oxygen content in pond water

Decomposition of organic matter
Creation of harmful bloom
High iron content in soil
Decomposition of leaves and branches of trees in water
Excessive application of wet cow dung in pond
Cloudy sky
Excessive turbidity in water
Fish stocking at high density

Dissolved carbon dioxide: Carbon dioxide plays major role in the production of natural food for fish. The amount of natural food in the pond water decreases when dissolved carbon dioxide content drops. However, water becomes toxic if dissolved carbon dioxide reaches more than 16 mg / L due to some reasons. Excessive organic matter and sediment (mud) at the pond bottom might increase dissolved carbon dioxide content in water. Carbon dioxide content more than 2 mg / L in water is good for fish production.

pH: The acidity and alkalinity of water are measured by pH. Water becomes acidic at a pH less than 7 and alkaline at a pH more than 7. If water pH of pond reaches to 11 or drops to 4, fish may die.

Biological features

Floating plants: Leaves of this kind of plants float on the water but the roots suspend in the water column. Such as, water hyacinth, water lettuce, duck weed etc. The floating plants make obstacle so sun light can not enter in to the pond, absorb nutrition from the applied fertilizer and this way reduces pond productivity.

Submerged plants: This type of aquatic plants are found in the pond bottom. They create obstacle so sun light can not enter in to the deeper part of the ponds. Fish movements are also hampered due to the submerged plants. Such as, pata jhangi, kanta jhangi, Najas etc.

Plankton: The very small (some are microscopic) organisms found in the water are known as plankton. Planktons are the natural food for fish. The presence of enough plankton in pond water indicates high productivity. Planktons are of two types – a. phytoplankton and b. zooplankton.

Aquatic insects: various types of aquatic insects live in the bottom of the ponds. They are included in the food cycle of fish. Such as, different types of larvae, water beetle etc.

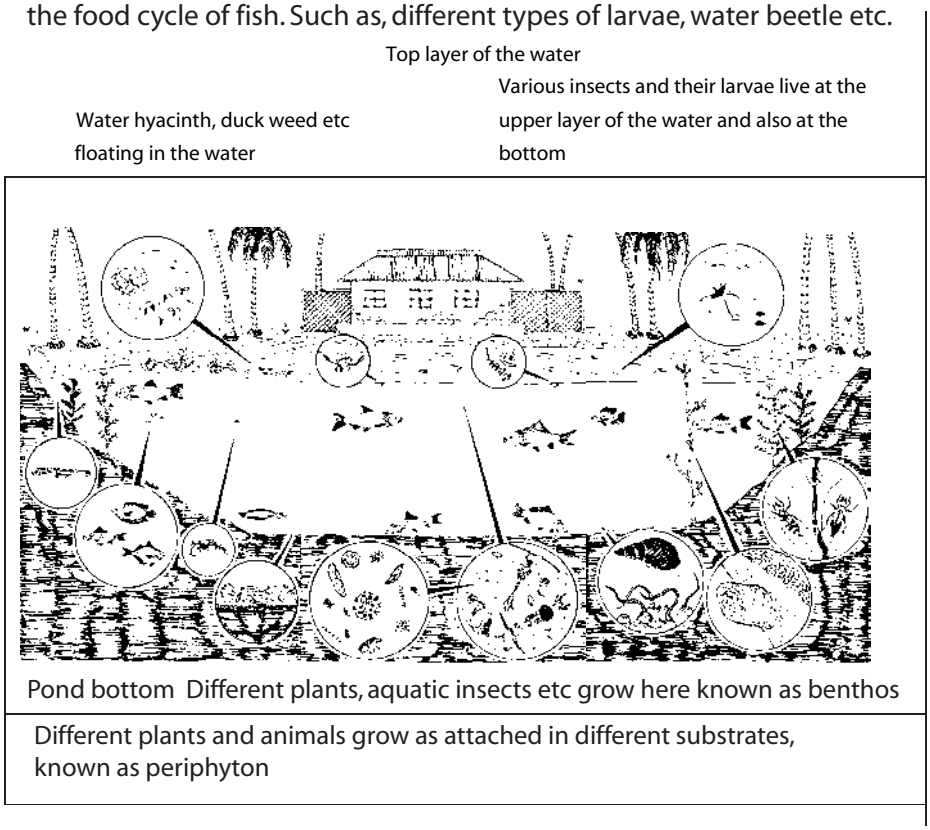


Figure. Different animals and plants found in pond water

Some aquatic plants and animals absorb nutrition from water and reduce normal pond productivity. As a result fish production drops.

Planned excavation of fish ponds to ensure appropriate environment for fish culture

Most of the ponds in our country are built to raise the homestead or for some other household purposes therefore, even someone wishes, can not make sure all elements of a culture pond. Therefore, during the excavation of new ponds suggestion should be taken from the fisheries experts so all necessary elements of a culture pond can be ensured. The aspects need to be considered in the excavation of a new pond in an area are described here:

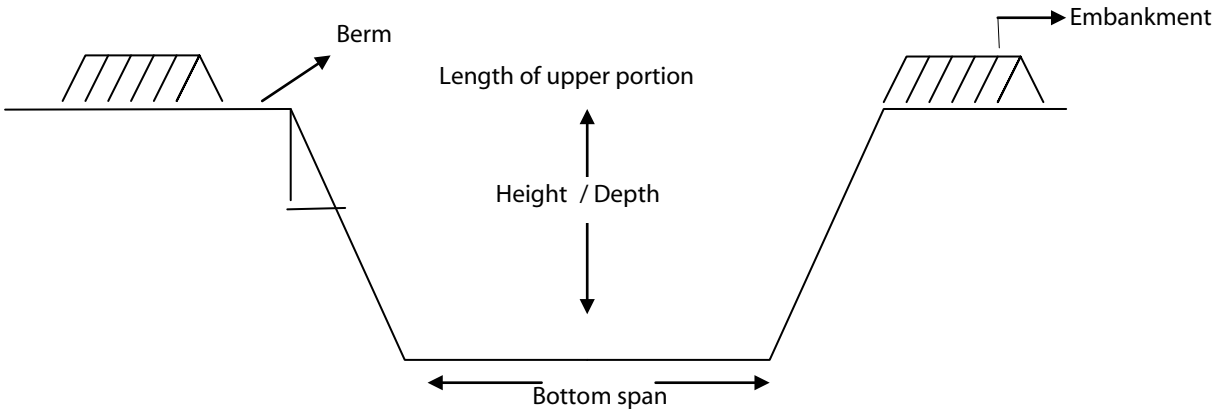
- What is the soil type of the area where the pond will be excavated? Sandy soil, loamy soil, sandy loam or red soil. If these are not considered during pond excavation, various problems like low water retention capacity, fast spoilage of pond dyke etc will be created in the long run.
- How is the flood situation of the area?
- How is the ownership scenario of the pond at present and in the future?
- At what month, pond excavation has been planned?
- The location where pond will be excavated – is it lowland, highland or with slope?

Other aspects

Embankment: In general, the embankment of a medium to large pond is 5 – 6 feet. This should be higher (elevated) than level of flood or flush flood (due to excessive rain).

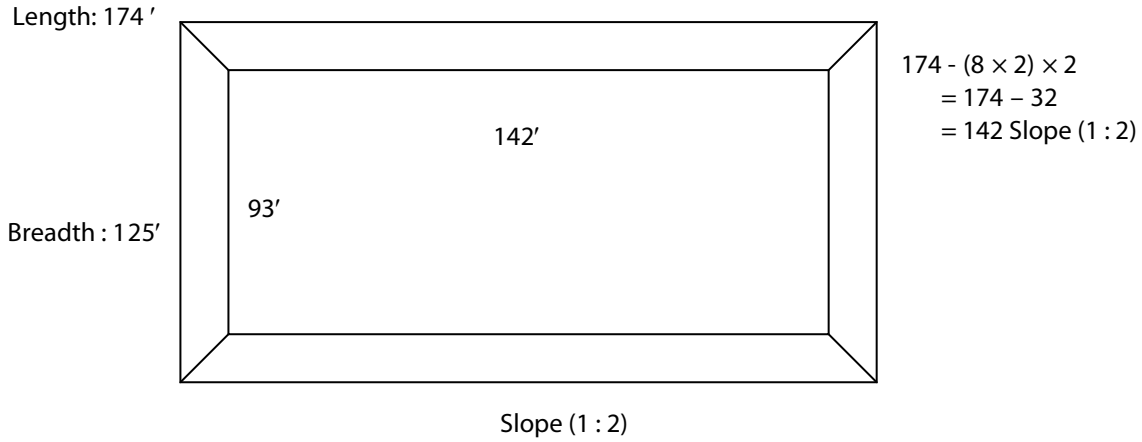
Berm: A level space (raised barrier) between the edge of the top layer of pond and embankment should be kept unfilled. The area is known as berm. In a medium sized pond, generally 3-4 feet space towards inner side from the embankment should remain unfilled

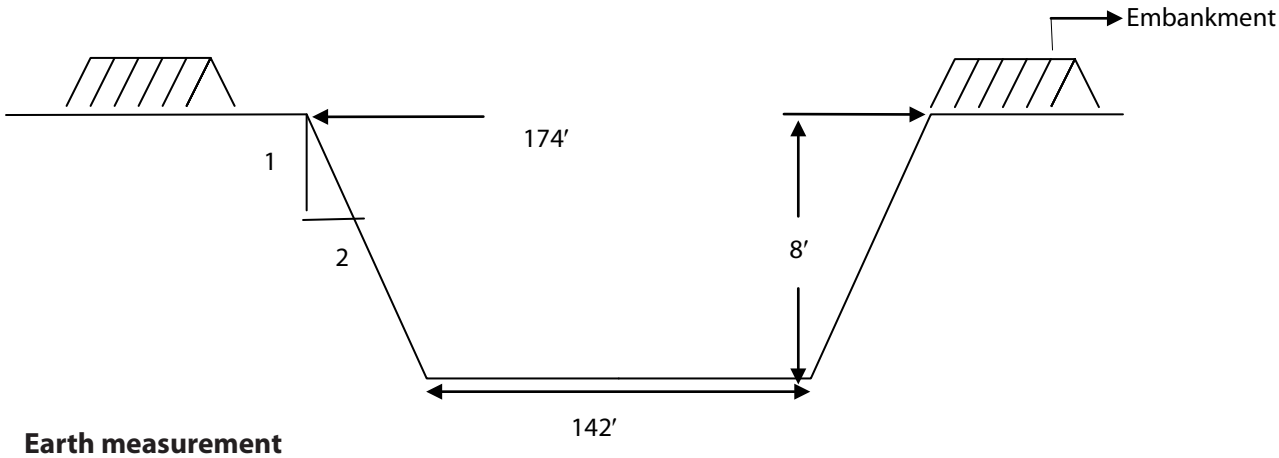
Slope: The angular line starting from the pond embankment towards the pond bottom is known as pond slope. Suppose the slope of a pond is 1 : 2, this indicates if someone digs a pond 1 foot vertically, to ensure 1 : 2 slope, the pond should be dug horizontally 2 feet towards the inner side. That will be the design of the bottom of the main gully of the pond. This way, earth excavation should be started for a 8 feet deep pond along the depth, after fixing a spot on the embankment, another spot should be fixed at the 16 feet distance both length and breadth-wise from the first spot. As a result, the slope created from the embankment channel along the main gully will be 1 : 2 (1 : 2 means vertically 1 and horizontally 2).



Earth calculation of 50 dec pond

If the slope of a 174 feet long and 125 feet wide and 8 feet deep pond is 1 : 2, the n how much earth need to dig and what will the cost?





Earth measurement

Length x Width xDepth

$$\frac{174' + 142'}{2} \times \frac{125' + 93'}{2} \times 8' \quad \text{cubic feet}$$

$= 158 \times 109 \times 8$ cubic feet = 1,37,776 cubic feet

(It can be noted that 1000 cubic feet earth is known as 1000 earth. If the cost of 1000 earth is Taka 1500 then total cost for a 50 dec pond = Taka 2,06,664.00)

Identification of good quality fry

There is no alternative of good quality seed for any kind of crop production. Accordingly the importance of god quality fry in fish culture is immense. The quality of fry depends on the source, health age and weight of mother (brood) fish and overall environment of the source (water body). The ways ro recognize good quality fry are described here:

Identification of good fry: Only stocking of fish fry in appropriate quantity can not ensure good production. To obtain high yield, good quality fish fry should be stocked along with appropriate stocking density. The source and handling (management) can affect the quality of fry. The fish farmers may face huge financial loss if bad quality fry are stocked, whatever the reason is. Size also affects the fry quality. Generally the mortality rate of large sized fry is comparatively low and as they grow faster, the production cost also is low. If right quality fry are not stocked -

- Fry may face mass mortality after stocking in the ponds
- Low growth rate
- As they do not grow to marketable size in time, may fetch low market price

That's why the quality of fry need to be made sure prior to stocking. The identifying characters of good and bad fry are described her

Fish fry

- Health fry are restless and swimming fast, bad quality fry are calm and quiet
- Good fry are shiny, bad fry are pale
- The body of good fry smooth, the body of bad fry is not smooth (rough)
- There won't be any spot or mark on good fry, red marks can be seen in the body, fins and gill of bad fry
- If tails are pressed, good quality fry shake head vigorously, bad fry shake head very slowly
- If current is created in plate full of water, good fry swim against the current, bad fry gather at the center of the plate.

Expected yield are obtained from stocking of large size fry in the ponds under CSISA-BD Project at the first year. In seasonal ponds, from the stocking of fast-growing fishes like catla, silver carp, common carp, Thai sarpunti, tilapia etc, high production can be obtained.

The availability and amount of investment in fish culture

The main principle of successful fish culture is to accomplish right task in right time. Due to the lack of ideas about necessary investment for fish farming, Most of the fish farmers can not manage the capital in time. Therefore, per decimal capital required for different type of fish culture are described in the following table:

Type of fish culture	Capital required per dec pond sequentially (Taka per decimal)					Total cost
	Lease	Pre stocking	Stocking	Post stocking	Harvest and marketing	
Poly culture of carps		50	235	600	65	950
Poly culture of carps -shing		40	550	1.125	100	1,815

N.B. The expenses may increase or decrease based on the market price of the input

Group Session Planning

Day – 01	Time – 11.15	Duration – 45 min

Target Group : Carp/Carp-Shing Farmers
Title of the Session : Fish culture management and preliminary activities of fish culture
Goal : The trainees will get clear ideas on pond renovation, weed control, removal of predatory fish Liming and fertilization during pond preparation, checking of natural food, control of harmful insects of pond, netting or harra pulling in the pond, fry agreement, pattern, methods, quality of pond, soil and water, good fry and investment in fish culture so they will be able to increase fish production in their ponds following the activities properly

Objectives : **At the end of the session**

- Trainees will be able to renovate bottom and embankment, filter setting and repair
- Trainees will be able to explain the measurement of pond and water area
- Trainees will be able to control aquatic weed
- Trainees will be able to control of predatory fish and harmful insects
- They will be able to explain lime application in detail
- They will be able to test natural food items in the pond water
- They will be able to test the toxicity of pond water and to make fry agreement

Subjects to be discussed in the session	Training method	Time
Introduction		3 min
1. Welcome: Welcoming the participants and exchange of greetings 2. Objective verification of earlier session 3. Linking with present session 4. Explaining the objectives of present session and worlds of encouragement	Discussion Question answer	
Subject matter		40 min
1. Pond renovation 2. Measurement techniques of pond and water area 3. Aquatic weeds and weed control measures 4. Control of predatory fish and harmful insects 5. Lime application 6. Fertilization during pond preparation 7. Testing natural food items in the pond water 8. Testing the toxicity of pond water and making fry agreement	Question answer Speech Flip chart	
Summary		2 min
1. Review of the major points 2. Verification of the Objective • What do you understand by pond renovation? • What are the different methods of aquatic weed control? • What are the importance of the application of lime and fertilizer? 3. Distribution of the handouts	Question answer	

Linking with next session:

Training materials Flip cart, white board, marker and handout

Planning of the flip chart

(Please follow the handout for detailed description)

<table>
<tr>
<td>Fish culture mana gement and preliminary activities of fish culture</td>
<td>Removal of predatory fish and testing toxicity of water
The importance of predatory and weed fish removal:
The methods of predatory and weed fish removal: The dose of rotenon
<table>
<tr><th>Power</th><th>Application dose (Dec / foot depth)</th></tr>
<tr><td>9.1 %</td><td>18 – 24 g</td></tr>
<tr><td>7.0 %</td><td>24 – 30 g</td></tr>
</table>
Dose determination method: based on water area of pond
$\frac{\text{(Length x width x mean depth) feet} \times \text{dose applied}}{453.6} = \text{Rotenon g}$
Caution in application:</td>
</tr>
<tr>
<td>Stages and activi ties of fish culture management
A. Pre stocking management
Removal of excessive mud from the bottom
Removal of aquatic weed and predatory fish
Application of lime and
Application of fertilizer
B. Management during stocking
Secretion of appropriate species of fish
Identification of good and bad quality fry
Fry transport and
Fish stocking
C. Post stocking management
Application of fertilizer
Application of supplementary feed
Maintaining water quality and
Fish health management</td>
<td>Application of lime:
What is L ime:
Reasons of liming
Types of lime
<table>
<tr><th>Name of lime</th><th>Chemical structure</th><th>Availability</th></tr>
<tr><td>Lime stone</td><td>$CaCO_3$</td><td>generally not available in the market</td></tr>
<tr><td>Burnt lime or Quick lime</td><td>CaO</td><td>Available as lime stone in the market</td></tr>
<tr><td>Slaked lime</td><td>$Ca(OH)_2$</td><td>Available in the ma rket in powder form</td></tr>
<tr><td>Dolomite</td><td>$CaMg(CO_3)_2$</td><td>More availability in shrimp farming area</td></tr>
<tr><td>Gypsum</td><td>$CaSO_4.2H_2O$</td><td>Available in some markets</td></tr>
</table>
Doses of lime application
<table>
<tr><th>pH</th><th>Quick lime</th><th>Slaked lime</th><th>Lime stone</th></tr>
<tr><td>3 -5 (tannin)</td><td>6 kg/ dec</td><td>9 kg/ dec</td><td>12 kg/ dec</td></tr>
<tr><td>4–6 (Clay)</td><td>4 kg/ dec</td><td>6 kg/ dec</td><td>8 kg/ dec</td></tr>
<tr><td>5-7 (Loam)</td><td>1 - 2 kg/ dec</td><td>3 kg/ dec</td><td>4 kg/ dec</td></tr>
</table>
Caution in lime application</td>
</tr>
<tr>
<td>Pond bottom repair, dyke clearing, filter setting and repair
A. Pond bottom and dyke repair
• If dyke of pond and ghersare damaged
• If pond bo ttom is uneven
• If excess organic maters are present at the bottom of pond/ gher
• If large bushy tree branches or bush are present in dyke
B. Filter setting and repair
• Setting filter at the water inlet and outlet of the ponds
• Inlet filter should be two -tiered
• The mesh of first tier is 1.5 mm and the mesh of second tier is 0.5 mm
• A bamboo fence is set before the filter will increase filter capacity</td>
<td>Preparatory fertilizer application and checking of natural food
The important matters of pond fertilization
Typ e of fertilizer: Organic manure and inorganic fertilizer
The aspects on which quantity of fertilizer depend on:
• Soil quality • Nutrient demand of phytoplankton
• Climatic condition (temperature, cloud, rain
• Quality of fertilizer • Availability of f ertilizer etc.
<table>
<tr><th>Fertilizer</th><th>Dose</th></tr>
<tr><td></td><td>Traditional estimate</td></tr>
<tr><td>Cow dung or
Compost or
Poultry litter</td><td>5 - 7 kg / dec
8 – 10 kg / dec
3 – 5 kg / dec</td></tr>
<tr><td>Urea</td><td>100 - 150 g / dec</td></tr>
<tr><td>T S P</td><td>50 – 75 g / dec</td></tr>
</table>
Checking of natural food</td>
</tr>
<tr>
<td>Measurement method of pond s and water bodies
The importance of measuring pond and water area:
(a) Determination of the doses of lime
(b) Determination of the doses of fertilizer
(c) Determination of the fish stocking density
(d) Application of rotenon etc.
Measurement method of pon ds and water bodies:</td>
<td>Other necessary activities
Netting or harra pulling in the pond
Agreement for the fry
Sun hemp (Dhoincha) sowing on the dyke and bottom of the pond</td>
</tr>
</table>

Fish Culture Management and Preliminary Activities of Fish Culture

According to environmental scientist and Food and Agricultural Organization (FAO), fish culture is the gradual application of different techniques to produce natural food for fish in the water. In general, it can be said that the fish culture is the gradual application of the different techniques to produce more fish from a unit area of water body than what is normally obtained. That is, fish culture is the collection of the techniques required to make the environment of water body suitable for the natural and healthy growth of fish. Mainly the initiatives of fish culture management can be divided based on the three culture stages.

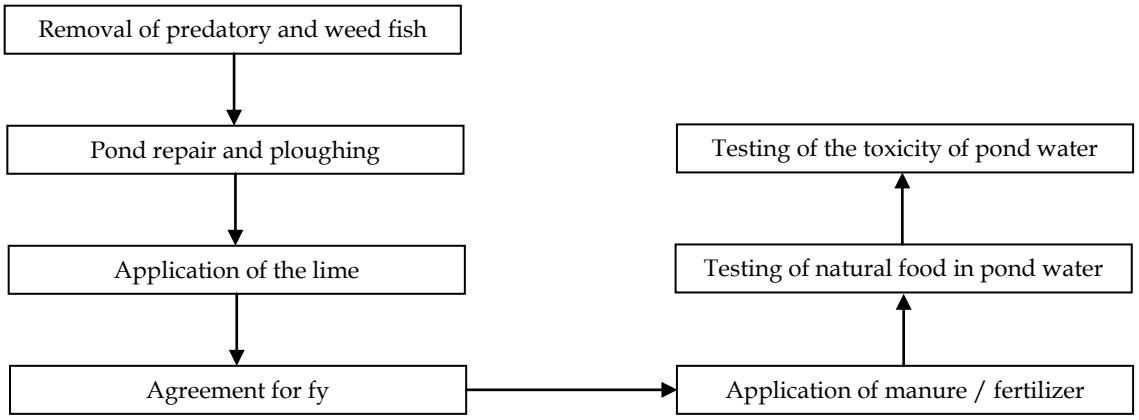
Pre stocking management: At this stage, the aquatic environment are made suitable for fish culture through the removal of bottom mud, removal of aquatic weeds and predatory fishes, and the application of lime and fertilizer / manure.

Management during fish stocking: Appropriate species of fish are selected for stocking in the ponds along with identification of good and bad quality fish fry, fry transport following right techniques and stocking of fish

Post stocking management: At this stage, the main activities are maintaining natural fish food equilibrium, application of supplementary feed if necessary, maintaining the standard water quality, and ensuring fish health management.

Pre stocking management

Pre stocking management is in fact pond preparation. There are seven major activities under this stage –



চিত্রঃ পুকুরের ভাঙ্গা পাড়

Renovation of the fish pond

A. Repair of bottom and dyke of the pond

If the dyke of the pond / gher is damaged, predatory and unwanted fish enter in to the pond
Netting is difficult in a pond with uneven bottom, prawn can not be harvested.

Excessive organic matters at the bottom of ponds / ghers create toxic gas (specially ammonia)
As a result, when water level is very low during Choitra - Joustha (April – May), fish and prawn suffer from mass mortality
If there are large branches of trees or bush (hedge) are present on the pond dyke, sufficient sun light can not enter in to the pond, toxic gases are produced in the pond due to the decomposition of fallen leaves and fish and prawn are attacked by predatory animals. After drying out the ponds / ghers dyke should be repaired and pond bottom should be leveled using physical labour. The bush and large trees on the dyke should be cut down and excessive bottom mud (more than 4 inches) must be removed.

B. Filter setting and repair

- If there are inlet and outlet in the pond, filter should be set in both ways
- At the inlet, filter should be two-tiered
- The mesh of first tier should be 1.5 mm and the mesh of second tier 0.5 mm
- At the outlet of the pond one filter is sufficient. The mesh size should be 1.5 mm.
- A bamboo fence should be set before the filter to increase filter capacity

Measurement method of pond and water area

What is meant by pond measurement?

Pond measurement means calculating area of the pond. This area can be calculated 2 ways - with dyke or without dyke. Usually, pond area is measure in decimal.

Water area measurement: Calculating water area of the pond means water area measurement. Before stocking fish in any pond, its water area should be calculated. Generally average water area of a pond is calculated.

Importance of measuring pond and water area

In fish culture, farmers first should know the water area of the pond / water body. If water area is not calculated properly, problems may be created in every aspect of fish culture. Such as, a. Determination of lime requirement, b. Determination of fertilizer requirement, c. Estimation of stocking density of fish and d, Rotenon application etc.
Measurement method of pond and water area: 1. Hand (cubit) / Bamboo method, 2. Tape method and 3. Foot (leg span) method

Usually, the unit of pond measurement is decimal. 435.6 square feet = 1 decimal, 100 decimal = 1 acre;

Average length of any pond (foot) x average width (foot) 435.6 = ? decimal

Aquatic weed and control

Aquatic weed: The aquatic plants that are directly or indirectly harmful to the production of fish / prawn are known as aquatic weeds. Usually four different types of aquatic weeds are found in ponds.
i. Floating - The weeds that float on the surface are known as floating aquatic weed. thera re of two types-
• Root in the soil leaves on the surface – absorb nutrient from the soil. Such as water lily / shapla (Nymphaea), paniphal (Trapa sp.), shusni shak (Marsilea sp.) etc.
• Free floating – They absorb nutrient from water – Such as water hyacinth, duck weed, water lettuce etc.
ii. Creeper - Roots of this type of aquatic weeds are under water of the embankment slope and stalks and leaves extends in the water column and water surface. Such as water spinach / kalmi lata (Ipomoea aquatica), helencha (Enhydra sp), creeping water primrose / Keshordam (Jussiacea sp.) etc. They absorb nutrient from soil
iii. Submerged – This type of aquatic weeds are found under the water. Their roots are attached at the pond bottom and leaves and branches never come on the water surface. Such as – jhanji (Utricularia sp), kata sheola (Ceratophyllum sp.) etc.
iv. Emergent - Some part of this type of aquatic weeds remain under water and some part out of the water. Such as Bishkatali (Polygonum sp.), Arail (Leersia sp.) etc.

The harmful effects of aquatic weeds

All kind of aquatic weeds absorb nutrient content from soil and water which is essential for the growth and reproduction of plankton. Due to the lack of nutrient content, the production of plankton as well as the production of fish may endure setbacks. Photosynthesis is also hampered as aquatic weed block the entrance of sun light in to the water.

Controlling aquatic weed – Though aquatic plants are known as weed and harmful, all aquatic plants are not detrimental. Some of the aquatic plants are even beneficial to fish culture. Besides, kuti pana (Wolffia sp.), khudi pana (Lemna sp.) etc. are widely used as feed for grass carp and sar punti. Compost can be produced from the water hyacinth and other aquatic weeds. Aquatic weed can be controlled using the following methods –

Figure: manual control of pond weeds

Using manual labour – All the aquatic weeds can be pulled out up manually after cutting with chopper / scissors. Sometimes using a rope, the root of aquatic weed can be pulled up.

Biological method – There are many fishes – can control aquatic weed by foraging on them, e.g., grass carp. In addition, mirror carp and carpio pull up the root of the submerged aquatic weed. The pulled up aquatic weed can be removed manually. The role of grass carp in controlling aquatic weed is as follows -

Weed	Quantity of weed (kg / dec)	Number of grass carp (per dec)	Individual weight of fish (g)	Duration (day)
Hydrilla	275	2.6	113	42
Spyrodela	24	5	474	20
Lemna (khudi pana)	8	4	1124	11

Aquatic weed control using grass carp (Singh et al., 1969)

Manual labour and biological control are the best method of aquatic weed control

Control of aquatic weed using fertilizer – Submerged aquatic weed can be controlled using a little over dose of organic manures.

Control of aquatic weed using chemicals – The chemicals used in our country for aquatic weed control

- 2- 4 D, 138 – 180 g / dec – for destroying floating and creeper aquatic weeds
- Cimagine, 3 mg / L for destroying aquatic weed
- Endathol, 1 - 3 mg / L for destroying aquatic weed with pollen-tubes (angiosperms)

Control of predatory and unwanted fishes

Fish culture undoubtedly is a profitable venture. Even though, many people do not get much profit from fish culture and many even loss money. Among many reasons of the loss in fish culture, a notable one is most of the stocked fish disappear during culture and not found during harvesting. the main reason behind this disappearance is predation by the predatory fish. Therefore pond should be free of predatory fishes before the fish stocking.

What are the predatory and unwanted fishes?

Predatory fish: The fishes that predate directly on other fishes are known as predatory fish. Such as – shol, taki, gojar, boal, kankila, bele, foli, chitol etc.

Unwanted fish: The fishes that do not directly predate on the target or cultivable species of fish but compete with target species for food, habitat, oxygen etc are known as unwanted or weed fish. A fish that is target species in one pond may be dubbed as unwanted or weed fish in another pond.

Among the fishes available in the pond, the notable indigenous species are mola, darkina, punti, chanda etc. Based on the bioavailability of vitamins and minerals, the most valuables fish are mola, darkina and punti among the small fishes. The small fishes feed on the plankton, insects, worms and their larvae along with other supplementary feeds. In fry and fingerling ponds, the small fishes are very damaging because they predate on stocked spawn and larval fish. Besides they compete with stocked small fry for food. In the production ponds of large fish, these small fishes (except chanda) are extra nutrient-rich resources. Their impact is not such big and negative in the fish ponds, if natural pond productivity is maintained by regular fertilization and their density is controlled by repeated harvesting. Therefore, if they are not considered unwanted in producing large fish and are kept in the ponds, the small fish will not only bring financial gains for the fish farmers, they will play an important role in fulfilling the demand of vitamin A, iron, zinc and calcium of the household members particularly of women and children. An important point is, the eye and head of mola never be thrown out during pre-cooking processing. Because the eye and head contain the highest amount of vitamin A.

Predatory and unwanted fish control methods

Predatory and unwanted fish can be removed from the ponds using three methods.

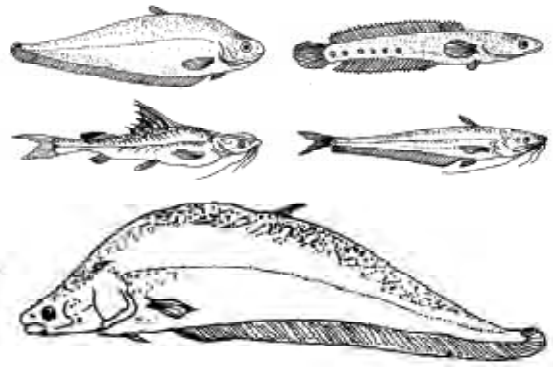


Figure: Predatory Fishes

1. Drying out of ponds: This method is very effective in removing predatory and unwanted fishes. All fish will be caught if ponds are dried. In addition, different harmful insects-worms, mussel and snail will also be removed. Pond bottom will be exposed to direct sun light and will be free of toxic gas. Pond bottom can be repaired easily (removal of bottom mud, bottom leveling) and better fish production can be achieved. However, if the pond is big and very deep, drying out by irrigation would be difficult and expensive.

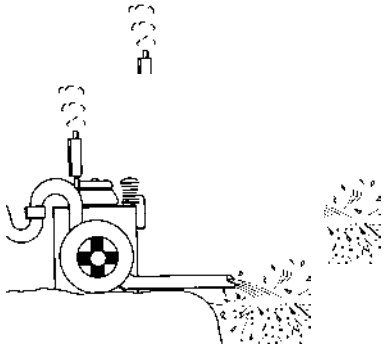


Figure: Drying out of fish ponds

2. Seining with small-meshed nets: If drying out of ponds is not possible, netting can remove most of the predatory and unwanted fish. The predatory fishes are very claver. Many predatory fish bury themselves inside the mud during netting. In addition, if predatory fish hide in crab hole or in the roots of dead trees, netting won't be very efficient to capture all of them. However, if the ponds are new with leveled bottom, removing predatory and unwanted fishes is possible just by netting. If the number of predatory fish is not much, they can be captured using hook and line with live small fish as bait.

3. Rotenone application: If netting and drying out are not possible, predatory and unwanted fishes should be removed applying rotenone. Rotenone is a herbal product made from the root of one kind of plant (Derris elliptica). It is available in powder form. Its efficacy in water lasts only for seven days. It is safe to consume rotenone-killed fish except their gills.

Figure: Control of predatory fish by netting

The doses of Rotenone:

Power (Active ingredient)	Doses of application (Per foot decimal water)
9.1%	18 - 24 g
7%	24 – 30 g

Method of determining required quantity: Of the water area of pond –

$$\frac{(\text{Length} \times \text{width} \times \text{mean depth}) \text{ feet} \times \text{dose applied g}}{453.6}$$

Example: If a pond with length – 150 feet, width – 90 feet and mean depth – 4 feet; if the dose of rotenone is 24 g / decimal / foot depth, then rotenone needed

$$\frac{(150 \times 90 \times 4 \times 24)}{453.6}$$

Techniques of mixing and applying: Based on the pond area and depth, the quantity (g) of rotenone should be calculated. The rotenone should be mixed with water little by little to make the thick paste. Then the whole amount should be divided in to three portions. The first portion should be made to small balls and should be evenly distributed to the surface of the entire pond. The rest two portions should be mixed with water and should be distributed to the entire pond after 15 – 20 minutes of application of rotenone balls. The dead / floating fish should be fast removed by catching using a net. Fish harvested by this method are not unsafe for human health.

Figure: Rotenone application in controlling predatory and unwanted fishes

Time of rotenone application: 10 – 11 am at the morning of a sunny day.

Cautions in rotenone application:

- During mixing rotenone with water and application in pond, hands should be covered with a polythene paper/ bag and entire face should be covered with a piece of cloth (gamchha)
- In a cloudy day or a cool day, rotenone application does not give good output
- Rotenone should be applied in the direction of air flow

Except in nursery, only to kill small indigenous species of fish (SIS), poison should not be used and ponds should not be dried

After rotenone application, hands should be washed well with soap, and the utensil should be well cleaned and should be kept out of the reach of the children.

Lime application

What is lime?

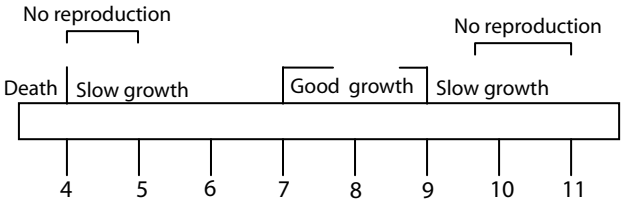
Lime is calcareous inorganic compound which assists in reducing or controlling acidity and in the formation of animal structure (skeleton).

Reasons of lime application: Lime is applied in ponds due to two reasons.

Firstly: To keep the pH of pond soil and water suitable for fish culture and maintain alkalinity of pond water more that 20 mg / L.

Figure: Liming in pond

Secondly: To create abundance of nutrient materials in ponds by enhancing the decomposition of organic matters at the bottom and to remove parasites and germs through the application of quick lime during pond preparation.



The optimum pH range of water is 7 – 9 for fish farming. If pH is less than 4 or more than 11, fish may die.

What is pH ?

pH is the estimates of negative hydrogen ion concentration, ranges between 1 and 14. The acidity and alkalinity of water is measured by pH. Here pH 7 is neutral, pH more than 7 indicates alkalinity (7 - 14) and pH less than 7 indicates acidity (7 – 1).

The source of acidity: The main source of acidity is black soil or acid sulfate rich soil and polluted waste materials.

The effects of acidic water

- If pH of water drops below 5 sodium and chloride of fish blood come out through osmosis. As a result, weak fish die. This becomes even more serious if calcium content is low in water.
- Huge quantity of slimes is created on fish skin and gills become infected.
- The fish immunity decreases, fish lose appetite and wounds are not healed easily.
- Spawns and fry of large fishes get infected fast.
- The natural pond productivity drops.
- Reproductive capacity of fish decreases.

The source of alkalinity:

- Calcium and silica rich soil
- If pond water is deep green then due to excessive photosynthesis, water pH increases a little during day time

The effects of alkaline water: If water pH reaches 11, fish die quickly. At high pH –

- The fish gill become damaged
- The eye lenses and cornea destroyed
- The natural pond productivity drops
- The osmoregulatory capacity of fish decreases, as a result fish become weak.
- The fish immunity decreases and fish lose appetite
- Reproductive capacity of fish decreases

The relationship among lime, pH, hardness and alkalinity

If water is very alkaline (pH more than 9) or very acidic (pH less than 5), then water hardness is less than 20 mg / L which in turn impacts on natural productivity. The hardness and alkalinity is the estimates of different ions present in the water. The hardness generally is the estimates of calcium and magnesium ions and alkalinity is the estimates of carbonate, bicarbonate and hydroxyl ions. In many cases the concentration of hardness and alkalinity are observed more or less equal.

Fertilizer application in any pond means to provide the food for plankton as nitrogen and phosphorus supply. If pH of that pond is higher or lower than optimum then planktons can not use the nitrogen and phosphorus properly for their growths. A little acidic (pH 5 – 6.5) or a little alkaline (pH – 9) water is not that harmful for the planktons and most of other aquatic organisms. However, in these cases, they require more energy for their growth and survival (Please see the example in the box).

The hardness is low in acidic water. That means, in a state of low pH, both hardness and alkalinity are low. As a result, the availability of necessary carbon is low for photosynthesis of planktons. The real lime type materials hold / bind carbon dioxide as carbonate and supply that for the photosynthesis of plankton through diffusion process with aerial carbon dioxide. The phosphorus present in acidic soil or water or the applied phosphorus remain at bound stage and is of not much use.

The situation can be compared with fish swimming at two different conditions. First – a fish is swimming in a fast flowing river and second – a fish is swimming in a calm river. The food abundance for the fish in two rivers are equal. The fish in fast-flowing river is spending more energy to maintain his position, part of this energy can be used in its bodily growth. On the other hand, the fish swimming in the calm river is using most of its energy for physical growth.

The significance of lime application

A. Assist in maintaining equilibrium state of hydrogen and hydroxyl ions, that is, helps in keeping the pH neutral. As a result the appropriate environment is created for the growth of planktons.

B. Provide calcium and other important ions for the growth of plankton. Calcium and silica help in the formation of physical structure (skeleton).

C. Increase the supply of carbon dioxide for photosynthesis

D. Free the phosphorus bound in sediment for plankton growth

Types of limes

Name of lime	Chemical structure	Availability
Lime stone	$CaCO_3$	Generally not available in the market
Burnt lime or Quick lime	CaO	Available as lime stone in the market
Slaked lime	$Ca(OH)_2$	Available in the market in powder form
Dolomite	$CaMg(CO_3)_2$	More availability in shrimp farming area
Gypsum	$CaSO_4.2H_2O$	Available in the markets of some areas

The uses of lime

Name of lime	Effectiveness
Burnt lime or Quick lime	This lime is excessive alkaline. The application of this lime instantly increases the pH rapidly. Its application in dry pond is safe.
Lime stone / Dolomite	If water pH is less than 7 and hardness and alkalinity are less than 20 mg / L, dolomite application is very effective in organic matter rich pond sediments
Gypsum	Gypsum is very effective in controlling turbidity created by washed sediments. If water hardness is low and alkalinity is high (if linked to carbonate / bicarbonate / hydroxyl ion and other ions like aluminum), gypsum woks well.

The application of lime

Application of lime in the pond is required or not that will be realized from the following two statements-

A. If water hardness is a little less or more than 20 mg / L, then lime application will not be ineffective (Boyd, 1979).

B. If water harness is more than 20 mg / L then no need to lime application. Again if the water hardness is low and alkalinity is high, lime application will not be very effective (Delince, 1992). Everyone believes that pH should be measured before the application of lime. It should be remembered that, one of the main reasons of lime application is to increase the availability of carbonate ion in water. Carbonate ion in the water may increase due to different reasons other than lime application, eg., rain-fed water that can be proved by plankton abundance. In this case scientific testing is not needed.

In a survey conducted by BAFRU in 1993 in the fish farms under Department of Fisheries (DoF) and Grameen Bank, it was observed that, the pond alkalinity of the fish farms allover the country except in North-West was more than 20 mg / L and most cases it was 70 mg / L. The average pH was 7 – 7.5. Though no survey was conducted among the project farmers but the aforesaid survey could give us a generalized idea.

How to estimate how much limes are needed: For lime application, the pH and alkalinity of water first needs to be estimated. Pond productivity in rural pond management need to be understood which mostly depend on the acidity/alkalinity of water.

Water acidity and alkalinity measurement methods:

a. Water quality testing kit (Hack kit)
b. pH meter
c. Chemical method (titration method)
d. pH paper
e. Using soap – Alkalinity more than 40 mg / L indicates presence of hard water. In this water, soap generally produces less foam. On the other hand, soap produces enough foam easily in water with alkalinity less than 40 mg / L.
f. Using betel spittle – If betel spittle is thrown in water and the colour of spittle does not change then the pH of that water is more than 5. If the colour of spittle turns to blackish, then the pH of water is less than 5. This technique is very effective in testing the water of old, derelict and pond with clear water.
g. By observing water colour: In many cases, the colour of acidic water is blackish or coppery.

Methods a, b and c are not suitable and applicable in all cases. In many cases these are nearly impossible. However before investing in the construction of new fish farm, the pH of the soil of that area and of surrounding water needs to be known. It can be noted that every Upazilla Fisheries Office now has hack kit. Water can be tested in Upazilla Fisheries Office. If testing of water is not possible using the said three methods, following methods can be used in determining the pH of water –

- Know the history of the pond – Information on prior liming in the pond, pond age, natural productivity and fish production record.
- Know the surrounding scenario – If neighbouring fish farmers had any problem due to acidic water, Is there any problem in pond productivity, does the water taste sour or what about the natural production after fertilizer application in pond. To collect information from the farmer about the bad soil, reddish soil or acidic soil in this area.
- Observation through soap test or betel spittle test.

To get ideas from experience: An expert farmer realizes - what is the requirement of his / her cropland instantly after stepping up in the land. This skill of the farmer is the result of long term practice. This way, to know the dose of lime in the pods of any area, after being familiar with the history of a pond, lime should be applied and impact should be observed over a few days. The main matter of observation in this case will be natural productivity of that pond which can be realized by checking the water colour. If water turns to greenish or light green without applying any fertilizer, this indicates the pH of pond water is optimum. Based on this observed condition, the doses of lime can be determined for the pond of that area.

Soil pH measurement method: A handful of water should be collected from the pond bottom. The soil needs to be dried and made powder. The soil powder should be mixed with clean boiled water for minimum 24 hours. Soil pH should be measured using a pH meter from the precipitated water.

The dose of lime

The doses of lime depend solely on soil pH and types of lime. When only pH is considered, the dose of lime should be determined considering that the quick lime is twice more potent than the limestone and 1.5 times more potent than slaked lime. The doses of different limes are described in the following table –

pH	Quick lime	Slaked lime	Lime stone
3 -5 (Red soil)	6 kg/ dec	9 kg/ dec	12 kg/ dec
4–6 (Clay)	4 kg/ dec	6 kg/ dec	8 kg/ dec
5-7 (Loam)	1 - 2 kg/ dec	3 kg/ dec	4 kg/ dec

N.B. Fish culture in the water and soil with pH 3.5 is very costly. It is better to discourage the fish farmers.

Determining lime doses is not very easy because aquatic environment is ever-changing. Only the fish farmers can determine the doses of lime from his/her long observation and experience (observing algal growth after lime application).

Based on the soil type, per decimal dose of the quick lime (at farmers level) are described here –

Type of the soil	New pond	Old pond
Loam	1 kg	2 kg
Clay	4 kg	6 k g

Lime application techniques

During pond preparation: Required quantity of lime should be distributed to the entire pond with dike after mixing with water or in powder form in an earthen pot (chari) or in a drum.

If there are fish in the pond: The required amount of lime should be divided in to 2 – 3 portions and after soaking in the water for at least 12 hours, should be applied at 2-3 days interval.

Timing of lime application: Lime should be applied 2-3 days after ploughing in case of the dry ponds and 3-4 days after predatory and weed fish removal or 7 days before the fertilizer application in water-filled ponds. Once in a year during pond preparation and if algae are not grown even after fertilizer application, a little extra lime need to be applied. The right dose of lime is that which produces sufficient algae in the water. It should be remembered that lime is more effective in bright sun light. Therefore lime should be applied in a sunny day.

Cautions in lime application:

1. During mixing lime with water and application in pond, entire face should be covered with a piece of cloth (gamchha).
2. In no condition, lime should be mixed with water in a plastic bucket.
3. Before pouring water in the bucket containing lime, its top should be covered with jute made bag (chot/bosta).
4. Lime should be added after putting water in the bucket.
5. Lime should be applied in the direction of air flow.
6. If the eyes get in touch of lime, eyes should be repeatedly washed with clean water.

Fertilizer application during pond preparation

The following aspects need to be considered in pond fertilization –

Availability of natural nutrient	History of pond	The past use of pond: Any inputs were used or not, a little or sufficient inputs were used, the pond is derelict or a new one .
	Soil type	Acidic, organic matter -rich, sandy soil or loamy soil
	Pond location	The types and usage of the surrounding land – from where the nutrient content enters in to the pond with washed water during rain .
	Shape and size of pond	Nutrient material p recipitates at the bottom of the very deep ponds that can not act effectively with nutrient cycle. In long ponds, pond water gets more in touch with air and nutrient mixes well.
Climatic factors	Water temperature	Use of nutrient in organic systems varies based on the seasonality .
	Sun light	Use of nutrient is generally low in a cloudy weather .
	Rainfall	In rain fed ponds, as the water volume increases, so does the nutrition demand .
Quality of inputs	Organic manure	The nutrient content in the water fluc tuates based on the humidity, decomposition, animals and their food habit.
	Inorganic fertilizer	Generally no variation in the nutrition content However, in many cases due to humid weather and due to the adulteration by the producers or dealers, the nutri ent content varies .
	Compost or farm effluent	Nutrient contents var y due to difference in production techniques, timing, humidity and drying .
The users of nutrient content	Consumers and producers	The abundance of producers particularly phytoplankton de pend on the concentration of the necessary nutrient materials. Again the abundance of zooplankton depends on the availability of phytoplankton. In fish culture at low density in rural ponds plankton is not a big problem. However if fish are stocked followi ng appropriate rate and density, planktons play an important role in fish production .

When an advisor will be well informed about the factors that affect the ever changing doses of fertilizer, then he / she will be able to recommend the farmers about increasing pond productivity using local resources (farm effluents) effectively.

Fertilizer application: The main objective of fertilizer application is to increase the production of plankton – the primary food for the stocked fry.

Theoretical concept of fertilizer application: Nutrients have always been recycled in the ponds under an active nutrient cycle. The main actors of the nutrient cycle are planktons, bacteria, decomposed organic matters, aquatic plants - phytoplankton, tiny aquatic animals (minute insects / worms) - zooplankton and fish. They all are involved in production and consumption and are known as producers and consumers. The producers (some bacteria and phytoplankton) need dissolved nutrient materials, temperature and sun light. Their production continues when ample nutrient materials, bright sun light and worm condition are present in the ponds. The consumers are the fish that feed on the producers. This indicates that if there are abundant producers in the water, fish can feed on those producers results in expected fish growth.

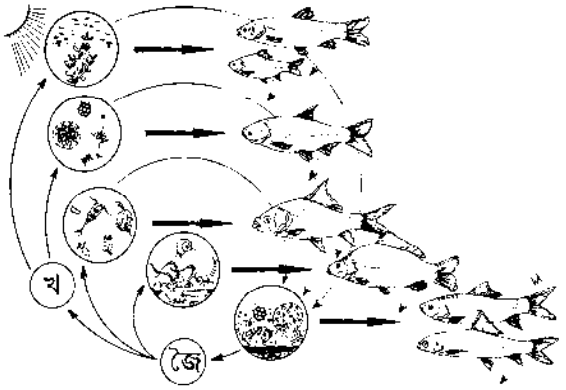


Figure: Food chain in the fish pond

Nutrient fertilizer and excretory materials: Bacteria free the nutrient materials for different actors by decomposing excretory materials of fish and other animals, dead animals and organic matters. Fish survive and grow in a eurotrophic aquatic environment. Fish biomass is comparatively low and fish growth is slow in an oligotrophic pond environment. To run the nutrient cycle of the pond fast forward, nutrient (The nutrient materials that make the nutrient cycle active and are necessary for plankton production are nitrogen and phosphorus. Carbon is also required but it has never been a limiting factor) should be supplied as much as possible (ensuring optimum utilization of labour and money and not making the pond environment polluted). Therefore, to maximize the fish production in pond, application of nitrogen and phosphorus at proper doses is essential. Only for this reason, farmers are advised to apply organic and inorganic fertilizers in pond. Because these materials are rich in nitrogen and phosphorus. As an example, it can be said that rice production is much higher in a crop land where fertilizer is used compared to the production of same area of crop land where no fertilizer used. The demand and availability of the nutrient materials is ever changing. This changing demand and availability of the nutrient materials impact on the dose of fertilizer application in fish ponds.

Type of fertilizer: Generally, two types of fertilizers are used in the ponds. Such as –

a. Organic fertilizers and
b. Inorganic fertilizers

a. Organic fertilizers

The fertilizers from animal sources like livestock animals or poultry birds are known as organic fertilizers. The easily available and low cost organic fertilizers are from the domestic animals and birds integrated with fish ponds. Such as cow dung and duck – chicken excreta.

Compost: Decomposed organic (plant – or animal - origin) matters are compost. Improved nutrient rich fertilizer is produced following the particular techniques of decomposition. It is a labour intensive job.

Leftovers of different crops: The remains of different crops with no particular use can be collected and made to fertilizers by decomposing. Though, sometimes the nutritional value of the fertilizers is not much. Nonetheless, as the remains have no alternate utility, compost production using them is rational.

Unused grass and aquatic plants: Unused grass and aquatic plants can be decomposed in an earthen hole and resulting compost can be applied to the fish ponds.

Figure: organic fertilizer application in pond

The importance of organic fertilizers

•The water retaining capacity of sandy and loamy soil increases as a result of organic fertilizer application
•Soil fertility increases
•More or less all nutrient contents necessary for phytoplanktons are available in organic fertilizers
•Preparation of organic fertilizers is not very costly and ingredients are easily available
•Organic fertilizers free nutrient in the pond water through decomposition over relatively long duration

Negative impact of organic fertilizers

- As organic fertilizers are compound matter, the effect of their use in many cases is not evident
- Responsible for carrying the hosts / vectors of disease and parasites

If there are organic matters in the pond bottom and organic fertilizers are applied, dissolved oxygen content drops quickly and production of toxic gasses enhances.

b. Inorganic fertilizers

i. TSP: It is a phosphate fertilizer rich in phosphorus. Commercially the fertilizer is known as Triple Super Phosphate. The chemical formula of the fertilizer is 3Ca(H2PO4)2. 39% P2O5 or phosphate is present in TSP, from which 20% active phosphate is obtained. The fertilizer is available throughout the country. It can be preserved and applied easily.

ii. Urea: It is a nitrogen rich fertilizer and chemical formula is CO(NH2)2. 42-46% nitrogen is present in the urea available in the market. The fertilizer is available in the market in sufficient quantity.

Inorganic fertilizers mainly help in phytoplankton production – which is the food of zooplankton. Urea and TST are used in fish ponds as inorganic fertilizers.

Advantages of inorganic fertilizer

- Commercially and easily available
- Can be applied easily
- Nutrient available in exact quantity
- Work fast

The dose of fertilizer depend on the following aspects

- Soil condition
- The demand from pond water
- Climatic conditions – temperature, cloud, rainfall etc.
- The quality of fertilizer
- The availability of fertilizer, etc.

Comparison between organic fertilizers and inorganic fertilizers

Fertilizers	Inorganic fertilizers	Organic fertilizers
Cost	TSP 30 taka / kg and Urea 20 taka / kg; relatively expensive	Cow dung per kg 0.25 – 1.00 taka. Only labour costs for other organic fertilizers; relatively low cost
Availability	Easily available in all areas and in all seasons of the year	Depend on the ownership of animals and birds. Demands increase based on the seasons.
Preparation	Preparation is easy for appli cation	Can be directly used / applied in integrated farms, ver y minimum requirement of labour.
Quality	Quality mostly remains unchanged . However, some heavy metals are present.	Quality depends on the sources and application methods.

It should be remembered that even though the cost of inorganic fertilizer is high, its effectiveness and impact (in phytoplankton production) is higher than that of the organic fertilizers.

The following aspects need to be considered -

1. The moisture content of fresh cow dung, phosphorus and nitrogen are respectively, 85%, 0.5 % and 0.3%. That means phosphorus present in 153 kg of cow dung is equivalent to the phosphorus of 1 kg TSP which will cost 153 (0.25 taka – 1.00 taka) = 38.00 taka – 153.00 taka. Therefore application of cow dung to fulfill only phosphorus demand of pond is not economically viable.

2. The most important aspect of organic fertilizer is that, it contains many other necessary nutrient contents along with phosphorus and nitrogen. In addition, the fiber of organic fertilizer creates refuge of bacteria that are directly eaten by carps and tilapia.

3. Organic fertilizers have other utilities (like as cooking fuel) and economic values.

4. Organic fertilizers need extra transport cost and preparation is a little labour intensive.

Fertilizer application methods

To ensure expected growth of stocked fish, fertilizer application during pond preparation is essential. It is better to apply organic fertilizer instead of inorganic fertilizer in newly excavated or dry ponds. Ponds excavated in sandy soil have very low quantity or in some cases no organic matter at all. Therefore, high doses of organic fertilizer should be recommended for sandy ponds. If there is a problem of turbidity in the ponds, application of organic fertilizers particularly cow dung is very effective. Application of organic fertilizer also in perennial ponds is helpful. However, fertilizer dose may vary. It depends on the materials that will be used later on. Inorganic fertilizers specially TSP is more effective when organic matters (crop remains and rotten grass) are abundantly available in the pond water. However, in this case, extra nitrogen from ecosystem might not be required. Like lime, the dose of fertilizer also varies. Because the demand of fertilizer depends on a number of factors. Determination of the dose of fertilizers mostly depends on experience.

The sample of recommended fertilizer doses are described in the following table –

Fertilizer	Commonly practiced dose
Cow dung or	5 – 7 kg / dec
Compost or	8 – 10 kg / dec
Duck – chicken excreta	3- 5 kg / dec
Urea	150 – 200 g / dec
T S P	75 – 100 g / dec

Handy techniques of fertilizer application

1. Dry pond: After spreading necessary amount of organic fertilizers (Animal excreta / crop remains / compost / grass) in the pond bottoms, the fertilizers need to be mixed well with bottom soil. Then slowly pond should be filled with water. This will be more effective if the pond is filled with about a foot of water and kept this way for a week under sun light. Finally after applying required amount of urea and TSP, water level should be increased.

2. Water filled ponds: TSP and cow dung should be soaked in adequate water for 12 – 24 hrs. Just before applying the mixture of TSP and cow dung, urea should be evenly applied in the entire ponds.

The timing of fertilizer application: Preparatory fertilizers should be applied 5 - 7 days after liming and 8 – 10 days before fry stoking.

Some useful tips about fertilizer application

- Fertilizers are less effective in acidic soil. In the water with high and low pH, phosphorus precipitates quickly at the bottom.
- Fertilizers are less effective in turbid water.
- The fertilizer activity reduces if there are aquatic plants in the pond water. Because in the competition of nutrient materials, aquatic plants out compete the phytoplanktons.

- If pond water does not retain more than three weeks, the effectiveness of fertilizer decreases.
- In a deep water pond, phosphorus can not act well. Here phosphorus becomes unproductive in bottom sediments as precipitation
- In case of the application of mixed fertilizers, adequate water should be mixed with
- Fertilizers are generally less active if applied in a cloudy or rainy day.
- If water turns to deep (excessive) green, fertilizer application should be stopped temporarily.

As an alternate of nitrogenous fertilizers, nitrogen binding plants can be grown to enhance the fertility of soil. Such as sun hemp (dhoincha) or other leguminous plants can bind aerial nitrogen in their legumes that in turns can increase the soil fertility easily. The dhoincha seed (40 - 50 g per decimal) can be spread at the bottom and dike of dry ponds. After the germination of the plants from seed and filling the ponds with 1 – 1.5 feet of water, all the dhoincha plants should be crashed and mixed with water. After a few days, water will turn to deep green.

Organic fertilizers act directly as the feed of zooplankton and bacteria. Inorganic fertilizers assist in phytoplankton production by releasing nutrients in the water. Cow dung, compost, duck-chicken excreta can be used in fish ponds as organic fertilizers.

Testing of natural food

Due to ponds own fertility and application of fertilizers from external sources, minute plants (phytoplankton) and animals (zooplankton) grow in the ponds that fishes use as food. Primary producer organisms are phytoplankton. For the production of these primary producer organisms, some key nutrients are essential. The key nutrients primarily are carbon, nitrogen and phosphorus and secondarily potassium, calcium and magnesium. In addition, primary producer also need some micronutrients like cobalt, silicon, molybdenum, vanadium etc. Except nitrogen and phosphorus, remaining all other nutrients necessary for production of the natural foods for fish - plankton are more or less present adequately in the soil. Therefore, the supply of only nitrogen and phosphorus is required.

Phytoplankton produce carbohydrate types of food through photosynthesis in the presence of sun light when primary and secondary nutrients are abundantly available in water. This, in turn, increases the production of phytoplankton. That's why the prerequisite of natural food production is adequate nutrient materials and sun light. Therefore, in culturing fish, nutrient materials and sun light should be carefully monitored. In addition, application of organic fertilizers in ponds and the presence of sufficient mud at the pond bottom results in the production of minute animalcules in the pond bottom that are foods particularly for mrigal and carpio.

Minute aquatic plants and phytoplankton produce carbohydrate types of food in the presence of adequate sun light and enhance their growth and production. Therefore, phytoplankton and aquatic plants are primary producer organisms in aquatic food chain. Silver carp, catla, grass carp etc. feed on this produced phytoplankton. The figure shows that the loss of a major portion of energy to pass through the first level towards second level. Again at the third level, zooplankton eater fishes like carps feed on the food of second level and spend a major share of energy by movement and metabolism. The predatory carnivorous fishes of fourth level (boal, shol) feed on the food of third layer. Therefore during stocking fish, we should consider the food levels. If the fishes of fourth level like boal, shol etc. are stocked, fish production will definitely be very low. If the fishes of second level like silver carp, catla etc. are stocked, fish production will be maximum.

Extensive fish culture in ponds needs ample natural food. In that case, stocking density should be low and no supplementary food is required. In case of semi intensive fish culture, natural food should be maintained at medium level, supplementary food should be supplied and stocking density will be medium. In intensive culture system, requirement of natural food is very low, balanced diet needs to be supplied and fish are stocked at high stocking density.

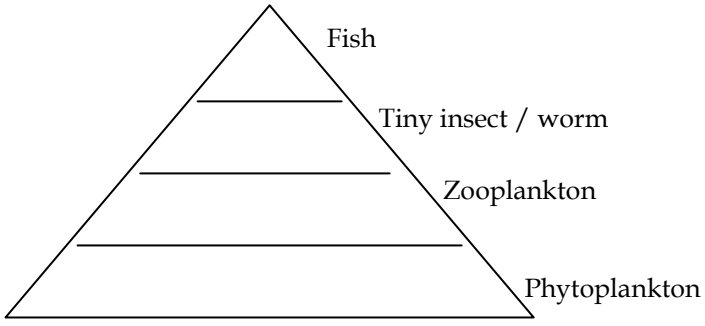


Figure: Food pyramid of fish

Water colour turns to green or brown if adequate natural foods are present in the pond. Water should be tested before fish stocking. The greenish or brown water colours indicate the presence of natural food in the pond water. However, deep green, coppery red or clear waters are not good for fish culture. Therefore, pond water should be tested if there are ample natural foods present in the water or not from eye observation by standing at the pond dyke. In addition, the presence of natural food in the water can be tested by the following techniques –

Secchi disk test: Secchi disk is special plate made from iron. The diameter of secchi disk is 20 cm and colour is black and white. It is hanged by a three coloured nylon thread. From the base of the thread up to 20 cm is red coloured, next 10 cm is green and rest (100-120 cm) is white coloured.

Using protocol: After plunging the thread of secchi disk up to red colour, if the black white colour can not be seen in naked eye, that indicates there is excess natural food in the water. However, this could happen due to turbidly as well. At this condition, fry stocking and food and fertilizer application should be stopped.

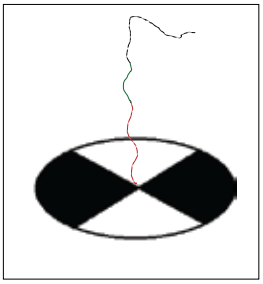


Figure: Secchi disk

After plunging the thread of secchi disk up to green colour if the white colour of the disk can not be seen in naked eye that indicates there is right amount of food in the water. At this condition, spawn and fry can be stocked and no need to fertilizer application. However, to maintain this condition, a little fertilizer and food should be applied at regular basis.

After plunging the thread of secchi disk up to green colour if the white colour of the disk can be seen in naked eye that indicates there is a little food in the water. At this condition, more fertilizer should be applied. If fry are stocked in the pond, supplementary feeding should be continued.

Time of secchi disk testing: Secchi disk should be used between 1 am to 11 am in the morning. Same person should use this at the same place. It should be used standing at the opposite of the direction of sun.

Gamchha (napkin) glass test: After 5-7 days of fertilizer application during pond preparation, the pond water should be taken in a clean drinking glass after filtering / sieving by a gamchha. If minute particle and tiny animalcule (5 – 10 / glass) can be seen inside the glass in the sun light, then this will indicate the presence of natural food in the pond water. This will not work if water is tested in a coloured, printed / stained or opaque glass.

Hand method: If the hand with open palm is plunged in the water up to elbow and palm is not easily seen and water colour is greenish, that indicates there is enough food in the pond water. The hand of children or dirty or blackish palm will not give accurate result. The clean and bright palm is good for this test.

Plankton net (zooplankton): Plankton net is iron made circular ring attached with a net of very fine meshed cloth tied with a small glass bottle at the end. The handle of plankton net is made of iron or wood. Using the handle, the plankton net needs to be pulled at the 0.5 foot depth from the surface within 2 feet distance five times at the same direction to collect the plankton in glass bottle tied with the net. The amount of natural food should be tested by observing the density of plankton in the glass bottle.

Testing water toxicity and fry agreement

The water toxicity is such a state of pond water that creates adverse condition for the survival of stocked fry in the ponds. The toxic materials of water react with blood corpuscles, are accumulated on the gill surface and create obstacles in breathing. As a result, stocked fish may die.

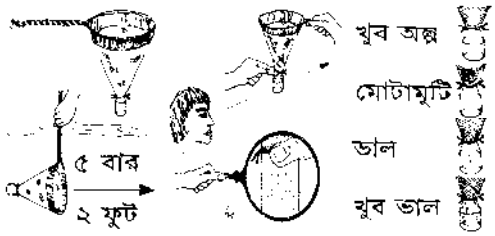


Figure: Testing of the effectiveness of the fertilizer using plankton net

The origin of water toxicity: There may be more than one source of water toxicity. Some examples are given below-

- Application of poison in the pond
- The pesticides used in controlling aquatic insects
- Decomposition of excess organic maters accumulated at the bottom

The importance of testing water toxicity: The longevity of the poison that are generally used in controlling predatory and unwanted fishes in Bangladesh may be 7- 30 days. If fry are stocked before the active period of the poison ends, they may face mass mortality. Therefore, to ensure the survival of fry, water should be tested for toxicity before stocking them in the ponds.

Timing of testing water toxicity: Water should be tested for toxicity 1-2 days before the fish stocking.

Techniques of water toxicity testing: A hapa should be set in the fish pond. Some fry of any fish should be released here and observed for 12 hours. Survival of most (70%) of the fry within this time indicates that pond water is not toxic. If most (70%) of the fry die within this time, then the water is toxic.

Netting or harra pulling in the pond: Toxic gas may be formed in the ponds after fertilizer application. That's why chot net or harra are pulled carefully at the pond bottom to remove the gasses one day before fry stocking. Harra is made with some weighty stuff like broken brick, or chip (kathi) made from earth or iron tied in a rope one after another.

Harra pulling at the pond bottom is a simple task. Though, this does not have a particular technique, to get a good result, the recommendation is harra should be pulled along the extent of pond bottom by holding two ends in a direction and this procedure should be repeated from opposite direction as well.

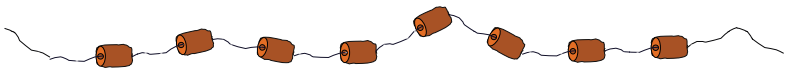


Figure: Harra

This way 6 – 8 times harra pulling can remove more or less all the gasses from the pond. Toxic gasses may be formed at the pond bottom even after fish stocking. That's why, it is better to drag the harra after 15 - 30 days interval. However, in that case, the following cautions should be taken -

- No way should water be turbid due to harra pulling
- Harra should not be pulled in a cloudy or rainy day
- Harra should not be pulled early in the morning before sun rise

Fry agreement

Fish should be stocked as soon as possible after the ponds are ready for fish culture. To do this, plan should be made about fish fry. The most important point in fry purchasing is the good quality fry from trusted source. Keeping this in mind, nursery or hatchery owner should be contacted based on the quantity-wise and species-wise need of total

Group Session Planning

Day – 01	Time – 12.15	Duration – 45 min

Target Group : Carp/Carp-Shing Farmers

Title of the Session : Cultivable species in carp/carp - shing poly culture andmanagement during stocking

Goal : The trainees will get clear ideas on cultivable species in carp poly culture and basic biology of fishes, the features of good quality fry, fry transport and stocking, species selection and determination of stocking density etc. so they will be able to increase fish production in their ponds following the activities properly

Objectives : **At the end of the session**

- Trainees will be able to speak about cultivable species in carp poly culture
- Trainees will be able to speak about basic characteristics of cultivable species
- Trainees will be able to select appropriate fish species and to determine stocking density
- Trainees will be able to identify good quality fry, and transport and stock fish in the ponds

Subjects to be discussed in the session	Training method	Time
Introduction		2 min
1. Welcome: Welcoming the participants and exchange of greetings 2. Review of previous session 3. Linking with present session 4. Explaining the objectives of present session and worlds of encouragement	Discussion Question answer	
Subject matter		40 min
1. Introduction of cultivable species in carp poly culture 2. Basic biology of cultivable species in carp poly culture 3. Species selection and determination of stocking density in carp poly culture 4. Control of predatory fish and harmful insects 5. The features of good quality fry, fry transport and stocking	Question answer Speech Flip chart	
Summary		3 min
1. Review of the major points 2. Verification of the Objective • What do you understand by cultivable species in carp poly culture? • What are the different species of cultivable specie in pond fish culture? • What are the characteristics of good quality fry? • What should be done before stocking fish in the ponds? 3. Distribution of the handouts	Question answer	

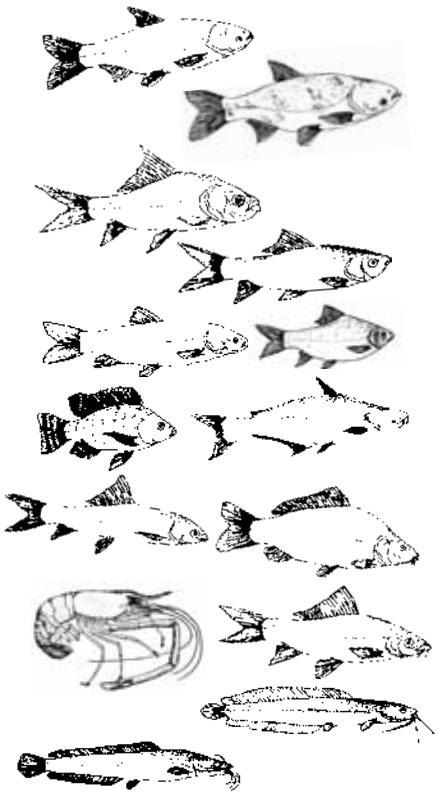
Linking with next session:

Training materials Flip cart, white board, marker, handout and photos of fish

Planning of the flip chart

(Please follow the handout for detailed description)

Cultivable fish species and management during stocking



Stocking density:
Seasonal pond
Samp le of per dec stocking density in carp poly culture

Species	Model 1	M odel 2
Silver carp	8 - 15	8 - 15
Catla	4 - 6	4 - 6
Rohu	4 - 6	4 - 6
Sarpunti	-	24 – 30
Tilapia	40 - 50	-
Grass carp	1 - 2	1 - 2
Common carp	3 - 6	4 - 6
Mola	100 – 150 g	100 – 150 g
Total	60 - 85	45 - 65

Perennial pond
Sample of per dec stocking density in carp / carp - shing poly culture

Stocking type	Model 1	Model 2	Model 3
Silver carp	8 – 12	8 – 12	10 – 15
Catla	4 – 8	-	4 – 8
Bighead carp	-	4 – 8	-
Rohu	8 – 12	8 – 12	10 – 15
Mrigal	4 – 8	4 – 8	6 – 8
Common carp	2 – 4	2 – 4	4 – 6
Grass carp	2 – 3	2 – 3	2- 3
Sarpunti	10 – 15	10 – 15	-
Total	38 - 62	38 – 62	36 - 55

Carp - Shing

Stocking type	Model 1	Model 2
Silver carp	12	5
Catla	4	6
Grass carp	4	-
Rohu	8	5
Mrigal	-	2
Common carp	-	2
Shing	100	700*
Total	128	716

Cultivable fish species in c arp/carp - shing poly culture

Cultivable species are as follows:
Indigenous carp: Catla, rohu, mrigal, kalibaus, bata

Exotic carps: Silver carp, bighead carp, grass carp , common carp (carpio and common carp) and sarpunti

Tilapia: Mixed and monosex fry

(Please add the photos of the fish species with their basic biology here)

The characteristics of good quality fry :
Fish fry

- Healthy fry ar e restless and swimming fast, bad quality fry are calm and quiet
- Good fry are shiny, bad fry are pale
- The body of good fry smooth, the body of bad fry is not smooth (rough)
- There won't be any spot or mark on good fry, red marks can be seen in the body, f ins and gill of bad fry
- If tails are pressed, good quality fry shake head vigorously, bad fry shake head very slowly
- If current is created in a plate full of water, good fry swim against the current, bad fry gather at the center of the plate.

Fish spec ies selection
The following aspects should be considered in species selection:

- Selected species should be able to properly utilize the natural food of ponds
- Able to eat cheap and easily available supplementary foods
- With short food chain and fast growing
- Not of predatory nature
- Local demand and market price are high
- Easily available in the area
- Highly resistant to different diseases
- Do not compete for food
- Respond in both culture type (mono / poly)
- Experience of fish farmers
- Financial ability of the fish f armers

Fry transport and stocking
Causes of fry mortality during transport:
Lack of oxygen
Excessive stocking density
Lesions / wound in the body
Formation of ammonia
Long distance of transport
Physical weakness
Not acclimatized

Transport density of carp fry

Transport method	Size (inch)	N umber / L water	Transport time (hrs)
Oxygenated bag	1 – 1.5	33 – 35	10 -11
	1.5 – 2	20	10 – 12
	2 – 2.5	13	10 - 12
	2.5 – 3	5	10 - 12
	3 – 3.5	4	10 - 12
Hari / Patil	1.5 – 2	15	3 – 4
	3 – 4	5 – 6	3 – 4

Determination of stocking density
The following aspects should be

Cautions during fry transport

Cultivable fish species and management during stocking

About 260 fish species and 24 prawn species inhabit the freshwater of Bangladesh. In addition, 12 more exotic fish are also available allover the country. However, all the fish and prawn can not be cultured in the ponds profitably. From the experience it has been seen that the species –

- Able to properly utilize the natural food of ponds
- Able to eat cheap and easily available supplementary foods
- With short food chain and fast growing
- Not of predatory nature, high local demand and market price
- Easily available fry in the area
- Highly resistant to different diseases
- Do not compete for food
- Respond in both culture type (mono / poly)
- Experience of fish farmers
- Financial ability of the fish farmers

Farming of only those species can yield maximum production and financial benefit. Considering those aspects the species which can be cultured profitably are –

Indigenous carp: Catla, rohu and mrigal

Exotic carps: Silver carp, grass carp, common carp (carpio and common carp) and sarpunti

Pangas: Thai pangas

Shrimp / prawn: Golda and Bagda

Basic features / biology of cultivable species in carp poly culture

Rohu

The body of rohu is more or less spindle-shaped. The head is comparatively smaller than the body. Elongated wide body and gradually narrow towards the tail region. Bilaterally symmetrical depressed body. Entire body is covered with bright scales. Scales are round shaped, smooth and arranged in rows. Fringed serrated lips. A pair of short maxillary barbels.
Figure: Rohu

Their geographical distribution includes India, Bangladesh, Pakistan, Myanmar and Nepal. However, recently they have also been cultured in the Philippines, Sri Lanka, Japan, Malaysia, former Soviet Union and several countries of Africa through export for aquaculture purpose. The fish generally live in the water column (mid layer) of rivers, streams, beels, ponds, ditches, canals, haor, baor and floodplain. Rohu usually thrive on the mid layer of the water bodies and consume food materials from that layer. However, the free movement of rohu is also observed in surface and bottom layer of the water bodies. They feed on natural foods like zooplankton, decomposed organic maters and small insects.


চিত্র- রুই মাছ

Their growth depends on the aquatic ecosystem and culture management. Rohu can grow up to 1.25 kg in the first year and 2-3 kg by second year in ponds and beels. They reach to sexual maturity in two years and spawn during May - July in wild environment. They lay eggs in relatively shallow and flowing water. Rohu can not breed in captive waters. However, mass seed can be produced in the hatchery by induced breeding.

Catla

The head of catla is relatively large, mid portion of the body wide and bilaterally symmetrical. The cleft of mouth is wide, lower lip flashy and wider at the front. The body colour is silvery bright but the ventral side somewhat darker. Catla is found in India, Bangladesh, Pakistan, Nepal, Sri Lanka and Myanmar. However, they are exported to former Soviet Union, China, Japan, Philippines and Malaysia for aquaculture purpose.

Catla is particularly a fish of fast flowing rivers. However, they can inhabit all kids of freshwater bodies like beels, ditches, canals, haor, baor and floodplain. Even they can adapt in semi saline waters. Usually catla live in the upper layer of the water bodies. The species is mainly a zooplanktovorous fish. However, it can consume algae, small insects, plant particles, decomposed organic matters etc. as food from pond ecosystem.

Figure: catla

Catla is a fast growing fish. In can reach maximum 6 feet in length and 45 kg in weight. If ample foods are available catla can be 2-3 kg in a year and 4-5 kg in 2 years. In natural environment, catla attains sexual maturity in two years. However, according to experts, catla does not become sexually mature before 4 years in Bangladeshi environment. Catla does not breed in captivity; spawn in flowing rivers during May – July. Catla can be cultured from the spawn collected from the natural water bodies. Presently, spawns are mostly produced in the hatcheries by artificial breeding.

Mrigal

Elongated body somewhat rounded. Head very small; mouth relatively large. Body colour coppery at the back and two sides and ventral side silvery. The lip of mrigal is thin and upper one relatively larger. Mrigal can be found in entire India and Bangladesh. In addition, it can also be found in Myanmar and Pakistan.

Like rohu and catla, mrigal can also be found in any kinds of freshwater bodies. They are available abundantly in the rice fields during monsoon. They usually live in the bottom layer of the water bodies. They consume food from the muddy bottom sediments of water bodies. Mrigal prefers to eat zooplanktons, small / large insects / worms living at the bottom, decomposed organic matter, mud, sand etc. Mrigal is relative slow-growing compared to the growth of rohu and catla. They can reach 600 – 800 g in a year. Adult fish may reach 3 feet in length.

Figure: Mrigal

Mrigal attains sexual maturity in a year. According to some people, they become sexually mature even in six months. The male fish attain sexual maturity earlier than the female of same age. A mature female of 1 kg mrigal can lay up to 100,000 eggs. Mrigal also does not breed in captivity; spawn in flowing rivers during May – July. However, fish seed can be produced in the hatcheries by induced breeding from April.

Grass carp

Elongated body, wide head, small mouth and lips relatively long. Two rows of pharyngeal teeth present. Grass carp can easily slash the grass using their pharyngeal teeth. The ventral side of the body silvery white; dorsal side blackish grey or greenish. The original geographical range includes China, Hong Kong and the Amur river of Russia. Grass carp was first time brought in our country in 1966 from Hong Kong. Next, grass carp was also imported from Japan in 1970 and from Nepal in 1979. The induced breeding of grass carp became successful in 1980.

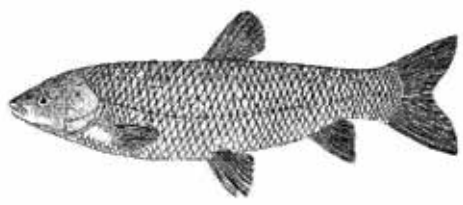


Figure: Grass carp

They inhabit all the layers of ponds, canals and ditches. However, they prefer to swim close to the pond embankment. Grass carp mainly is of harbivorous nature. As fry, they prefer to eat zooplankton and mosquito larvae. As the fish grow, they change their food habit and start eating jhangi, (bladder wort), Hydrilla, Spyrodela, Lemna (khudi pana), water lettuce, duck weed, soft grass etc. from pond environment. They also prefer to eat leaves of banana, potato, drumsticks (Sojne data) and leafy greens of winter supplied from outside. Grass carp consume plant materials 40 – 50 % bw. Even they can eat supplementary feeds like oil cake, rice bran, fish meal etc. like other carps.

Among the exotic fish, the growth rate of grass carp is comparatively higher. If feeds are supplied regularly, they can attain 3-5 kg in the first year of culture. Adult grass carp may reach 1.5 m in length and 30 kg in weight. The mail and female grass carp attain sexual maturity respectively, in 2 and 3 years. They can become mature in captive condition but do not breed. They are bred artificially using pituitary hormone (PG) and human chorionic gonadotropin (HCG) during May – August.

Silver carp

Silver carp by and large looks like hilsa. The mid portion of the body is wide, and narrow towards head and tail region. Mouth is upward like catla. Body is covered with tiny silvery scales. Head and back grayish. The length of their intestine is longer than that of grass carp. As they have numerous gill rakers in their gill, they consume very minute phytoplanktons in large quantity through filtering the pond water.

The origin of silver carp is the rivers of south and central China and the Amur basins. From the original territory, the fish has been distributed in to the different countries of the world for aquaculture and research purposes. The silver carp has been brought in our country form Hong Kong in 1969 and the induced breeding became successful in 1976.

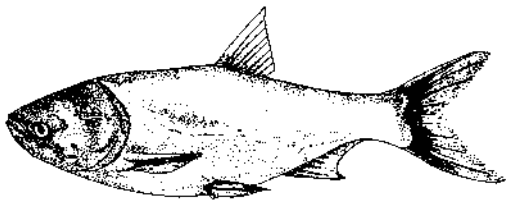


Figure: Silver carp

They thrive in the upper layer of water in the river, canals, ditches, haor, baor and ponds. Comparatively small fry are used to consume zooplanktons. When the fry become relatively larger, they switch their food habit to phytoplanktons, and prefer to continue eating mainly phytoplanktons for rest of the life. The growth rate of silver carp is very high. Under pond culture, they reach 1.5 kg in 1 year and 4-5 kg in 2 years.

Silver carp become sexually mature in 2 years. A fish of this age can lay up to 800,000 eggs. They do not spawn in captive waters. Fry are produced by induced breeding in the hatcheries. Their breeding season starts from the end of March.

Carpio

The head of carpio is much smaller compared to their body, broad abdomen and dorsal side convex like a bow. Body colour is light brown. Body is covered by scale. It is assumed that their original habitat is temperate regions of Asia particularly China. The fish was imported to our country from Hungary in 1960.

They live in the bottom layer of haor, baor and ponds. They intake foods from the bottom of the ponds. For food, they comb through bottom mud and the soil of pond embankments and surrounding and made the soil loose. As fry they eat zooplanktons, the adult carpio prefer to feed on plankton, small / large insects, small snail, earthworm, decomposed organic matters etc. This is also a fast growing fish. Under poly culture system, the carpio can grow up to 1- 3 kg in a year.

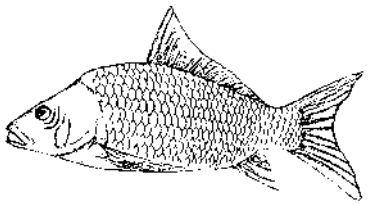


Figure: Carpio

They become sexually mature in 5 – 6 months. They are capable to spawn in captive water and spawn twice a year (January – March and July – August). The fish seed can be produced in the hatcheries as well by artificial breeding.

Sarpunti

Bright silvery body colour, caudal fin forked, the edge of anal and pelvic fin blood-orange coloured. Tip of mouth rounded, two pair of barbels present. The fish was imported to our country in 1977 from Thailand.

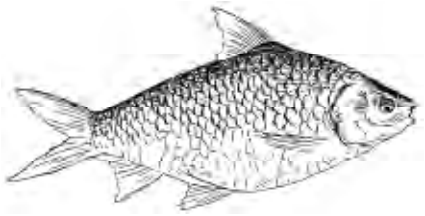


Figure: Sarpunti

They thrive in all layers of the rivers, beels, canals, haor, baor and ponds. As fry, they consume unicellular algae and small zooplanktons. As adult the fish is herbivore. Among the plant materials, their preferred food items are duck weed, hydrilla, soft grass, papaya leaves, banana leaves, cabbage etc.

The fish is fast growing. They reach to table size (100 – 200 g) within 3 – 6 months. In optimal condition in Thailand, the fish may grow to maximum 3 – 3.5 kg, however, in Bangladesh, maximum weights are recorded as 1.0 – 1.5 kg. The sarpunti become sexually mature within a year and spawn during April – May. They do not breed in captivity. Fish seeds are produced in hatcheries by artificial breeding. However, if in particular conditions, such as if water current is present in hatchery connected ponds or rain water can enter in to the ponds with a flow, sarpunti may breed in the ponds as well.

Tilapia / Nilotica

The Latin name of the fish is Oreochromis niloticus. The body of nilotica is ash coloured. Body covered with scales. The number of dorsal spine is 17. The genital of male is conical with forked front. The origin of nilotica is Africa. The fish was imported to our country from Thailand in 1974. They live in small ponds, ditchs, canals, beel, jheel, reservoirs etc. and other shallow water bodies.

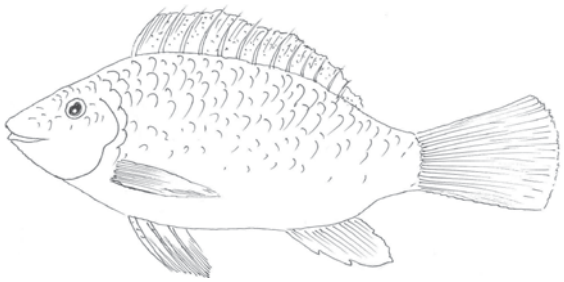


Figure: Nilotica

The main enemy of nilotica is protozoan parasite. The nilotica can be infected by Trichodina and Chilodonella of parasitic ciliate group in the nursery ponds. The disease resistance ability of nilotica is very high. They can eat all kinds of food materials. However, the major foods for tilapia are aquatic algae and insects. As supplementary foods, fine rice bran, mustard oil cake and other balanced diet can be used.

Nilotica become sexually mature within 3 - 4 months. The male tilapia build nest in the deeper part of ponds and water bodies during breeding season. This time male tilapia invites female to spawn in the nest. The larvae hatch inside the mouth of female tilapia. Tilapia multiply rapidly. They spawn 3-4 times a year. Tilapia can be marketed after 3 - 4 months of stocking. They can grow up to 5 – 6 inches within 3 - 4 months. Presently, the demand of tilapia is increasing.

Shing

The Latin name of the fish is Heteropneustes fossilis. Elongated body, tubular at the front. Laterally depressed at the tail region. Naked body, head dorso-ventrally flattened. Body is covered with thin skin. Four pair of barbels present with poisonous spines in pectoral fins. The body colour is nearly blackish. However, the fish looks reddish at young stage. The fish is available in Pakistan, Nepal, Sri Lanka, Myanmar, India and Bangladesh. They live in ditches, beels, canals, ponds and rice fields. The shing is a very tasty fish and very popular because it is believed to be very good for health. Protein (23 g), fat (0.6 g), calcium (670 mg) and phosphorus (650 mg) are present per 100 g shing. The fish is believed to be an excellent food for diseased and anemic convalescent people.

Figure: Shing

Shing eat proteinous food. At young stage they eat phytoplankton and zooplankton. However at adult, they eat mainly insects. They usually eat insects, worms and organic matters at the pond bottom. They even eat decomposed mud and sediments. Shing grow up to 12 – 13 inches. Shing should be marketed live after harvesting using net. Because dead shing fetch very low price in the market. Presently the price of 1 kg shing is 300 – 500 taka. IN recent years, the lesions are observed on the shing body due to infections from different parasites. The fish reach 5 inches in the first year and become sexually mature. The right spawning time for this fish is April – July, however, peak breeding occurs in monsoon.

Mola

The Latin name of mola is Amblypharyngodon mola. The body of mola is covered by thin tiny scales and colour light silvery. The skeleton of mola is soft, upper lip absent, jaws covered with thin cover. Fish grow up to 3.5 inches (I have seen much bigger) in length. The mola is abundantly available in the ponds, ditches, rivers and streams allover Bangladesh. Mola live at the upper layers of water bodies. The fish is generally attacked by dropsy and trichodiniasis. The fish is very useful for small children.

Figure: Mola

Calcium, phosphorus, iron and vitamin A in high quantity are present in mola. At present, the fish has high demand in the market. Mola feed on small insects. They can consume wheat bran, oil cake, rice bran and algae as well. The breeding season is May to October. To allow their breeding, mola should not be caught during this time. The female mola can spawn 500 eggs at a time.

The fish has high market demand. Among all the small fishes, the demand of mola is the highest. When mola reach 1.5 inches, they should be marketed quickly after harvesting with fine meshed net. At present, the market price of mola is 80 – 150 taka per kg. (200 – 400 taka).

Species selection and determination of stocking density in carp poly culture

In extensive and semi intensive fish culture management, the basic principle is ensuring abundance of natural foods in pond water. Different natural foods grow in different layers of pond water such as upper, mid and bottom layer. On the other hand, the fish and prawns that are cultured in ponds, their food habits are different, they live in different layers and consume foods from that particular layer. Among the cultured species, catla, silver carp and bighead carp live in the upper layer, Rohu in mid layer and Mrigal, carpio, mirror carp, pangas and prawn live in the bottom layer of water. Sarpunti and grass carp move through all the layers of water. That's why, if fish or prawn that are stocked live in a single layer, they compete for food and habitat in that layer but other layers remain unutilized. Therefore, considering all the natural foods available in the water layers of pond, required amount of fish of different species should be stocked so maximum utilization of food from all the layers are ensured.

Poly culture not only ensures the proper utilization of natural food and habitat in the waterbodies, it also plays major role in the production of natural foods in the water and protection of pond ecosystem. All stocked fish in the ponds do not consume supplementary food right away. Rohu, mrigal, mirror carp, carpio, grass carp and sarpunti prefer rice bran types of supplementary food, however, catla, silver carp and big head carp do not like rice bran that much. They prefer to consume mainly phytoplankton and zooplankton. On the other hand, sarpunti and grass carp feed on soft grass and aquatic weed. As a result, the quantity of excretory products of rohu, mrigal, mirror carp, carpio, grass carp and sarpunti is relatively high. This excretory products help in the production of natural food for catla, silver carp and bighead carp in water. In addition, the bottom dwelling fishes free the toxic gasses by making the bottom sediments loose during feeding and this way make pond water fertile by mixing the nutrients.

Fish species and their food habits

Fish species	Name of the layer where fish live	Major food items
Silver carp / Big head carp	Upper layer	Phytoplankton / zooplankton
Catla	Upper and Mid layer	Phytoplankton / zooplankton
Rohu	Mid layer	Zooplankton, small insects and algae
Mrigal / Calibaus	Bottom layer	Zooplankton, organic matters and benthos
Common carp / Mirror carp	Bottom layer	Zooplankton, decomposed organic matters and benthos
Grass carp	Upper, Mid and Bottom layer	Aquatic plants, soft grass, weeds, creepers and herbs
Thai sarpunti	Upper and Mid layer	Phytoplankton and animalcule, duck weed
Shing / Magur / Koi	Bottom layer	Zooplankton, decomposed organic matters and benthos
Tilapia	Upper and Mid layer	Phytoplankton / zooplankton
Mola	Upper layer	Phytoplankton / zooplankton

In carp poly culture 6 – 7 different fish species can be stocked. In addition, carp poly culture with golda and pangas is also highly profitable. However, as prawn and pangas live in the bottom layer of the ponds and feed on the natural foods from that layer, that's why it's better not to stock other bottom dwelling fishes such as mrigal, carpio or mirror carp in this type of poly culture. In conclusion, it can be said that the following aspects should be taken in to consideration before deciding – what type of fish should be stocked –

- Regional availability of fry
- Type of culture (mono culture / poly culture)
- Type of ponds (seasonal / perennial)
- The experience of fish farmer
- The marked demand of produced fish species
- Financial ability of the fish farmers

Determination of stocking density: The growth and production of fish largely depends on stocking of particular quantity of fishes covering all the layers of the pond. Excessive fish stocking results in severe scarcity of necessary foods, oxygen and space for fish. As a result, the normal growth of fish is hindered, ecosystem loses equilibrium and outbreak of different diseases occurs. Therefore, farmers do not get expected yield and profit. On the other hand, fry stocked lower than necessary also results low production. Therefore, stocking density of fry should be decided based on the overall condition of ponds and management procedures. The following aspects should be considered in determining stocking density for profitable fish culture:

The productivity of pond: The fish stocking density in a water body may vary based on the quality of soil and water. eg., The productivity of sandy and muddy soil is much lower than the productivity of loamy soil. Accordingly, the stocking density will be a bit higher in the ponds of loamy soil than in the ponds excavated in other soils.

Expected harvest size: Big sized fry should be stocked in low density to ensure timely production of large table size fish. In a particular time frame, high stocking density results low average weight compared to low stocking density.

The size of fry and production cycle: Stocking of large sized fry (4 – 6 inches) results high production in relatively short duration. However, in many cases, large sized fry are not available during stocking, therefore, relatively smaller size of fry are stocked at a slightly higher density. In case of large sized fry, stocking density can be 25% lower than the normal recommended density.

The type of ponds: Stocking density depends on the type of ponds. That's why fish stocking density is different for seasonal and perennial ponds.

Culture method: Stocking densities are different in mono culture and poly culture.

Type of management: When only fertilizers are applied, stocking density should be a little lower. When both fertilizers and foods are applied, stocking density can be slightly higher. If there is provision for partial water exchange and aeration, the stocking density can be even higher.

Stocking density and stocking rate of fry in a pond depend on its physicochemical parameters and culture management. Nevertheless, the experts came up with a generalized model after necessary trials and errors in this aspect. According to fisheries scientist Alikunhi (1971), 3,000 – 3,500 fish fry of different cultivable species can be stocked per ha (2.47 acres = 1 hectare) stocking pond. Other experts also gave their opinions on stocking (per ha) of 2,400 – 3,000 fish under extensive culture system, 3000 – 4250 under semi intensive system and 4,850 – 5,150 under intensive culture system. They also gave general indication on how much fish should be stocked in the upper, mid and bottom layers of 6-10 feet deep ponds. However, estimating layer-wise stocking density of fish following their suggestions is somewhat difficult for a common fish farmer. Therefore, following the expert opinions and considering pond types, culture systems, management etc. different stocking densities (per dec) have further been formulated that are being widely practiced in our country. Some of the stocking densities based on the pond types are described here –

Seasonal ponds

Sample of per dec stocking density in carp poly culture

Species	Model 1	Model 2
Silver carp	8 - 15	8 - 15
Catla	4 - 6	4 - 6
Rohu	4 - 6	4 - 6
Sarpunti	-	24 – 30
Tilapia	40 - 50	-
Grass carp	1 - 2	1 - 2
Common carp	3 - 6	4 - 6
Mola	100 – 150 g	100 – 150 g
Total	60 - 85	45 - 65

Perennial ponds

Per dec stocking density in carp / carp - shing poly culture

Fry of 6-7 species can be stocked in poly culture in perennial ponds. The physical growth and production of fish largely depend on layer-wise stocking density. According to the experts, the stocking density of fish in the different layers of the ponds should be as follows -

Water layer	Species	Rate of stocking density 1	Rate of stocking density 2
Upper layer	Silver carp , catla and big head	40%	40%
Mid layer	Rohu	30%	25%
Bottom layer	Mrigal and common carp	30%	25%
Others	Sarpunti and grass carp	-	10%
Total		100%	100%

As mentioned before shing can be culture with carps or carp poly culture. It is natural to have variation in stocking density and stocking rate in different poly culture as physical structure of ponds, nature of fish species and culture management are different in varying degrees. In the light of general indication of the aforesaid stocking rate, per decimal stocking density in different type of poly culture commonly practiced at the farm level are described here -

Stocking type	Model 1	Model 2	Model 3
Silver carp	8 – 12	8 – 12	10 – 15
Catla	4 – 8	-	4 – 8
Bighead carp	-	4 – 8	-
Rohu	8 – 12	8 – 12	10 – 15
Mrigal	4 – 8	4 – 8	6 – 8
Common carp	2 – 4	2 – 4	4 – 6
Grass carp	2 – 3	2 – 3	2- 3
Sarpunti	10 – 15	10 – 15	-
Total	38 - 62	38 – 62	36 - 55

Carp-Shing stocking density

Recently the popularity of carp – shing poly culture has been observed in the different regions of the country. To obtain expected yield in this type of poly culture the stocking densities described here can be followed -

Stocking type	Model 1	Model 2
Silver carp	12	5
Catla	4	6
Grass carp	4	-
Rohu	8	5
Mrigal	-	2
Common carp	-	2
Shing	100 - 200	700*
Total	128 - 228	716

N.B. In case of stocking density marked with asterisk (*), there should be arrangement for regular water exchange. In addition, stocking densities can be doubled or more than that, if water exchange facility and improved food can be provided.

Fish farmers in different regions are seen to culture some of their preferred fishes like bata, gonia etc. in carp poly culture. In this case stocking densities can be modified based on local experience.

The characteristics of good quality fry, fry transport and stocking

Only fry stocking in right quantity can not ensure good production. To get high yield, good quality fry should be stoked along with maintaining proper stocking density. The quality of fry is largely influenced by the source of fry and their handling. Whatever the reasons responsible for the bad quality of fry, fish farmers may lose huge money if those fry are stocked. If good quality fry are not stocked –

- Mass mortality may occur after stocking
- Growth rate may be low
- As the fish can not grow to marketable size in time, fetch low market price

That's why the quality of fry should be ensured before stocking. The characteristics of good and bad fry are described in the following table –

Good fry	Bad Fry
• The colour is shiny and bright • Scales are glossy • No spot or mark on body and gill • If tails are pressed, fry shake head vigorously • Always restless and fast swimming, if current is creat ed in a container full of water, fry swim against the current • The body structure is normal	• The colour is pale and dull • Scales are rough • Red marks on the body, fins and gill • If tails are pressed, bad fry shake head very slowly • Always calm and quiet, if current is created in a container full of water, fry move with the current or gather at the center of the container • The body is not normal

Fry transport and Stocking

Presently in our country the spawn of carps are transported in polythene bag using modern way and fry are transported in aluminum container by traditional way. However, fry transport in modern way is much safer. Water can be very hot or of low oxygen when fry are transported using traditional method. Even fry may face mass mortality during transport in traditional method. On the other hand, there is no chance of low oxygen or physical damage of fry, when transported in oxygenated bag. Accordingly, fry transport in traditional way needs much caution and preparation.

Causes of fry mortality: Fish fry may die due to more than one reason during transport or instantly after stocking. Generally, the common causes for this type of mortality are described here –

Lack of oxygen: The oxygen demand of fry is relatively higher than that of large fish and prawns. Therefore, if fry are transported in high density, dissolved oxygen in the water of the containers may drop very rapidly and fry may die.

Lesions / wound in the body: Fry may be wounded due to loosing of scale during netting, weighing, counting and transferring to one container from another. The mortality of such wounded fry is high during transport.

Formation of ammonia: Due to the decomposition of excreta of fry and juvenile, ammonia may be formed in the container during transport. This makes the water toxic. Fry die rapidly when the toxicity reaches more than bearable limit.

Long distance of transport: The more the transport distance, more is the physical pressure on the fry. As a result fry may die.

Physical weakness: The mortality of physically weak and diseased / infected fry during transport is much higher than the normal situation.

Not acclimatized: If fry are not acclimatized before the transport, they become vulnerable. Non-acclimatized fry can not take the pressure of transport.

Aspects need to be considered during transport -

• Transport density of fry depends on the species, weight / size, temperature and physiological condition etc. e.g., Transport density of catla and silver carp should be 30% lower than that of other fishes.

• As the temperature increases, oxygen demand of fry continues to increase. Therefore, water temperature in the container during transport should be maintained as low as possible. Generally the metabolism of fish is low at low temperature and a little high pH. To maintain low temperature in the transport container, good quality ice should be added to the transport container at the rate of 10 g / liter water / hour transport distance.

• With the increasing size of fry, transport distance should be shorter with the arrangement of more oxygen supply.

• If the stomachs of the transported fry are full, they pass the excreta in the transport containers. That's why, before the transport, the stomachs of the fry should be made empty. If stomachs of fry are not empty, protein metabolism and action of bacteria on the excretory products increase the ammonia content of water.

• It is better to use 3 g / liter table salt in the transport container to reduce the susceptibility of carp fry to cope the unpleasant situation during transport. However, salt should not be used in case of the transport of fry of pangas and prawn.

Fry transport density: Whatever the transport mode – modern or traditional, the transport density depends mainly on size and weight of fry and transport distance. Generally 36" x20" polythene bags are used in fry or PL transport.

The optimum transport density of fry in modern and traditional methods are described in the following table –

Transport density of carp fry

Transport method	Size (cm)	N umber / L water	Transport time (hrs)
Oxygenated bag	3	33 – 35	10 -11
	4	20	10 – 12
	5	13	10 - 12
	6	5	10 - 12
	7	4	10 - 12
Hari / Patil	3 - 5	15	3 – 4
	7 - 10	5 – 6	3 – 4

Transport density of shing fry

1000 shing fry of the average size of 3 – 4 inches in a container with 5 L of water can be transported to 5 - 6 hours distance.

Techniques of traditional transport

• 2 – 3 L of good quality pond water should be mixed with 10 – 12 L tube well water in the transport container
• After releasing the fry in the container, mouth of container should be covered with a fine meshed net.
• Two third of water of the container should be exchanged at every 2 – 3 hours during transport.

Techniques of transport in polythene bag

The packing and transporting of fry in modern method is more or less similar. The techniques of packing and transporting fry in modern method are described here –

• Feeding should be stopped at least 2 hours before the transport.
• Polythene bags should be examined carefully so the bags do not have any whole
• After inserting a bag to other one, the corners should be tied tightly so the fry are not strangled in those areas. Next 1/3 of the bag should be filled with water.
• Then fry should be released in water and remaining 2/3 of the bag should be filled with oxygen and the top of the bag should be tied firmly.
• If many fry bags are transported at a time, it is much safer to transport the bags keeping in a temperature non-conducting carton.

Cautions during fry transport

- Care should be taken so that the fry bags do not get pressure from any thing.
- Transport patil (pot) should be covered with wet cloths or chat (jute mat).
- Bag / patil should always be kept in a shadowy place during transport.
- Care should be taken so that the fry bags do not get pressed from any hard objects.
- It is better to add 10 g ice / L water/ hr transport distance to keep the water cool.

Environmental conditioning and fry release

The released fry may suffer from mass mortality due to the difference in temperature and oxygen instantly after stocking. This rate of mortality can easily be reduced if the fry are properly conditioned in the new environment. The acclimatization is nothing but bringing the water temperature of transport container and pond at the equilibrium. The step-wise activities of conditioning of fry in new environment are as follows –

• The transport containers should be kept as floating for 15 – 20 minutes in pond water
• After opening the bag or container with fry, water should be exchanged gradually between the pond and the bag / container and the temperature of the two should be brought in to equilibrium.
• The difference between temperature of container and pond should be examined now and then using hand. Temperature should be carefully monitored so the difference of two waters is no more than 1–2o C.
•When the temperature become similar, the bag/pot with fry should be slowly plunged in the pond water and with the help of mild current towards the container, the healthy and strong fry will come out from the container against the current.

Timing of fry release

Fish fry can be released in the pond at any time of the day in cool weather. However, releasing fry in the pond during early morning or late afternoon is better. Fry should not be released in ponds /ghers in the bright sun of noon time, in a cloudy or humid day (particularly in a day of low pressure).

Group Session Planning

Day – 01	Time – 13.00	Duration – 60 min

Target Group : Carp/Carp-Shing Farmers
Title of the Session : Post stocking management
Goal : The trainees will get clear ideas on post stocking activities such as post stocking fertilizer application, supplementary feeding, common problems in fish culture and the preventive measures, disease and health management of fish etc. so they will be able to increase fish production in their ponds following the activities properly

Objectives : **At the end of the session**
- Trainees will be able to speak about post stocking activities
- Trainees will be able to estimate post stocking fertilizer dose and apply
- Trainees will be able to estimate post stocking supplementary feed and apply
- They will know about common problems in fish culture and preventive measures
- They will be able to speak about disease and health management of fish

Subjects to be discussed in the session	Training method	Time
Introduction		2 min
1. Welcome: Welcoming the participants and exchange of greetings 2. Review of previous session 3. Linking with present session 4. Explaining the objectives of present session and worlds of encouragement	Discussion Question answer	
Subject matter		55 min
1. Post stocking activities in fish culture management and their importance 2. Post stocking fertilizer application 3. Supplementary feeding 4. Common problems in fish culture and preventive measures 5. Disease and health management of fish	Question answer Speech Flip chart	
Summary		3 min
1. Review of the major points 2. Verification of the Objective • What are the post stocking activities? • Give the post stocking fertilizer doses? • What do you understand by fish disease? • What do you understand by fish health management? 3. Distribution of the handouts	Question answer	

Linking with next session:

Training materials Flip cart, white board, marker, handout and photos of fish

Planning of the flip chart

(Please follow the handout for detailed description)

Post stocking management	Supplementary feeding: • Importance of feed application • Type of feeds and necessary ingredients • Aspects need to be considered in the selection of feed ingredients • Feeding dose • Feed preparation and application methods • Timing of feed application • Caution s in feed application
Post stocking activities in fish culture management and their importance: • Regular observation of natural feed in pond water • Regular fertilization • Regular supplementary feeding • Regular checking of growth and health status of fish • Record keeping of pond management • Keeping of cost – benefit record	Common problems in carp poly culture and preventive measures : • Entrance of predatory and un wanted fishes • Deep green layer on water surface • Red layer on water surface • Gradual increase of ammonia • Grasping of fish • Disturbance from predatory animals • Excess feed application • Turbidity • Black mud at the bottom • Floating of fish after rain
Post stocking fertilizer application: Importance of fertilizer application • Type of fertilizers • Dose of fertilizers • Fertilizer application methods • Caution s in fertilizer application	Fish diseases and health management: • The causes of disease in fish culture • General sympt oms of disease A. Common diseases of fish: 1.Lesions on fish body 2.Tail and fin rot 3.Dropsy 4.Argulosis 5.Diseases caused by nutritional deficiency
	B. Prevention of fish diseases • Provision of sufficient sun light in to pond water • Regular lime app lication after pond drying • Avoid excess fish stocking • Blocking the entrance of intruding unwanted animals and water from outside • Removal of excess mud from bottom • Application of fertilizer and feed at optim um doses • Avoid frequent netting in the ponds • Prev enting the source of turbidity in the ponds

Post stocking activities in fish culture management and their importance

Post stocking activities and their importance

Fish consume different kinds of phytoplanktons, zooplanktons, bottom insects / worms, larvae, caterpillars, larvae of small insects, bottom earthworm etc. as feed from pond environment. The fish production depends on natural feeds fully in extensive and largely in improved extensive and semi intensive culture managements. The feeds are produced naturally in water bodies with soil and water of average fertility.

The plants and animals found in aquatic environment are dependent on each other for food directly or indirectly. As a result, a nutrient cycle is always active in the ponds. This active nutrient cycle is known as food chain. An important part of the cycle is the release of inorganic nutrients by the decomposition of dead animal or organic matters. Therefoe, the cycle is also known as saprophytic food chain.

The major elements of the food cycle in the ponds are the phytoplanktons, bacteria, aquatic plants, zooplanktons, small insects and worms of the bottom, fishes etc. As they all are involved in production and consumption, they are known as producers and consumers. The position of the producers and consumers are at the three levels of the food chain. Such as –

First level – Primary producers (Phytoplanktons and bacteria)
Second level – Primary consumers (Zooplanktons and herbivorous animals)
Third level – Secondary consumers (Zooplanktivorous fishes and carnivorous animals)

The first level of food chain starts with primary producers – phytoplanktons. They are autotrophs and multiply through absorption of inorganic nutrients. The primary consumers that are present in the next level of food chain are mainly zooplanktons. Zooplanktons depend on phytoplanktons and bacteria of first level for their food. Some herbivorous fish also present at this level and feed on phytoplanktons. Same way, fishes present at third level depend on phytoplanktons and zooplanktons for food that are finally eaten by large predatory fish. On the other hand, the excretory materials and dead plants and animals are accumulated at the pond bottom. Then some particular bacteria and fungus decompose these materials and release the nutrients that are again used for phytoplankton production.

The aforesaid activities run naturally following a regular pattern to maintain the equilibrium of food for the animals living in water. However, when fish are cultured in the ponds, third level consumers consume more and more producers and consumers from the lower levels. This creates shortage of plants and animal at the lower levels. To maintain the nutrient balance at the lower levels, i.e., to accelerate the phytoplankton production, regular nutrients are supplied to the ponds from the external sources after stocking of fish fry.

Post stocking fertilizer application

There are a few more important aspects of post stocking fertilizer application along with supplying sufficient food for fish, maintaining balance in aquatic ecosystem and preserving biodiversity. The natural food produced in water due to the fertilizer application is the typical food for fish. Fish easily consume and digest the natural food. In addition, good nutrient quality and high food conversion ratios of natural food ensure the high production of fish.

Natural foods produced due to fertilizer application remain at the different layers of water. As a result, fish of different species can consume the food easily. Fishes of different species do not go through much competition for food because of the adequate food materials at different layers. Moreover, enough natural food can be produced by the application of fertilizer for the fish species that do not show much interest for supplementary food.

Different nutrients of a balanced food such as carbohydrate, protein, lipid, vitamin, minerals, essential amino acids and fatty acids are sufficiently present in natural food. Accordingly, when fish eat natural food, they grow rapidly with relatively lower incidence of disease infection and of problems related to nutrient deficiency. Therefore, the importance of post stocking fertilizer application in ponds is indispensable for profitable fish culture

Evaluating the necessity of post stocking fertilization

For fish farming the suitable colour of pond water is light green, reddish green or brownish green. Pond water turns to these colours because of the presence of floating phytoplanktons and zooplanktons. Water colours are changed and variations of water colours are observed in the same pond at different times due to the high and low density of floating phytoplanktons and zooplanktons. Therefore, fertilizers should be applied in the pond following the regular checking of high and low density of planktons.

The primary way of examining plankton density or presence of natural foods is eye observation. Water colour can be observed by naked eye standing on pond dyke in a sunny day. If water colour is green / reddish, green / brownish, green, the amount of natural food in the ponds should be estimated using hand or a secchi disk daily or at least twice a week. In a sunny day at around 10 – 12 am in the morning, if the palm is seen after plunging the hand in to the pond water up to elbow or black and white portion is seen after dropping the secchi disk in to the water up to green rope (30 cm), fertilizer need be applied.

The doses of fertilizer

The two essential nutrients for phytoplankton growth are nitrogen and phosphorus and their easily accessible source is organic and chemical fertilizers. Therefore, regular application of cow dung, excreta of duck and chicken, urea and TSP is recommended in the fish culture ponds.

Post stocking fertilizer application following a daily dose is better. However, if daily application is not possible, fertilizer can be applied in weekly basis / installment. Fertilizer are applied either daily or weekly, the doses may differ due to a number of reasons. A model dose of post stocking fertilizer application per decimal per day is given here –

Type of Fertilizer	Sample dose
Cow dung or Compost or Duck – chicken excreta	200 – 250 g 300 – 400 g 100 – 125 g
Urea	3 – 4 g
T S P	4 – 6 g

If daily application is not possible, then daily dose should be multiplied by 7 or by 15 to calculate the weekly or fortnightly dose.

Fertilizer application methods

Cow dung and TSP either together or separately should be soaked in three times more water in a bucket or drum for 12 – 24 hours. TSP must be mixed well with water. Before application, urea should be mixed with the solution of cow dung and TSP and then the mixture should be evenly distributed to the entire pond in a sunny day at around 10 – 12 am in the morning.

Cautions in fertilizer application

- Fertilizer application should be stopped temporarily if the water turns to deep / excessive green.
- No fertilizer application in a cloudy day or day with low pressure
- Urea loses its efficiency if kept open in the air.
- Fertilizers are less effective in acidic and turbid water.
- Mixed fertilizers should be mixed well before application.

Application of supplementary feed

The additional feeds that are applied externally along with the natural foods in water to ensure rapid growth of fish and to obtain high production in relatively short period of time are known as supplementary feed. To ensure normal growth of fish, presence of necessary amount of all nutrient materials like protein, carbohydrate, vitamin and minerals in fish feed is essential. The normal fish growth hampers if any of the nutrient material of necessary quantity is not present in fish feed. In high density fish culture using modern technology, only natural food can not fulfill the demand of fish for all the nutrients. To fulfill these demands of fish, different types of feeds from external sources should be applied in the ponds regularly. The feeds generally applied in fish ponds by the farmers of our country can be divided in to two types based on their sources. Such as –

Plant origin: Rice bran, wheat bran, broken rice, flour, molasses (sticky), mustard oil cake, sesame oil cake, khudi pana (duck weed), kuti pana (Azolla), soft grass, winter vegetables, banana leaves, papaya leaves, potato leaves, drumstick leaves, Napier grass etc.

Animal origin: Fishmeal, powder of prawn / shrimp head, crab powder, silk worm pupae, snail meat, blood of livestock animals, offal of duck – chicken.

Figure: Different types of easily available supplementary feed

Importance of supplementary feeds

Fish and prawn eat zooplankton, phytoplankton, bottom insects, caterpillars, larvae of small insects, bottom earthworms, dead organic matters etc. from pond ecosystem as food for their growth and survival. However, in high density fish culture using modern technology, these natural foods can not supply the necessary nutrient demand of fish. As a result, fish gradually become weak and their growth rate reduces that have negative impact on the overall fish production. To sustain normal growth of fish, application of supplementary feed in to the ponds along with marinating an ecosystem suitable for natural food production is essential.

At present, the average per decimal annual production of fish and prawn in the ponds and water bodies of our country is 6 kg. According to the experts, the production from the water bodies can easily be increased to more than five folds by the application of supplementary feed along with ample natural feed in semi intensive type of fish culture. Some of the important roles of supplementary feed in fish culture are given here -

- Fish can be cultured at high stocking density.
- Fish reach to marketable size in short time.
- Fish mortality decreases at a large extent.
- More production from small water area.
- Disease resistance of fish increases.

Aspects need to be considered in selecting feeds

The fish farmers in our country mainly use oil cake and rice bran as supplementary feed for fish. Other than the two, farmers use such type of food materials that are not economically profitable and even a few materials are detrimental for pond ecosystem. The main objective of the application of supplementary feed is production of more fish. Therefore, in selecting feeds for profitable culture of fish and prawn, the following important aspects should be considered –

- Easy availability of ingredients
- Financial ability of fish farmers
- Cost of ingredients
- Preferred feed for fish
- Nutrient demand of fish
- High food conversion ratio

Nutritional requirement of fish

For a healthy life with rapid growth, presence of all the ingredients of a balanced diet in fish feed is essential. However, among all the nutrients, protein is required in large quantity. For that reason, the nutrient demand of fish is generally known as protein demand. All other nutrients like carbohydrate, lipid and minerals are present in each of the ingredients that are used in the preparation of fish feed. Accordingly if protein demand is fulfilled, there is not much deficiency of other nutrients.

The nutrition demand of fish depends on age and species. The results of experiments show that the nutrient (protein) demand of carps is 35 – 40 %. Therefore, to obtain maximum yield, 35 – 40 % protein should be present in the food consumed by fish. However, fish receive only 5 – 15 % of total protein requirement from the natural feeds. In this consideration, prepared feed with 25 – 30 % protein can be considered as balanced feed.

Calculating nutritional composition of feeds

The research on commonly used fish feed ingredients of our country shows that the ingredients contain high nutrient content. The nutrient analyses of some ingredients observed in researches are given below –

Name of the ingredients	Nutrient content (%)		
	Protein	Carbohydrate	Lipid
Rice bran	11.88	44.42	10.45
Wheat bran	14.57	66.36	4.43
Mustard oil cake	30.33	34.38	13.44
Sesame oil cake	27.20	34.97	13.18
Fishmeal – grade A	56.61	3.74	11.22
Blood meal	63.15	15.59	0.56
Flour	17.78	75.60	3.90
Molasses	4.45	83.62	-
Duck weed	14.02	60.88	1.92
Kuti pana	19.27	50.19	3.49

In calculating nutrient content of fish feed only protein is estimated. The nutrient content of feed prepared from more than one ingredient can easily be determined using general unitary method. The technique of calculating protein content in food is shown below –

Suppose, 1 kg feed is prepared using fishmeal, mustard oil cake, wheat bran and flour as binder. The ratios of the ingredients used are fishmeal - 25%, mustard oil cake – 25%, wheat bran – 40% and flour – 10%. Then the protein content of the feed prepared from the ingredients will be –

Ingredients	Protein content (%)	Dose used (%)	Required quantity (g)	Protein available in feed (%)
Fishmeal	56.61	25	250	14.15
Mustard oil cake	30.33	25	250	8.33
Wheat bran	14.57	40	400	5.82
Flour	17.78	10	100	1.77
Minerals	-	-	1 spoon	-
Total		100	1000	30.07

Selection of ingredients

To prepare fish feed, low cost and high quality ingredients should be selected such a way that the prepared feed fulfills the nutrimental requirement of fish, the quality of feed is ensured and the feed preparation requires low investment. The supplementary feed able to meet up the nutritional requirement of fish can be prepared from the common feed ingredients available in our country like oil cake, rice bran, wheat bran, fishmeal, flour, molasses etc. Considering the financial ability and nutrient requirement of fish, samples of mixed feed at different ratios are given below -

Dose of different ingredients in the feed preparation for carps

Name of ingredients	Sample 1		Sample 2	
	% used	g / kg feed	% used	g / kg feed
Wheat bran	-	-	25	250
Rice bran	45	450	30	300
Mustard oil cake	45	450	25	250
Fishmeal	-	-	10	100
Flour / molasses	10	100	10	100
Total	100	1000	100	1000

In addition to mixed food, khudi pana (duck weed), kuti pana (Azolla), soft grass, winter vegetables, banana leaves, papaya leaves, potato leaves, drumstick leaves, Napier grass etc. should be provided if grass carp and sarpunti are included in carp poly culture. Grass carp can consume green plants up to 40 – 45 % body weight daily. As the individual fish size increases, the feeding rate decreases, however, total amount of feed increases. Daily ration (%) based on the fish size is given in the following table –

Relationship between weight of fish and feed application

Average weight (g)	Daily ration (%)
1 – 5	10
5 – 10	5
10 – 50	4
50 - 500	3

Preparation of supplementary feed: Fish feed can easily be prepared using different ingredients. Fish farmers can also prepare feed by themselves. If possible feed can be prepared using feed pelleting machine. The preparation techniques of mixed fish feed is described briefly here –

- Required quantity of oil cake should be soaked in double quantity of water at least 20 – 24 hours ago and oily water from the surface of the mixture should be thrown away.
- Rice bran, chaff and fishmeal should be sieved properly
- Broken rice should be boiled, if used
- All the ingredients should be mixed thoroughly in a container
- Flour should be boiled in necessary water to make it sticky
- Ingredients should be mixed with sticky matter to form paste and finally small feed balls should be prepared

Supplementary feed application: Fish feed during the day. For that reason, the daily ration should be divided in to two portions. One portion should be applied in the morning at around 10 – 11 am and other portion in the afternoon at 3 – 4 pm. Feed should be applied in feed trays to avoid feed loss and maintain good water quality. To feed carps, the feed trays should be placed 1 foot below the water surface. If using feed tray is not possible by any reason, feed should be applied daily in a few particular locations of pond bottoms.

Green feed application: The feed for grass carp and sarpunti should be applied in rectangular or circular feeding rings made by bamboo split or other materials. The frame should be set at 1- 2 m distance from the embankment. For a 30 decimals pond the volume of the frame is, generally, 10.76 square feet. Leafy plants should be applied as pieces in the frame. Banana leaves need to be made small pieces as well. As the feed finishes, more feed should be put in the frame immediately.

Feed tray: Feed application in trays saves money and ensures proper utilization of feed. In addition, estimation of feed quantity becomes easier.

Making of feed tray: The size of feed tray can be 10.76 square feet or 80 80 cm. The tray can be prepared with a mosquito net tied in a bamboo or wooden frame like a dharm jal. The height of the frame should be 4 inches. Two, four and six feed trays should be placed, respectively, in 30 dec, 60 dec and 100 dec ponds. If used, feed trays should be cleaned regularly.

Figure: Supplementary feed application in ponds.

Cautions in feed applications

- Feed should be applied daily at the same time and same location.
- Feed trays should be checked now and then to examine the amount of feed consumed (if there any leftover) and readjust feed quantity.
- If water turns to deep green, feeding should be reduced or stopped for the time being.

Feed for shing and application

Generally granular pellet feeds are used in shing culture. Shing are fed at 4- 5 pm in the afternoon and 10 – 11 pm at late evening. After stocking, 2 – 3 g shing fry are fed with 20% feed of total biomass. From the second month up to next 2.5 – 3 month, 10% feed of total biomass is applied. From then only 5% feed of total biomass is applied up to harvesting. Under this culture management, shing grow up to 40 – 50 g within 8 – 9 months.

Common problems in fish culture and the preventive measures

High yield and profit in fish culture completely depends on proper management. Even under good management, several technical difficulties may arise during fish culture with a possibility of large scale loss of production. Some of such common technical difficulties in fish ponds are discussed below -

The success of fish culture depends on food selection techniques. It has been observed from the experience of previous years that when farmers selected and applied feed considering the cultured species and size of their mouths, feed wastages reduced substantially and fish production was higher. Again, fish growth is not hampered if feeds are not applied one day in a week and next day fish appetite (feeding rate) increases. This reduces the feed loss and cost of feed.

Entrance of predatory and unwanted fishes

Even after pond drying and application of piscicide, in many cases, predatory and unwanted fish may remain in the fish ponds. Besides, with rain water or during fry stocking, shol, taki, koi, shing, magur, chanda etc. may enter in to the culture ponds. This can reduce the fish production massively.

Preventive measures

The predatory and unwanted fish enters through birds, fishing nets, water current or by human beings. Therefore, fish farmers should be very careful about these sources. By taking the following measures, the problem can be avoided –

- To prevent the entrance of water from external sources
- To be careful in using nets that are used in other ponds
- To monitor the children

Deep green layer on water surface

Water colour turns to deep green because of the presence of excessive algae in water. As a result, dissolved oxygen content drops during night and pH value increases during day. In addition, the dead algae accumulate at the pond bottom and create toxic gasses due to decomposition. In this situation, due to the heavy shortage of dissolved oxygen, fish start grasping on the water surface and sometimes face mass mortality

Symptoms

- Thick layer of algae at the surface of fish pond
- Fish float and grasp (suffocate) at the surface

Preventive measures

- Feed and fertilizer application should be stopped temporarily.
- If necessary, water should be exchanged.
- Lime at the rate of 1 kg / dec should be applied.
- Silver cap can be released for biological control.

Red layer on water surface

The red layer on the water surface forms due to the presence of excess iron or Euglenoid algae in pond water. This results shortage of food and oxygen in water.

Preventive measures

- The red layer floating on the pond surface can be pulled and picked up using a rope made by coiling rice straw or banana leaves.
- Spreading urea 2- 3 times at the rate of 100 -125 g / dec on the pond surface may result good outcome.
- Application of alum at the rate of 100 g / dec gives good result.

Excess ammonia

Ammonia may form at the pond bottom due to many reasons. Presence of ammonia at high pH is very detrimental for fish. As the phytoplankton in the pond increases, so does the water pH very rapidly. As a result, fish die in large quantity. When ammonia increases, the blood circulatory system of fish becomes infected quickly.

Preventive measures

- Stopping fertilizer and feed application after reducing stocking density
- 30 – 50 % water exchange if possible and pH control
- At the preliminary stage table salt @ 3.25 kg / dec / foot water can be applied.

Grasping of fish

The problem of fish grasping is very severe in many fish ponds during April – May and August – September. Generally during very early in the morning, fish start floating and grasping on the surface. It happens due to the shortage of dissolved oxygen in water. If shortage of oxygen is very high and long lasting, fish become weak and eventually die.

Symptoms

- Fish grasp on the water surface.
- Fish feebly float on the surface.
- If oxygen shortage becomes very severe, fish start to die and mouth of dead fish remain wide open.
- Snail, mussel and crabs gather near the embankment.

Preventive measures

- Swimming in the water or creating wave in the pond by any means
- Adding water flow to pond by a pump
- Easily available materials or chemicals from the market can be mixed with water and distributed in to pond water instantly. If oxygen shortage is not very severe, 250 – 500 g / acre and if the condition is very severe then 500 – 1000 g / acre oxygen producing chemicals can be applied in the ponds.

Disturbance from predatory animals

Snakes, frogs, crabs, otter etc. directly predate on fish and prawn and significantly reduce the production.

Preventive measures

- Whenever seen, snakes, frogs, crabs and otter should be killed at once.
- To control otter, lime filled egg shell can be placed on the pond dyke.
- Crabs can be caught using a bamboo trap – chai.
- Grass of the areas should be mowed where frogs lay their eggs like where embankment meets pond water.
- Ponds should be kept free of weeds, bush and hedge.

Excess feed application

If more feed are used than necessary, a large portion of the applied feeds are accumulated at the pond bottom and destroy the aquatic environment. As a result, fish easily get infected by different diseases and die.

Preventive measures

- The exact feed quantity should be determined before application.
- The excess mud built up at the place of food application should be removed from time to time.

Turbidity

The turbidity in pond is one of the major problems in fish culture. Excessive floating / submerged materials or minute soil particles create turbidity in water. In addition, pond water may be turbid due to clay particles and dirt washed with rain water. As a result, sun light can not enter in to the water and natural food production ceases. Even fish gill can be damaged due to excess turbidity.

Preventive measures

- Quick lime (1 – 2 kg / dec) or gypsum (1.5 – 2 kg / dec) should be applied.
- Application of alum (250 g / dec) can remove turbidity
- Per decimal 1 kg rice straw tied in a bundle can be put under the pond water.
- Pond dyke should be renovated properly so dyke slide can not make the pond turbid and block the incoming water from outside.
- Application of ash (4 – 5 kg / day) in to the ponds can eradicate water turbidity within a few days.

Black mud at the bottom

Due to build up of extra feed and organic matter at the pond bottom, soil of the bottom turns to dark and smelly. Particularly, the problem can be severe in a pond, where fish culture is going on for long time. As a result, fish may face mass mortality due to the toxic gas at the bottom.

Preventive measures

- Before fish stocking, excessive bottom mud should be removed.
- If mass mortality of fish fry is observed during culture period, water should be exchanged right away and fish density should be reduced.
- Application of feed and fertilizer should be stopped.

Floating of fish after rain

Sometimes, fish start floating on the pond surface just after rain. It happens due to the drop of pH level and toxicity from harmful hydrogen sulfide gas.

Preventive measures

Water pH should be measured after rain.
Every time, after heavy rain per decimal 75 – 80 g quick lime / dolomite should be used.

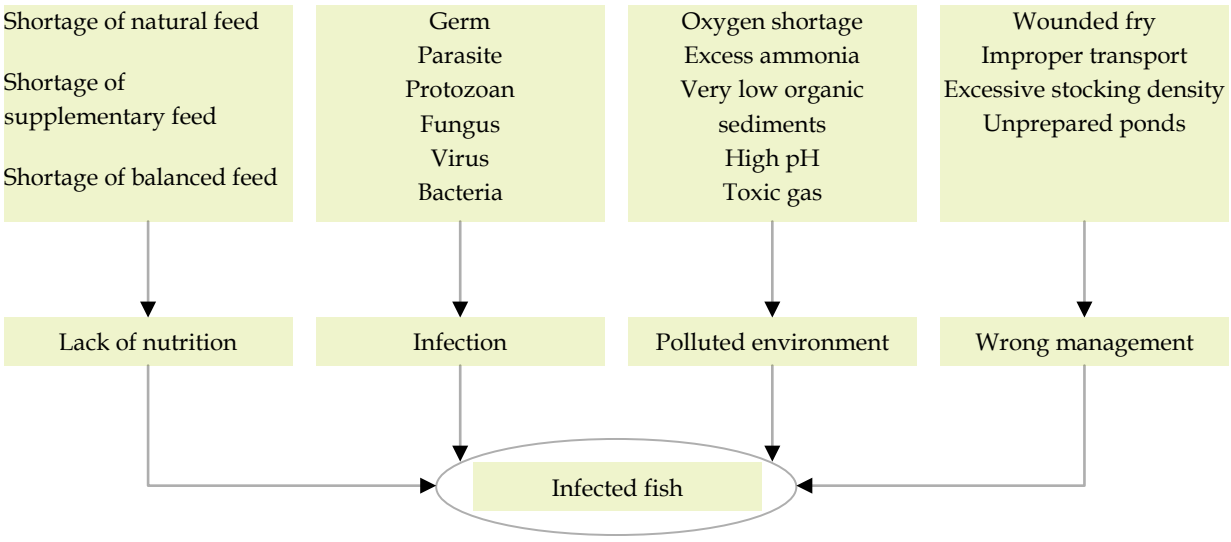
Fish disease and Health Management

A disease is an abnormal condition of an animal exposed by particular symptoms and signs. Like other animals, fish also get infected by various diseases. Due to ignorance and negligence about disease and health management, a lot of fish in the ponds of many fish farmers die every year, farmers become looser financially and the nation become deprived from earning of huge foreign currency.

Cause of diseases: Diseases mainly occur due to the action and reaction of pressure of aquatic environment, germs and pathogens and internal immune mechanism of fishes. For that reason, there may be more than one cause behind the fish disease. The reasons so far identified are as follows -

- Deterioration of the physicochemical parameters of water, e.g., water temperature, decomposed organic matters, pH, dissolved oxygen, ammonia, hydrogen sulfide etc.
- Application of excess feeds and fertilizers
- Entrance of polluted washed water from outside
- Excessive stocking density
- Nutritional deficiency
- Erroneous transport and handling
- Infection from parasites and pathogen

The reasons behind fish disease infection are described in detail in the flow diagram below –



There is a strong relationship between the cause of disease and fish mortality. It has been observed the morality and its rate are much higher when fish die from polluted aquatic environment than from other causes like pathogen, shortage of nutrient materials etc.

Common symptoms of disease

The symptoms fish show are different depending on the types of disease and infectious germs and pathogens. However, the most common symptoms and signs of infected fish are as follows –

- Fish lose balance and swim uncontrollably on the surface
- Lose natural brightness / shininess of the body
- Reduce feeding or completely stop feeding
- Float and grasp on the water surface
- Lose natural colour of gill
- Formation of red / black / white spots on the body
- No greasy slime on the body, body becomes rough
- Fish rub body with something at the bottom
- Eyes become swollen and puffy

Common fish disease

Treating fish disease is very difficult and costly. Because disease diagnosis and treating fish individually are virtually impossible. Nonetheless, treating fish and preventing them from disease should be done in emergency basis. Some common fish disease and their remedies are discussed below -

Fish diseases

1. Lesions / Ulcer

Ulcerative disease is a common problem in fish culture. Polluted aquatic environment is the main cause of this disease. Fish are attacked by fungus, bacteria and virus in this disease.

Symptoms

- At the preliminary stage, tiny red spots are seen on the fish body.
- Gradually red spots turn to deep lesions.
- Rot and lesion are seen on the fish body particularly on tail, fins and operculum.
- Fish do not eat and gradually die at a large quantity.

Prevention and control

- The ponds should be disinfected before stocking.
- In an infected pond, 1 kg lime and equal quantity of table salt / dec should be applied.
- Fish should be fed with 1-2 g oxytetracycline / kg feed over 5 – 7 days.

2. Tail and fin rot: Generally Aeromonas and myxobacteria cause the disease. Though mostly carps are infected, pangas also get infection. Fish are infected from the disease usually in summer and monsoon.

Symptoms

- The colous of fish turn to cloudy.
- Sliminess of skin decreases.
- At the preliminary stage, red spots are seen on tail and fins.
- Fin layers become disintegrated / tattered and gradually rot.

Control

- At the preliminary stage, the infected fin should be cult down followed by bathe in 2.5% brine solution for 2-3 minutes.
- Dip in 2-4 ppm potassium permanganate for one minute
- In an infected pond, 1 kg lime and equal quantity of table salt / dec should be applied.

Prevention

- Lime application in pond – 1 kg / dec

3. Dropsy

Fish get the disease because of bacterial infection. Mainly carps and shing type of fish are infected. Generally the infection is severe in the summer.

Symptoms

- Fluids are accumulated in the abdomen and under the scales.
- Fish abdomen looks like a balloon berceuse of swelling.
- Lesions on the skin are observed, intestine turns to bulgy and scales protrude.

Control

- Fish should be fed with 1-2 g oxytetracycline (Renavet) / keg feed over 4 – 7 days
- Oxytetracycline injection – @ 3 mg / 400 g fish

Prevention

- Application of balanced feed, less organic fertilizer and application of 1 kg lime / dec

4. Argulosis (Fish lice):

All types of fishes can be infected from the disease. Generally, an external parasite known as Argulus attack the fins and space among scales of fish. The infection is usually severe in the summer and monsoon.

Symptoms

- Fish become restless.
- The parasite attached to fish body can be seen by naked eye. Fish rub body with solid things.
- Red lesions are observed on different areas of body.

Control

- Bathe in 10 L water mixed with 200 g table salt
- Pond application of Dipterex 6 – 12 g / dec / foot over successive 4 weeks or
- Pond application of Sumithion 2 – 3 ml / dec / foot over successive 3 weeks

Prevention

- Lime application in pond – 1 kg / dec
- Stop using the net that has been used in infected ponds

5. Disease due to nutritional deficiency

Fish can contact various diseases due to the deficiency of required amount of vitamin and minerals

Symptoms

- Fish show scoliosis / deformity (curvy body and tail)

Control

- No preventive measure for fish with curvy body or tail

Prevention

- Application of balanced feed
- Application of feed enriched with vitamins and minerals.

6. Prevention of fish disease

Treating fish disease for the fish farmers of our country is not only difficult but largely impossible as well because of socioeconomic conditions, unavailability of materials and complexity of treatment methods.

Therefore, it should be remembered that prevention is much better than control. A frustrating issue like treating fish can easily be avoided if following initiatives are taken at the beginning of the fish farming –

- Provision of sufficient sun light in to pond water
- Regular lime application after pond drying
- Avoid excess fish stocking by any means
- Blocking the entrance of intruding unwanted animals and water from outside
- Removal of excess mud from bottom
- Application of fertilizer and feed at optimal doses
- Avoid frequent netting in the ponds and preventing source of turbidity in the ponds

Group Session Planning

Day – 02	Time – 10.00	Duration – 30 min

Target Group : Carp/Carp-Shing Farmers
Title of the Session : Review of the sessions of previous day
Goal : Reviewing the activities of yesterday, getting reflection of everyone and making clear some aspects, so the trainees can recall already discussed matters and this way make the sessions more effective

Objectives : **At the end of the session**
• The trainees will reach in agreement through reviewing the learning of previous day and correcting the mistakes and inaccuracy, if any

Subjects to be discussed in the session	Training method	Time
Introduction		2 min
1. Welcome: Welcoming the participants and exchange of greetings 2. Review of previous session 3. Linking with present session 4. Explaining the objectives of present session and worlds of encouragement	Discussion Question answer	
Subject matter		55 min
1. Reviewing the activities of yesterday by a trainee 2.Reflection on the discussed matter of yesterday by all the trainees	Question answer Speech Flip chart	
Summary		3 min
1. Review of the major points 2. Verification of the Objective	Question answer	

Linking with next session:

Training materials Flip cart, white board and marker

Group Session Planning

Day – 02	Time – 10.30	Duration – 45 min

Target Group : Carp/Carp-Shing Farmers
Title of the Session : Fish sampling, harvesting - restocking and marketing
Goal : The trainees will get clear ideas on checking the growth of stocked fish, marketing the saleable fish and restocking of fish fry in the ponds, and further actions so they will be able to reduce the risks in fish culture, to produce fish in ponds effectively and to increase income from fish culture

Objectives : **At the end of the session**
- Trainees will be able to examine fish growth in ponds
- Trainees will be able to market the marketable fishes
- Trainees will be able to restock fry in ponds

Subjects to be discussed in the session	Training method	Time
Introduction		2 min
1. Welcome: Welcoming the participants and exchange of greetings 2. Review of previous session 3. Linking with present session 4. Explaining the objectives of present session and worlds of encouragement	Discussion Question answer	
Subject matter		55 min
1. Sampling of cultured fishes 2. Harvesting and restocking 3. Fish marketing	Question answer Speech Flip chart	
Summary		3 min
1. Review of the major points 2. Verification of the Objective • Why are the cultured fishes sampled? • What do you understand by partial harvesting and restocking? 3. Handout distribution	Question answer	

Linking with next session:

Training materials Flip chart, white board, marker and handout

Fish sampling, harvesting - restocking and marketing

Sampling of cultured fishes

Sampling is a procedure where a representative number of fishes from the ponds are caught by seining to get clear ideas about the growth rate of fish, their total biomass and health condition.

Importance of sampling

To know the growth rate of fish
To determine the total biomass of stocked fish in the pond
To verify the appropriateness of the quantity of applied feed
To redetermine the quantity of applied feed
To know if fish reach harvestable size
To examine fish health, diagnose disease and take necessary actions

Sampling method

To get accurate result from sampling, at least 5 – 10 % of total stocked fish should be caught. If sampling of 5 - 10 % fish is not possible, a minimum of 30 – 40 fish should be sampled. The growth rate, physical condition, different organs, fins and gill and slime on the body of caught fish should be carefully examined. In addition, fish should be thoroughly examined for the spot / acne or attached parasites on body. Then species-wise fishes should be weighed separately and the individual mean weight of the particular species should be multiplied with the total number of stocked fish of that species to get the species biomass. This way, species-wise biomass should be estimated and added all the stocked species to get the total biomass of the pond.

Aspects need to be considered in sampling

- All fishes – small to large stocked in a pond should come under sampling.
- Using a seine net is good for sampling. However, if a seine net is not available, a cast net can also be used to sample a small pond. In that case, fish for sampling should be caught from different locations of the pond.
- Seine net with proper preparation should be pulled such a way that 90% or more fish are caught in the first haul. By no means, net should be pulled more than twice. Because the stress fish come across by a single haul in pond needs 1 - 2 days to recover.
- After keeping the selected fish for sampling in a hapa, the rest of the fish in the net should immediately be released in to the pond.
- Sampling should be completed as fast as possible and instantly after sampling, the fish should be released very gently in to the pond
- Sampling needs to be started after 1 – 2 months of stocking, that is, when fish become a bit larger and should be continued at least once a month

Fish harvesting and restocking

Harvesting is catching fish from pond for family consumption or for selling to others. Harvesting using right mode and right time is essential for profitable fish culture. Fish can be harvested from pond by two methods. Such as - 1. Partial harvesting and 2. Complete harvesting. Every pond has a particular carrying capacity. When fish biomass reaches the carrying capacity in a pond, the growth rate of fish of that pond slows down or stops at all. However, feeding and fertilization are still continued in that pond. As a result, fish framers become loser financially. Before pond biomass reaches carrying capacity, if large fishes are caught, rest of the small ones get the opportunity to grow larger and as a result, overall pond production increases. Therefore, if possible, partial harvesting is the most logical. In addition partial harvest reduces the risk of theft and natural disaster and farmers get good market price from timely sale. Fish harvested either partially or completely, the general aspects need to be considered in fish harvesting are as follows -

- The size and weight of fish
- Total biomass of fish
- Market price
- Risk
- Availability of fish for restocking

Size and weight of fish: Naturally all fish do not grow at the same rate. Therefore, for financial gain, it is better to create the condition for small fish to grow large through partial harvesting of large fishes. Fish should be harvested when they reach the following weights –

Catla	**:** 500 g or more
Silver carp and grass carp	**:** 750 g or more
Rohu	**:** 400 – 500 g or more
Shing	**:** 40 – 50 g

Biomass: Biomass is the total weight of stocked fish in a pond
The appropriate per decimal biomass under different culture systems are as follows –
Extensive culture: 8 – 10 kg
Improved extensive culture: 12 – 15 kg
Semi intensive culture: 20 – 25 kg
Intensive culture: 40 – 50 kg or more

Market price: As financial benefit is very closely related with fish culture, the link between fish harvesting and market price is very crucial as well. Market price fluctuates based on regions and seasons. Fish should be harvested taking in to account the advantageous market price.

Fish harvesting method: Harvesting method is normally selected based on the area of water body and quantity of harvest. Fish harvesting methods generally are three types –

Seine net method: Normally seine net is used in big ponds to catch large quantity of fish. The mesh size should be smaller in relation to fish size. The breadth of net should be twice the water depth and length should be 1.5 times of the pond length. Netting should not be done more than twice a day in same pond. Fish go through severe stress during netting and small fish die from wounds. After pulling the net, large fish should be caught immediately and small fish should be released without any unnecessary delay.

Cast net method: If the quantity of fish is not much, operating cast net is better.

Pond drying method: This method is most suitable for harvesting shing. In this case, the pond is drained out completely and fish are caught.

Time of harvesting: Fish should be harvested in a cool and clear weather. Specially, early morning is good time for fish harvesting. Besides, the timing of local market should also be taken in to account.

Restocking
To get high production, fish production cycle in the pond needs to be continued year-round. To continue the production cycle, whenever fish of any species are harvested, fish of that species should be restocked by equal number and 10 – 15 % extra. Considering the 10% mortality in the restocked large fry, extra fry should be stocked. Therefore, if 100 fish are harvested, 110- 115 fish should be stocked. The stocking is known as restocking. Thus, before partial harvesting, the availability of fry for restocking should be verified.

Fish marketing
Main aspect of fish marketing is maintaining the quality / freshness of produced / harvested fish. To do this, whatever is needed such as icing after harvesting, packing in hygienic container and transport should be carefully monitored.

Seasonal risks in fish culture
There are a number of risks in fish culture based on the seasons. There are high possibilities of production and economic loss if proper initiatives are not taken timely to counter the risks. Even whole venture can be at grave danger and collapses. The risks are as follows -

Risk in monsoon
The total stocked fish can float away due to damage of embankment or flush flood caused by heavy monsoon rain. Therefore, before the monsoon approaches, all marketable fish need to be harvested.

Risk in dry season
During dry season, water level may drop and pond water depth may go down as well. In this situation, the water temperature may rise quickly and results in the drop in dissolved oxygen content. As a result, all fish in the pond might die. Therefore, before this situation, all marketable fish should be harvested.

Winter risks
Since 80s, outbreak of epizootic ulcerative syndrome (EUS) has been observed in our country. The outbreak of the disease is generally high during November – February. The possibility of the disease increases if there is excessive biomass of cultured fish in the pond. Therefore, before this time, biomass of the pond should be reduced through harvesting large fishes.

Theft / poaching
It is a common social problem. As the fish grows to large size, the risk increases. Therefore, if large fishes are harvested, the risk of poaching decreases significantly.

Group Session Planning

Day – 02	Time – 11.15	Duration – 90 min

Target Group : Carp/Carp-Shing Farmers
Title of the Session : Vegetable culture on pond dyke
Goal : The trainees will get clear ideas on the importance of vegetable culture on pond dyke, points to be considered in crop selection, the basic features of vegetables / crop farming on pond dyke etc. so that they will be able to fulfill the nutritional demand of their families and earn an extra income through cultivation of valuable vegetable on pond dyke.

Objectives : **At the end of the session trainees**
- Will be able to speak/tell (?) about the importance of vegetable culture on pond dyke
- Will be able to speak on the points to be considered in vegetable /crop selection
- Will know the basic features of vegetables / crop farming on pond dyke
- Will be able to explain the management features of vegetables /crop cultivation
- Will be able to produce, process and preserve the vegetable seeds

Subjects to be discussed in the session	Training method	Time
Introduction		5 min
1. Welcome: Welcoming the participants and exchange of greetings 2. Review of previous session 3. Linking with present session 4. Explaining the objectives of present session and worlds of encouragement	Discussion Question answer	
Subject matter		75 min
1. Importance, advantages and important aspects of vegetable culture on pond dyke 2. Points to be considered on crop selection for pond dyke vegetable culture 3. Fundamental aspects of vegetables / crop farming on pond dyke 4. Vegetable culture management on pond dyke 5. Production, processing and preservation of the vegetable seeds	Question answer Speech Flip chart	
Summary		10 min
1. Review of the major points 2. Verification of the Objectives • What are the importance of vegetable culture on pond dyke? • What are the important points to be considered on crop selection for pond dyke culture? 3. Distribution of the handouts	Question answer	

Linking with next session:

Training materials Flip cart, white board, marker and handout

Planning of the flip chart

(Please follow the handout for detailed description)

Vegetable culture on pond dyke	• Source of seed / seedling • Time of vegetable / crop seed sowing or seedling transplantation • Special care for seed production • State of plant growth • Maintaining necessary distance • Top dressing of fertilizer • Intercultural operation (very important) • Soil condition Use of organic pesticide instead of chemical pesticide • High y ielding, disease resistant, short cycled varieties, and optimum use of slope and dyke
Advantages / significance of vegetable culture on pond dyke 1. Multiple use of small land holding 2. More profit 3. Fulfilling nutrition demand In addition, importance of vege table culture in homestead pond are as follows: • Year round vegetable supply for the family and combating nutritional deficiency • Extra earning from vegetable sale • Caring of fishes and at the same time attending and taking care of the crops, no extra labour for vegetable on the dyke • Change of food habit through vegetable consumption • Protection from unhealthy environment • Multiple use of resources ensured	Fundamental aspects of vegetables / crop faming on pond dyke • High pond dyke • Medium high pond dyke • Low p ond dyke • Medium low pond dyke • Wide pond dyke • Narrow pond dyke etc.
Important aspects of crop selection for pond / gher dyke culture • Type of dykes • Availability of sunlight • Soil type / quality • Market price • Financial ability of farmers • Vegetable / crops o f same Family	Vegetable culture management on the dyke of pond / gher 1. Mulching 2. Shading 3. Irrigation 4. Weeding 5. Soil loosening 6. Thinning of seedling 7. Top dressing of fertilizer 8. Gap filling 9. Earthing up 10. Staking 11. Trellising 12. Pruning and fruit thinning 13. Pollinatio n 14. Insect management 15. Disease management

Importance of vegetable culture on pond dyke

From the nutritional point of view, an adult human being should consume 200 – 250 g vegetable per day. However, on the basis of the total vegetable produced in Bangladesh, per capita per day share is only 80 – 100 g. Millions are suffering from malnutrition due to low vegetable consumption. Many people are the victim of night blindness, anemia, mouth sores, bleeding gums, beriberi, goiter etc. due to lack of different nutrients. It could be noted that per capita per day vegetable consumption in South Korea and Japan, respectively, is 549 g and 348 g. Therefore, vegetable consumption should be increased to a large extent in Bangladesh. Vegetables are rich in vitamins and minerals. Almost all leafy vegetables contain carotene that is converted to vitamin A after ingestion. Again coloured vegetables like carrot and sweet pumpkin also contain carotene. There are various minerals like calcium, iron, phosphorus, zinc etc. in many vegetables. In addition, lablab bean, yard long bean, pea, pointed gourd, bitter gourd, drumstick, teasel gourd are the best source of protein useful for good health. About 500,000 children in Bangladesh every year suffer from night blindness due to vitamin A deficiency. Again due to the same reason, daily 100 and annually more than 30,000 children become completely blind. Deep green leafy vegetables and coloured vegetables are full of carotene. Therefore, these vegetable are the best medicine to prevent and cure complete blindness and night blindness. To protect the children from the diseases, they should be fed daily with plenty of deep leafy greens and coloured vegetables since the age of 5 months.

It has been known that vegetables have cancer fighting abilities. Regular vegetable consumption can protect people from skin disease, scurvy, mouth sores, rickets, anemia and many such diseases. Vegetables are so beneficial for human body that physicians now-a-days recommending those to the patients suffering from diabetes, heart disease, skin disease and many other diseases. Fibers in vegetables are very good for curing constipation. There are no side reactions of vegetables. According to nutritionists, the vegetarians live longer. Therefore intensive vegetable cultivation on the pond dyke could easily meet the demand of the vegetable requirements of a family and thereby help fighting malnutrition of HH members.

Vegetable culture on the dyke of ponds / ghers is a kind of integrated culture management. And the integrated culture is producing multiple crops simultaneously in same land to earn extra revenue by ensuring maximum use of land and maintaining environmental balance. Such as rice cum fish and prawn culture, fish cum duck and chicken culture, rice cum fish and vegetable culture and fish cum livestock culture etc. Though the integrated farming is a relatively new concept in our country, it has been practiced from ancient time in other countries of the world. It is necessary to popularize integrated culture management for the rapid development of rural economy of our country.

Vegetable culture in the dyke of ponds / ghers

Vegetable culture on the dyke of ponds / ghers is culturing diversified vegetables and crops on the dykes of fish culture ponds / ghers following improved management considering the type of dyke, market demand and production season.

Importance of vegetable culture on pond dyke with fish

Vegetable culture on the dyke with fish is a modern culture management. This ensures maximum utilization of small land area. Through culturing vegetables one after another, on the dyke of pond / gher -

The taste of fresh vegetables is wonderful. Needless to say the nutritional quality of fresh vegetables is superb as well. Please ensure the extra earning and HH nutrition with pesticide free vegetable by vegetable culture on the dykes of your own ponds / ghers.

- Year round vegetable supply for the family and combating nutritional deficiency are ensured
- Extra earning from vegetable sale is obtained
- Caring of fishes and at the same time attending and taking care of the crops, no extra labour for vegetable on the dyke
- Change of food habit through vegetable consumption is possible

- Protection from unhealthy environment
- Multiple use of resources ensured
- Food supply increases in the markets
- Different crops can be grown in short time and with low investment

Points to be considered for crop selection for vegetable culture on the dykes of pond / gher

Crop/vegetables should be selected considering the type of dykes, availability of sunlight, soil type or quality, market price, financial ability of farmers, availability of seeds / seedlings, consumers' demand and whether the selected crops / vegetables damage the dyke or not. Besides, crops of the same family should not be cultivated in a land as they get infected by same type of diseases, attacked by same type of pests and compete for same kind of nutrients. The following aspects should be considered in selecting crops:

- Type of dykes
- Availability of sunlight
- Soil type / quality
- Market price
- Financial ability of farmers
- Vegetable / crops under same Family

The following matters should also be taken into account:

- Source of seed / seedling
- Timing of vegetable / crop seed sowing or seedling transplantation
- State of plant growth
- Maintaining necessary distance
- Top dressing of fertilizer
- Intercultural operation (very important)
- Soil condition
- Use of organic pesticide instead of chemical pesticide
- High yielding, disease resistant, short cycled varieties, and maximum use of slope and dyke

Preparation of dyke of pond / gher

Vegetables / crops should be selected depending on the type of the dyke. Culturing all kind of vegetables / crops in a particular dyke is not possible. Dyke should be prepared such a way that it suits that particular vegetable / crop. Based on the land type, pond dykes can be of many types, such as:

- High pond dyke
- Medium high pond dyke
- Low pond dyke
- Medium low pond dyke
- Wide pond dyke
- Narrow pond dyke etc.

Dykes of ponds / ghers need necessary modification for vegetables / crops cultivation. This could be done by following ways:

- For cultivating vine vegetables in low dyke, land should be elevated maintaining regular distance with earth or fertile soil from pond bottom. The size of pit will depend on the crops.
- For cultivating any crops in low and narrow dyke of ponds /ghers, dyke should be made little wider and elevated using necessary earth
- If the structure of the dyke of pond /gher is suitable for crop culture, the topsoil of the entire dyke should be dug with a sped and weeds should be removed and the earth should be made clod-free, soft and loose.
- For multi-layer vegetable culture, the entire dyke should be dug with a sped and weeds should be removed and the earth should be made clod-fee, soft and loose
- If a dyke is used for human movement, for culturing crop in that dyke, the side of the land connected with dyke of pond / gher should be made elevated (heap) using the earth for other lands.

• Without any modification of the structure of the dyke of pond / gher, the dyke can be made suitable for crop culture by making pits at particular distances

• For crop culture lands are prepared this way. During the preparation of dyke of pond / gher, required quantity of organic and inorganic fertilizer should be applied to make the land fit suitable for crop farming. Depending on the width of the dyke of pond / gher, crop can be cultured using one row or two row methods.

Pit formation on dyke

Bean or vegetables of cucurbit group such as bitter gourd, wax gourd, bottle gourd etc. can be cultured in the pits on the dyke of pond / gher. In that case good yield can be obtained by setting a machan (trellising) or sticking the base of bamboo sticks.

Size of pit /hole:

Bottle gourd, sweet gourd: 1 cubit 1 cubit 1 cubit
Ridge gourd, snake gourd, cucumber, teasel gourd, bitter gourd: 15 inches 15 inches 15 inches
Lablab bean: 1.5 feet 1.5 feet 1.5 feet

Distance from one pit to other:
Bottle gourd, sweet gourd: 4.5 cubits
Ridge gourd, snake gourd, cucumber, teasel gourd, bitter gourd: 3.5 cubits
Lablab bean: 5 feet

Fertilizer application in dyke pits:

Fertilizer	Amount of fertilizer / pit				
	7 – 10 days before seedling plantation	7 – 10 days after seedling plantation	30 - 35 days after seedling plantation	50 - 55 days after seedling plantation	70 - 75 days after seedling plantation
Organic	10 kg	-	-	-	-
T S P	100 g	-	-	-	-
Urea	-	25 g	25 g	25 g	25 g
MoP	40 g	20 g	-	-	-
Gypsum	15 g	-	-	-	-
Zinc	10 g	-	-	-	-
Borax	10 g	-	-	-	-

Vegetable model in dyke and slope of pond

Suitable place	Rabi crop	Kharif crop
Pond dyke and slope	Tomato, lablab bean, knol khol and bottle gourd	Bitter gourd, cucumber, bottle gourd, wax gourd, lady's finger / okra, sweet gourd

**Other than the listed crops, farmer may select any other crop depending upon the dyke and season*

Management of vegetable culture on the dyke of pond / gher

To ensure proper growth and to obtain expected yield from vegetable cultivation, the activities carried out starting from seed sowing or seedling plantation to crop harvest are collectively known as crop management.

Crop management activities are as follows

1. Mulching
2. Shading
3. Irrigation
4. Weeding
5. Soil loosening
6. Thinning of seedling
7. Top dressing of fertilizer
8. Gap filling
9. Earthing up
10. Staking
11. Trellising
12. Pruning and fruit thinning
13. Pollination
14. Insect management
15. Disease management

Brief description of some of the management activities:

Mulching: Covering plant base or bed with decomposed duckweed, hay, straw, dry grass clipping, leaves of creepers and herbs etc. is known as mulching. The right amount of mulch is 2.5 – 5 cm. The mulch increase the water retaining capacity of soil, reduce the weeds, enhance free movement of air and water through soil, prevents soil erosion, enriches soil with organic fertilizer through decomposing, increases the rate of germination, and make easy to utilize nutrients for the plants. Generally ants and termites build nests in mulch. Therefore mulch sometimes should be altered to deter ants and termites.

Creating shade: During seedling plantation, due to strong sun or heavy rain, seedlings may die or take long time to revive in the soil. Therefore just after the plantation of seedlings, they should be covered with chopped banana plant or some other materials for the protection from strong sun shine or heavy rain.

Irrigation: Irrigation is an important management in vegetable culture. Therefore to meet up the water demand, dyke should be started irrigating from the time of seed sowing or seedling plantation. For vegetable culture, soil should at least have some moisture. Therefore, it is easier to water the plants with a small bucket or a watering can rose. Watering must be done after top dressing of fertilizer. Most 5 – 7 times waterings are needed.

Weeding: Weeds are arch rival of vegetables. Land should be always maintained as free of weeds. Expected production can not obtained if weeds are not controlled timely. Land should be maintained as weed-free up to at least 30 - 40 days after germination. If weeding is done in the morning, the uprooted weeds die in the sun shine.

Soil loosening: During the vegetable culture on the dyke, keeping soil as soft and loose is known as soil loosening. After rain or irrigation soil becomes sticky after drying. Soil can be loosened using trowel, rake, spade, rototriller etc.

Thinning of seedling: Maintaining always right / equal distance of seeds is not possible in vegetable culture using sowing method. In that case, plants become dense after germination. From the dense areas relatively weak and extra seedlings should be uprooted within 8 – 10 days of germination to maintain the remaining plants thin and with equal and right distance.

Top dressing of fertilizer: Top dressing of fertilizer in vegetable culture should be carried out following recommended doses. However, watering must be done after top dressing of fertilizer.

Staking: Staking is essential for vegetative growth of some vine vegetables and some other particular crops. The vegetative growth is hampered if bamboo stick, tree branches or other support is not provided. The plants bend down or flop result in low production. Bamboo, bamboo branches, jute stick sun hemp etc. can be used as staking materials.

Trellising: Vine crops can not grow freely on the land. These types of crops grow rapidly if supports over the land are provided. Therefore, for culturing vine vegetables, trellising should be built using bamboo, bamboo branches, jute stick sun hemp etc to allow the plants to expand their branches.

Figure: Machan for lablab bean

Pruning: The excessive vegetative growth of fruit crops reduces expected yield. Therefore to control plant growth and boost up fruiting, excess brunches / buds should be removed during vegetative growth. Besides, the practice also entails targeted removal of diseased, damaged or dead, branches.

The pruning of top of the ribbed gourd and smooth gourd sapling enhances their early branch expansion and fruiting at the lower stalk. The size of tomato becomes larger due to the pruning of the branches of tomato plant. If the old okra and aubergine plants are pruned, they give fruits earlier than the new saplings.

Pollination: It has been observed in most of the vegetables under Cucurbitaceae family that fruits rot or decompose and fall off within a few days of opening of the female flowers. The lack of pollination due to the absence of insects or bees creates this situation. Therefore, the crops should be pollinated artificially. In the morning or afternoon, a newly opened male flower should be picked up and all the petals should be removed keeping the stamen intact. Then if the top of the carpel of female flower is touched 2- 3 times gently in soft hand with that stamen, pollination occurs. This way using a single stamen, it is possible to pollinate 8 – 10 female flowers.

Figure: Artificial pollination for wax gourd flower

Insect and disease management: Diseases and insects are vicious enemy of crops. If crops are not protected from diseases, their growth ceases and yield drops. In that case instead of using chemical pesticide at the beginning, manual control (Ploughing land properly, keeping neat and clean), mechanical control (Pruning of diseased portion) and biological control (Using beneficial insects) should be followed.

Culture methods of various vegetables on the dyke of ponds / ghers

Name of the vegetables	Variety	Time of sowing / plantation	Sowing / plantation distance (foot / inch)	No. of seeds / dec (40 m^2)	Cropping duration (day)	yield kg / dec
1. Tomato	Improved & high yielding verities	September - October	R R : 2 feet S S : 15 inches	1.5 g / 90 – 100 seedlings	After plantation : 70 – 90 After sowing : 100 -120	70 - 100
2. Lablab bean	BARI Shim – 1 BARI Shim – 2 Baromasi White IPSA – 1 Violet IPSA - 2	Middle of June	R R : 6.5 feet P P : 6.5 feet	40 – 50 g	Early variety : 130 – 150 Late variety : 150 - 200	85
3. Knol khol	Improved & high yielding verities	Aug – Sept – Oct - Nov	R R : 1 foot S S : 9 inches	3.2 g	40 - 60	100 - 120
4. Bottle gourd	BARI -1 (Winter) BARI – 2 (Winter & summer)	August – October and March - April	P P : 10 feet Pit size: 21 × 21 × 18 inches	20 – 25 g	140 – 185	140
5. Bitter gourd	BARI Corolla - 1	February - May	R R : 3.2 feet S S : 3.2 feet Pit size: 17.5 × 17.5 × 17.5 inches	25 g 4- 5 seeds / pit	After sowing : 100 -120	20 - 25
6. Cucumber	Improved & high yielding verities	Mid February - mid April and July - August	R R : 5 feet P P : 5 feet Pit size: 17.5 × 17.5 × 17.5 inches	20 g (direct sowing)	75 - 125	100 - 120
7. Sweet gourd	Improved & high yielding verities	Year round However July – October is better	P P : 10 feet Pit size: 16 × 16 × 16 inches	5 g	100 - 120	150 - 170
8. Wax gourd	BARI Wax gourd – 1	February - May	R R : 8 feet P P : 8 feet	15 – 20 g	120 – 130	80 - 100
9. Okra	BARI - 1	Year round However February – May is better	R R : 2 feet S S : 1 foot 6 inches	25 – 30 g	80 - 100	80 - 120

N.B. R R – Row to Row distance; S S – Seedling to seedling distance and P P – Pit to pit distance

Major diseases of vegetables, introduction to pest and integrated pest management

Name of the vegetables	Name of the insects	Symptoms	Control measures
1. Lablab bean, bottle gourd, cabbage, wax gourd, cucumber	Aphid	Sucks sap from the flowers and fruits. Flowers and fruits fall off	Application of organic pesticides like nim (margosa) oil and tobacco gives good result. Paste is made by mixing 20 ml nim (margosa) oil with 60 g soap powder and the paste will be dissolved in 10 L water. Finally the filtered solution is sprayed on the plant using spray machine. Powder of tobacco leaves is soaked overnight and the filtered solution is sprayed to control Aphid. In addition 10 ml malathion 57 EC or Edma ier-200ml mixed with 10 L water can be properly sprayed
2. Lablab bean, tomato	Pod borer	Nymph and caterpillar enter into the fruits by boring hole and eat the internal part of fruit and fruits become rotten	If symptoms appear at the early stage, the pes t can be controlled by uprooting the infected plants and burying under soil. Even though if the infection becomes severe, 10 ml Lebacid 50 EC or Sevin 85 SP mixed with 10 L water should be sprayed
3. Bottle gourd, sweet gourd, wax gourd and other cucurb it vegetables	Fruit fly	Fruits become rotten at the young stage and fall off	Use of poison bait: 100 g ripe sweet pumpkin is chopped, smashed and mixed with 0.25 g Mispin or Sevin 85 powder in 100 ml water in an earthen pot. It should be placed with three bamboo sticks such a way that the pot with poison bait remains about 1.5 feet above the ground. Bait should be replaced with a new one after 3 -4 days. Use of sex pheromone: The pest can be controlled by placing poison baits or sex pheromone traps in the c rop field at 13 yards distance.
4. Bottle gourd, wax gourd, bitter gourd, ribbed gourd and teasel gourd	Red pumpkin beetle	Adult and caterpillar bore holes in roots or shoots under soil. So the trees become wilted and finally died down from drying	At se edling stage, up to 20 – 25 days, seedlings should be covered with a mosquito net. If the infection is severe 2 – 5 g carbofuran mixed with water per seedling should be sprayed at th base of the plant
5. Okra, tomato and brinjal	White fly	Spread viral di sease	10 ml Malathion 57 EC or Edmier – 200ml in 10 L water should be sprayed at the bottom side of the leaves

Major diseases of vegetables grown on pond dyke and their control measures

Name of the vegetables	Name of the disease	Symptoms	Integrated d isease management
Lablab bean, tomato, papaya	Virus	Papaya leaves turn to green and yellow mosaic coloured. In lablab bean and tomato, leaves become thicker and curly	White fly is the vector of the disease. Therefore to prevent the entry of the fly int o the crop land, organic and chemical pesticides need to be applied at the young stage of plants at every 7 – 10 days intervals. Infected plants should be quickly uprooted from the pond dyke and burnt. To chemically control white fly, 1 ml dimecron / L wat er should be sprayed at 15 days interval. In addition nim (margosa) oil can also be applied.
Okra, sweet gourd and ribbed gourd	Root and foot rot	At young stage, foot of seedling rotten, lodged and fall down	If the infection is observed, irrigation shoul d be reduced. Here 10 g Diathen M - 45 or Rovral - 50 WP or Antracol 70 WP mixed in 10 L water should be thoroughly sprayed at every 7 – 10 days interval at the base of the plants successively 2 -3 times.
Chilli and lablab bean	Anthracnose	Stem/twig and fr uits become ruptured and infected fruits fall off	Infected plants or dead plants should be removed and the dyke should be kept clean. 20 g Diathen M – 45 or Ridomil gold of any fungicide of Mancozeb group mixed in 10 L water should be thoroughly sprayed at every 7 – 10 days interval into the infected plants successively 2 -3 times.
Lablab bean, pea and Indian spinach	Pata dag rog (Leaf spot disease)	Sporadic watery round spot observed on leaves, the spots eventually unite and form large spot	20 g Diat hen M – 45 or Ridomil gold of any fungicide of Mancozeb group mixed in 10 L water should be thoroughly sprayed at every 7 – 10 days interval successively 2 -3 times.

Vegetable seed production, processing and preservation

The prerequisite of good crop production is maintenance and preservation of seed of improved quality. It does not mater how good the crop variety, expected yield can not be obtained if active and fresh seeds are not used. Therefore the necessity of improved seed to increase crop production is undeniable. Different techniques of vegetable seed production are described below –

1. Selection of vegetables and different varieties: The good quality vegetables and their varieties should be selected such a way that seeds can be produced in local environment.

2. Foundation seed collection: Seed should be produced after collecting foundation seed from dependable sources. The seed quality can only be maintained if seeds are produced with foundation seeds instead of other kinds of seeds.

3. Land selection: The following aspects should be taken in to consideration in selecting land for vegetable production -

- Land with good access of sunlight and air
- Fertile loamy soil enriched with organic matter
- Land with good irrigation facilities

4. Selection of cropping season: In case of seed production cropping season needs to be selected such a way that suitable weather is available in that time.

5. Land preparation: The field should be ploughed thoroughly a few times and made free of weeds. Then after breaking the clods, earth should be made soft and loose. Finally basal doses of fertilizer should be mixed with soil.

6. Fertilizer application: At the different stages of cropping, a variety of nutrients are required to ensure proper seed structure, nourishment and increment of yield. In seed production, phosphorus and potassium fertilizers are very effective.

7. Cultivation method: Seed crops must be cultivated maintaining right distance and in line.

8. Weeding: Weeds compete with crops for light – air and nutrient and provide refuse for diseases and pests. If there are weeds in the crop field, they can destroy the genetic purity of seeds through cross pollination.

9. Irrigation management: Irrigation management is very important for seed crops. Due to the lack of the sufficient moisture in the soil, the normal growth and nourishment of seeds is hampered. The pollen dries out, seeds become prematurely ripened due to dryness and yields decrease. On the other hand if there is stagnant water on the land, plant respiration is hindered due to lack aeration, plants die, seed grains turn chita (unfilled grain) and become infected by fungal and viral diseases. Therefore timely water drainage system is necessary to avoid the situation.

10. Disease and pest infection: Infectious disease of seed crops are caused by the pest and diseases. Therefore different prevention and control measures should be followed to protect seed crops from pests and diseases.

11. Roguing: In seed crop field, removing of other vegetables, other varieties and weak, thin and diseased pants of desired crop is known as roguing. The rogues destroy the purity of seeds. Therefore timely removal specially before the pollination of rogues is necessary.

12. Isolation distance: To maintain genital / hereditary purity through preventing cross-pollination, seeds crops are cultivated keeping a particular distance. This is known as isolation. Due to isolation, pollinations do not occur among different varieties, varieties do not mix during crop collection and pests and disease from other crops under same group do not spread to seed crops. Therefore Isolation in seed crops is very essential to maintain health and purity of seeds.

Isolation in seed crops can be maintained using distance and time gap. To carryout isolation by distance in seed crops, the nature of crop should be considered - either the crop is self-pollinated or cross-pollinated. In case of crops that are mainly pollinated by cross-pollination, isolation distance should be longer.

13. Pruning: In cultivating seed crops, the plants become strong, firm and healthy if some unwanted branches, twigs and buds are cut down. The quality seeds are obtained from these plants. The quality of seeds of cucumber, wax gourd, bottle gourd etc. become superior, if 3- 4 main branches are kept and remaining branches are pruned.

14. Fruit thinning: In general, fruits of base and top of the plant are unhealthy and smaller. Therefore if these fruits are picked, the fruits in the middle grow to right size, shape and colour. Therefore good quality seeds are obtained from these well-nourished fruits.

15. Harvest and collection of seed crops: To ensure the quality of seed and high yield, seed crops should be harvested and collected only after the crops mature properly. Both the yield and quality of seeds are affected by the collection of immature or ultra-mature crops. In case of most of the vegetables, all crops or all seeds or fruits of a crop do mature at the same time. The pattern and sign of maturity are different for different crops. Therefore seed crops should only be collected after maturity at the right level.

Seed processing and preservation

Seed processing means cleaning the seed samples of extraneous materials like straw, hay, dust, inert materials and other seeds, drying them to optimum moisture levels, preserving for improved quality and making the seeds usable.

At first with the mild blow or winnowing by a platter and manually straw, hay, dust, gravels, clods and other seeds should be removed. Next seeds should be sieved with different meshed sieves and winnowing with platter to obtain only the right seeds. Then seeds should be sun dried to reduce the moisture to a particular level. Due to the high moisture content, seed quality fast deteriorates and can not be preserved for long time. Seeds are also infected by a variety of pests and diseases. Therefore, moisture content of seeds should be reduced to 6 – 8 %.

Vegetable seeds can be directly dried in the sun putting on chatai (bamboo mat), jut mat, other mats, or polythene on the ground or on the concrete floor. Seeds must not be dried in the strong sun. During drying, seeds should be stirred to ensue equal drying. After proper drying, seeds should be cooled down. To examine the drying at proper level, a few seeds should be pressed with teeth. Croaking sound indicates the proper drying of seeds.

The quality of dried seed remains excellent if stored in any type of tin container or drum. Besides, seeds packed in thick polythene bag can be stored in coloured glass containers with tightly closed top. Powder of nim (margosa), bish katali (water pepper) in small quantity with stored seeds can be used to protect from pests and disease. The stored seeds need to be sun dried now and then to maintain the good quality of seed up to the next season.

Group Session Planning

Day – 02	Time – 13.30	Duration – 30 min

Target Group : Carp/Carp-Shing Farmers
Title of the Session : Economic analyses of fish and vegetable culture and record keeping
Goal : The trainees will be able to maintain the records of fish and vegetable culture and to calculate cost and benefit

Objectives : **At the end of the session**
- Trainees will be able to calculate cost and benefit in fish and vegetable culture
- Trainees will be able to keep the records

Subjects to be discussed in the session	Training method	Time
Introduction		2 min
1. Welcome: Welcoming the participants and exchange of greetings 2. Review of previous session 3. Linking with present session 4. Explaining the objectives of present session and worlds of encouragement	Discussion Question answer	
Subject matter		25 min
1. The economic analyses of carp poly culture (per decimal) 2. The economic analyses of carp shing poly culture (per decimal) 3. The economic analyses of vegetable culture (per decimal) 4. Record keeping	Question answer Speech Flip chart	
Summary		3 min
1. Review of the major points 2. Verification of the Objective 3. Distribution of the handouts	Question answer	

Linking with next session:

Training materials Flip cart, white board and marker

Economic analyses of carp poly culture

Fish culture is a profitable business. In comparison to other agriculture activities, fish culture can give high revenue in relatively short time and low investment. Moreover, there are fewer risks in fish culture. However, the cost and benefit depend on a number of factors –

- Experience of farmers
- Culture type
- Management technique
- Input availability
- Input cost
- Culture duration
- Harvest method and timing
- Marketing facilities, weather and natural condition

To run the fish farming activities, money is needed mainly for lime, poison, fertilizer, feed, fish seed, labour wages, pond renovation etc. The input price varies based on locality, time and situation. Consequently, cost-benefit varies depending on the situation. A generalized analyses of cost and benefit of carp and carp-shing culture per decimal water bodies is described below –

Cost benefit analyses of carp poly culture (per decimal)
Cost per decimal

Sl No.	Items	Quantity	Unit cost (Taka / Kg / Number)	Total cost
1.	**Pond preparation**			
	a. Dyke renovation and weed removal	-	-	100.00
	b. Rotenone (for 4 feet water)	80 g	350.00	28.00
	c. Lime	1 kg	15.00	15.00
	d. Cow dung	5 kg	2.00	10.00
	e. Urea	150 g	20.00	3.00
	f. T S P	75 g	25.00	2.00
2.	**Fish seed**	50	5.00	250.00
3.	**Fertilizer**			-
	Cow dung (2 kg × 2 × 10 months)	40 kg	2.00	80.00
	Urea (75 g × 2 × 10 months)	1.5 kg	20.00	30.00
	T S P (100 g × 2 × 10 months)	2. 0 kg	25.00	50.00
4.	**Restocking**			-
	Silver carp	12	3.00	36.00
5.	Supplementary feed (Mustard oil cake and auto rice bran)	28 kg	18.00	504.00
6.	Lime	1 kg	15.00	15.00
7.	Treatment cost	-	-	10.00
8.	Fish harvesting	-	-	20.00
9.	Miscellaneous	-	-	45.00
Total				**1198.00**

Income:

Fish production per decimal : 25.00 kg
Unit price : 75.00 Taka / kg
Total value of fish (income) : 1875.00 Taka
Total cost of culture (cost) : 1200 Taka (approximate)
Expected profit (Income – cost) : 675.00 Taka

Cost benefit analyses of carp shing poly culture (per decimal)

Cost per decimal

Sl No.	Items	Quantity	Unit cost (Taka / Kg / Number)	Total cost
1.	**Pond preparation**			
	a. Dyke renovation and weed removal	-	-	100.00
	b. Rotenone (for 4 feet water)	80 g	350.00	28.00
	c. Lime	1 kg	15.00	15.00
	d. Cow dung	5 kg	1.00	5.00
	e. Urea	150 g	20.00	3.00
	f. T S P	150 g	25.00	4.00
2.	**Fish seed**	128	5.00	640.00
3.	**Fertilizer**			-
	Cow dung (2 kg × 2 × 10 months)	40 kg	0.50	20.00
	Urea (75 g × 2 × 10 months)	1.5 kg	20.00	30.00
	T S P (100 g × 2 × 10 months)	2. 0 kg	25.00	50.00
4.	**Restocking**			-
	Silver carp	12	3.00	36.00
5.	Supplementary feed (Pelleted feed)	32.5 kg	30.00	975.00
6.	Lime	1 kg	15.00	15.00
7.	Treatment cost	-	-	10.00
8.	Fish harvesting	-	-	50.00
9.	Miscellaneous	-	-	90.00
Total				**2076.00**

Income:

A. Carp production per decimal	:	20.50 kg
Unit price	:	75.00 Taka / kg
Total value of carp	:	1537.50 Taka
B. Shing production per decimal	:	4.80 kg
Unit price	:	400.00 Taka / kg
Total value of shing	:	1920.00 Taka
Total production	:	25.3 kg
Total fish value (income)	:	3457.00
Total cost of culture (cost)	:	2076.00 Taka
Expected profit (Income – cost)	:	1382.00 Taka

N. B. Interest on investment and own labour of framers are not considered in analyses

Cost benefit analyses may vary to some extent because of the variation in the local price of input and market price of fish

Economic analyses of vegetable culture on pond dyke

Calculation of cost benefit of vegetable culture

We have known earlier that crops should be selected based on the type of dyke. Again cost benefit varies based on the crops. Production costs of some crops are relatively very low like red amaranth and water spinach. On the other hand, production costs of some vegetables are relatively high like tomato and bitter gourd. Same way the income from different crops varies as well. Cost benefit analyses of some vegetables suitable for culture on pond dyke are given below –

1. Economic analyses of bottle gourd / sweet gourd / wax gourd / bitter gourd / cucumber culture (per decimal)

Sl No.	Cost items	Quantity	Cost (Taka)	Comments
1.	Plastic rope (*jangla / macha*) and bamboo	1 kg and 1	250	
2.	Land preparation	0.5 labour	100	Family labour along with 0.5 labour
3.	Seed / seedling	5 – 20 g	60 – 130	
4.	Fertilizer	Urea - 2 kg, T S P – 1.8 kg, MoP – 1 kg and borax – 50 g	100	
5.	Pesticide and other management		100	Poison bait / sex pheromone and other pest control
6.	Irrigation	3 times	60	
	Total cost		670 – 740	
	Income items			
1.	Yield	100 – 170 kg	2000 – 2550	15 – 20 Taka / kg
2.	Leaves and twigs	30 kg	300	In case of bottle gourd
	Total income		2000 – 2850	
	Total profit		1330 – 2110	

** Land price, cost of organic fertlizer and family labour are not included*

2. Economic analyses of lablab bean culture (per decimal)

Sl No.	Cost items	Quantity	Cost (Taka)	Comments
1.	Bamboo for mulching	2	200	
2.	Seed / seedling	5 0 g	50	
3.	Land preparation	0.5 labour	100	
4.	Fertilizer	Urea – 350 g, T S P – 100 g, MoP – 300 g and borax – 40 g	30	
5.	Pesticide and others		50	if necessary
6.	Irrigation	3 times	60	
7.	Others		10	
	Total cost		500	
	Income items			
1.	Yield	90 kg	1530 – 1800	17 – 20 Taka / kg
	Total profit		1030 – 1300	

** Land price, cost of organic fertilizer and family labour are not included*

3. Economic analyses of knol khol culture (per decimal)

Sl No.	Cost items	Quantity	Cost (Taka)	Comments
1.	Land preparation	0.5 labour	100	
2.	Seed / seedling	250 seedlings	150	
3.	Fertilizer	Urea – 0.8 - 1 kg, T S P – 400 g, MoP – 400 g, gypsum – 75 g and zinc – 20 g	55	1000 Taka / kg
4.	Pesticide and others		35	if necessary
5.	Irrigation	3 times	60	
	Total cost		400	
	Income items			
1.	Yield	150 kg	1500 – 1800	10 – 12 Taka / kg
	Total profit		1100 – 1400	

** Land price, cost of organic fertilizer and family labour are not included*

4. Economic analyses of okra culture (per decimal)

Sl No.	Cost items	Quantity	Cost (Taka)	Comments
1.	Land preparation	0.5 labour	100	
2.	Seed / seedling	25 g	40	
3.	Fertilizer	Urea – 600 g, T S P – 400 g, MoP – 600 g, gypsum – 280 g, boron – 80 g and zinc – 20 g	60	Cow dung / compost own (cost not included)
4.	Pesticide and others		40	if necessary
5.	Irrigation	3 times	60	
	Total cost		300	
	Income items			
1.	Yield	55 kg	825 - 1100	15 – 20 Taka / kg
	Total profit		525 – 800	

** Land price, cost of organic fertilizer and family labour are not included*

5. Economic analyses of tomato culture (per decimal)

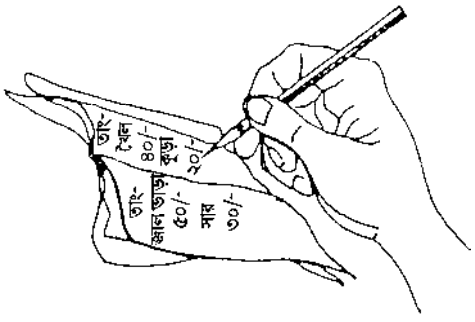
Sl No.	Cost items	Quantity	Cost (Taka)	Comments
1.	Land preparation	0.5 labour	100	
2.	Seedling	150	200	
3.	Staking	3 bamboos	300	
4.	Fertilizer	Urea – 800 g, T S P – 1.8 kg, MoP – 1 kg and borax – 50 g	80	
5.	Pesticide and others		100	if necessary
	Irrigation	If necessary	60	
	Total cost		840	
	Income items			
1.	Yield	210 kg	1680 - 2100	8 – 10 Taka / kg
	Total profit		840 – 1260	

** Land price, cost of organic fertilizer and family labour are not included*

Maintaining records

To verify the success and failure of running any business, record keeping is very important. Necessary record keeping in fish culture not only helps in economic analyses, it also provides future direction for the improvement of culture management. Therefore, from the very beginning to the end of the entire culture period, records on the following aspects should be maintained –

- Physical parameters of the pond
- Water depth
- Description of the activities during pond preparation and the expenses
- Fish seed collection, transport, stocking and the expenses
- Number of fry stocked
- Information on fertilizer application, kinds, weight and expenses
- Information on feed application, kinds, weight and expenses
- Sampling information
- Harvest quantity of fish, prawn, income etc.



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There is no set rule for record keeping. Recording necessary information exactly is more important than the way of recording. Fish farmers can record necessary information by any method according to his/her own advantages. SCISA-BD project use a notebook for record keeping. Besides, by keeping records on the aforesaid aspects, fish farmers can easily maintain breakdown of cost benefit in fish culture.

Some necessary measurement units used in fish culture

12 inches	=	1 foot
435.6 square feet	=	1 decimal
10.76 square feet	=	1 square meter
40.48 square meter	=	1 decimal
1 meter	=	3.281 feet
100 decimals	=	1 acre
247 decimals	=	1 hectare
10,000 square meter	=	1 hectare
1 inch	=	2.54 centimeters
35.31 cubic feet	=	1 cubic meter
1 cubic feet	=	28.317 liters
1 cubic meter	=	1,000 liters
1 kilogram	=	1,000 grams = 2.205 pounds = 1.07 ser
1 metric ton	=	26.7924 maund
1 gram	=	1,000 milligrams
1 liter	=	1,000 milliliters
1 ppm	=	1 milligram / Liter = 1 gram / cubic meter

Cubic feet
35.31 x ppm = gram /milliliter

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