



USAID
FROM THE AMERICAN PEOPLE

SEE
FEED
CHANGE **FUTURE**



উন্নত ব্যবস্থাপনায় ঘেঁরে বাগদা চিংড়ি চাষ প্রশিক্ষণ ম্যানুয়াল

সেপ্টেম্বর ২০১১

সিরিয়াল সিস্টেমস্ ইনিসিয়েটিভ ফর সাউথ এশিয়া ইন বাংলাদেশ
(CSISA-Bangladesh), ওয়ার্ল্ডফিস সেন্টার



IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE



Training Manual on Improved Shrimp Culture in Gher

Cereal Systems Initiative for South Asia in Bangladesh (CSISA-BD) Project
WorldFish Center, House No. 22B, Road No. 7, Block F, Banani, Dhaka-1213

Editorial Committee

William J. Collis
Md. Mokarrom Hossain
Md. Mahbubul Alam Miah
Ashoke Kumar Sarker
Md. Mazharul Islam (Jahangir)
Sattyanarayan Roy
Gopal Chandra Saha
Israt Jahura

Overall assistance

Dr. Benoy Kumar Barman, Dr. Manjurul Karim, Dr. Benjamin Belton,
Dr. Khondker Murshed-E-Jahan, Khandaker Irshad Mahmud,
Bijoy Bhusan Debnath, Khandker Hasib Mahbub, Bilas Mitra,
Afrina Choudhury, Billal Hossain & Md. Humayun Kabir

Published by

Director
WorldFish Center

September 2011

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

Written by

Sattyanarayan Roy, Md. Mizanur Rahman, Sudhindra Nath Sarkar & Biswajit Mondal

Design & Printing

Sparrow Communication (01711-142520)

Training Manual on Improved Shrimp Culture in Gher
A Course Manual for Shrimp Farmers



Preface

Due to inadequate technical knowledge and training in advanced methods of gradually growing shrimp culture, farmers are not getting expected yield. From the very beginning of the CSISA-BD project, WorldFish Center has taken initiative to introduce advanced methods of shrimp culture in south-west of Bangladesh. To do this, the shortage of skilled trainers and training materials, has, particularly, been realized. Presently, a number of manuals on shrimp culture from Department of Fisheries, Bangladesh Fisheries Research Institute, WorldFish Center and different GOs and NGOs are available which are not very user-friendly at farmers' level. The training manual on 'Improved Shrimp Culture in Gher' has been developed by the World Fish Center based on practical experiences from the field 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 Shrimp Culture in Gher' is well-suited to the training needs of extension workers working in different GOs and NGOs and shrimp farmers. Extension workers and shrimp farmers shall be benefited from the manual during project period. The manual can further be improved in the light of the outcomes and experience from field. 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.



Contents

Sessions	Subject matter	Page
	Introduction of Training Manual	ক-খ
Session	Inauguration, Registration and Introduction to the Course	২
Session	Basic Concepts of Shrimp Culture	৪
Session	Shrimp Nursery Management	১৮
Session	Shrimp Production or Stocking Gher Management (Pre Stocking & Stocking)	২৭
Session	Shrimp Production or Stocking Gher Management (Post Stocking)	৩৪
Session	Sampling, Harvesting-Restocking and Marketing	৪৬
Session	Economic Analyses of Shrimp Culture and Record Keeping	৫৩

Training Manual on Improved Shrimp Culture in Gher

Introduction to the Manual and its Application

Shrimp culture in the ghers in the southern part of the country 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 losing money in shrimp culture. With particular emphasis on this, the training manual 'Training Manual on Improved Shrimp Culture in Gher' has been prepared by CSISA-BD Project. We are hopeful that the manual would play a unique supporting role in the improvement of shrimp gher management by 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 farmers live or on the dyke of the gher or any other convenient places.

Training Methodology

Most of the learning matters should be accomplished using participatory approach. Here, ample opportunities would be given to a shrimp farmer to exchange his own views and experience, so all the farmers can easily participate 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. Speech-Discussion and
6. Real Objects and Practical Demonstration
7. Question and Answer

Number of Trainees

Maximum 25 shrimp farmers can take part in the training. Because, the way the participatory techniques have been designed, if the number of trainees are more than 25, there may be problems in effective communication between trainers and trainees. Mainly the manual has been designed for target shrimp 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 materials 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 to each other and assist in achieving learning goals.

Training theme and useful instruction

The themes 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 will be 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. The precondition of this is demand-led 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 directions 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-prepared 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 considering the knowledge and experience of the trainees.
4. Training methodologies and technicality of each session are described in detail. These have been carefully planned to ensure active participation of the trainees in the training. Sticking to the methodologies will ensure the active participation of the trainees 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 for both trainers and trainees.
6. Assessing the success of the training programme is important for both trainers and trainees. Therefore, learning of the trainees needs to 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 lively.

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 others, 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 a 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 understanding.
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.

Timetable

Duration: 2 days

Day	Time	Subject matter/Theme
1	10.00-10.30	Inauguration-Registration and Course Introduction
	10.30-11.45	Basic Concepts of Shrimp Culture
	11.45-12.00	Tea Break
	12.00-13.00	Shrimp Nursery Management
	13.00-14.00	Shrimp Production or Stocking Gher Management (Pre Stocking & Stocking)
2	10.00-10.30	Review of the previous day
	10.30-11.45	Shrimp Production or Stocking Gher Management (Post Stocking)
	11.45-12.00	Tea Break
	12.00-13.30	Sampling, Harvesting-Restocking and Marketing
	13.30-14.00	Economic Analyses of Shrimp Culture and Record Keeping

Group Session Planning

Day – 01

Time – 10.00

Duration – 30 min

- Target Group : Shrimp 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 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 express 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
Introduction		2 min
Welcome: Welcoming the participants, exchange of greetings and sitting arrangement	Speech	
Subject matter		25 min
Distribution of training materials and registration <ul style="list-style-type: none"> • Notebooks, pens etc. should be distributed among the participants • Registration of the name of participants in particular form Knowing each other <ul style="list-style-type: none"> • Trainer will introduce himself/herself to the trainees through chatting and discussion Inauguration of the training course <ul style="list-style-type: none"> • 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 Assessment of the training expectations <ul style="list-style-type: none"> • Trainer will know the training expectation of the trainees Course timetable <ul style="list-style-type: none"> • 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 attach 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 <ul style="list-style-type: none"> • 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

Training Course on Improved Shrimp Culture in Gher

Goal and Objectives of the Training

Training goal

To improve the knowledge and skill of the trainees on shrimp farming so they can get increased yields and more financial benefits from shrimp farming in gher following proper and improved technologies.

Overall objectives

At the end of the course the trainees -

- will be able to talk about basic concepts of shrimp farming
- will be able to work on shrimp nursery management
- will be able to work on shrimp production and gher management (pre-stocking , stocking and post-stocking)
- will be able to sample, harvest, re-stock and market the shrimp
- will be able to analyze the cost benefit and keep the record of shrimp farming

Group Session Planning

Day – 01

Time – 10.30

Duration – 75 min

- Target Group : Shrimp Farmers
 Title of the Session : Basic aspects of shrimp farming in gher
 Goal : The trainees will get clear ideas on importance of shrimp farming, problems, types and methods of culture and other basic aspects of shrimp farming so realizing the importance of the said aspects they will be able to increase shrimp production in their gher using advanced technology
- Objectives : **At the end of the session**
- Trainees will be able to speak on the importance of shrimp farming
 - Trainees will be able to speak about shrimp farming technologies and traditional methods
 - Trainees will be able to explain the properties of soil and water in shrimp farming
 - Trainees will be able to practice of good shrimp culture
 - They will be able to practice good shrimp culture, will get primary idea of principles of HACCP and will accomplish

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 earlier session 3. Linking with present session 4. Explaining the objectives of present session and words of encouragement	Discussion Question answer	
Subject matter		60 min
1. Importance of shrimp farming 2. Shrimp farming methods and traditional culture methods 3. Properties of soil and water in shrimp farming 4. Good culture practice in shrimp culture 5. Primary idea of principles of HACCP at culture level	Question answer Speech Flip chart	
Summary		10 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, marker and handout

Fundamental aspects of shrimp farming in gher

Planning of flip chart
(Please follow the handout for detailed description)

<p>Importance of shrimp farming</p> <ul style="list-style-type: none"> • One of the important livelihood strategies of coastal rural people of Bangladesh • A special position in the export business / foreign currency earning of the country • The shrimp production can be substantially increased only by methodological improvement and application of proper culture management • The farmers can ensure increased production by practicing environmental friendly shrimp culture method and proper management 	<p>If the soil and water parameters of gher are not in the optimum range –</p> <ul style="list-style-type: none"> • Natural food for shrimp will not be produced in sufficient quantity • Supplementary feed will be wasted • Shrimp growth rate will not be as expected • Shrimp may die from disease and other pest • There will be low shrimp production resulting financial loss of farmers
<p>Shrimp culture methods</p> <ul style="list-style-type: none"> • Extensive culture method • Improved extensive culture method • Semi intensive culture methods • Intensive culture method <p>The presently practice shrimp culture methods in Bangladesh :</p> <ol style="list-style-type: none"> a. Traditional culture method a. Improved extensive culture method b. Best Management Practice c. Modified traditional method d. Closed system Technology 	<p>The advantages of water exchanges in shrimp gher</p> <p>Dissolved oxygen content increase in gher water</p> <p>New natural foods are added</p> <p>The fertility of water increases</p> <p>The pollutants generated in gher are removed</p> <p>It helps in moulting of shrimp (shell changing)</p>
<p>Properties of soil and water in shrimp farming :</p> <p>Loamy soil is the best suited for shrimp farming .</p> <p>pH - ?</p> <p>Phosphorus - ?</p> <p>Nitrogen - ?</p> <p>Organic matter - ?</p>	<p>Good aquaculture practice in shrimp farming</p> <ul style="list-style-type: none"> • Location of farm • The water used in culture • Surrounding environment • care and precaution on shrimp feed • Use of different chemical in shrimp farming • The practices need to be followed during harvesting • Caring and preparing for transport
<p>Properties of water :</p>	<p>The step -wise activities of shrimp culture</p>

Improved shrimp farming in gher

Over the last two decades, shrimp farming have become a major livelihood strategy in the rural community of coastal regions particularly in the greater Khulna, Bagerhat and Satkhira districts of south west. The gradual expansion of shrimp farming now has a special position in the export earning of the country along with upliftment fo the livelihood status of the rural community. As the traditional gher method is easy to practice, shrimp farming is expanded widely. However due to absence of proper scientific farming management, the yield of those ghers is very low. Besides, the shrimp farmers face manifold problems including the disease of shrimp. The shrimp production can be substantially increased only by methodological improvement and application of proper culture management. From the visit of farms of the field level farmers and by discussion different aspects of the farm management, it can be concluded that the expansion of shrimp farming is unplanned and myopic. For example, during allowing the tidal water in to gher, most of the gher owners do not use any filter. As a result, with incoming water many other non-target shrimp / prawn and fishes enter in to the gher and compete for food and space with stocked shrimp and destroy the environment of gher. In addition, manifold problems prevail in the shrimp gher due to natural catastrophe. Among these, one of the crucial one is occurrence of unknown viral infection in shrimp. As there are no effective control measures against viral infection, we have to build efficient preventive measures so by no means virus can infect the cultured shrimp. By practicing environment friendly shrimp culture method and management, farmers can ensure increased yield from shrimp farming. It is hoped that if the manual is followed properly and step by step, the positive change in shrimp farming is possible that may play important role in overall increase in shrimp production and in maintaining the quality of shrimp.

WorldFish Center through Cereal Systems Initiative for South Asia in Bangladesh (CSISA-Bangladesh) project give the priority of training the shrimp farmers of the south on the use of virus free post larva (PCR tested) and improved culture managemnet considering the aforesaid problems and prospects of shrimp farming with utmost priority. A part of this effort is the publication of this manual that will assist field level officers in conducting farmers tainting

Shrimp culture methods

Improved culture method is to ensure the increased growth of shrimp through scientific way by proper utilization of different ingredients and techniques in the maximum acceptable and eco-friendly environment. The main motto is profitable shrimp production by harmonizing five fundamental aspects of production such as – 'Gher,'Water','Environment','Post larvae (PL)' and 'Investment'. Because of different mode of coordination of the five aspects, the shrimp culture has four major methods. These are discussed below -

a. Extensive culture method: Shrimp are cultured under this type of management with virtually no cost or very little cost. Only a few shrimp PL are released in the gher. No fertilizer or supplementary feed are used in the gher, shrimp fully depend on natural food present in the gher. Besides, neither any initiatives are taken nor any technological aspects of farming are considered in extensive culture method. As a result, only 0.5 kg of shrimp per decimal are produced annually in the gher. Example can be given as releasing shrimp PL in the gher without any calculation and not following gradual steps of shrimp culture and harvesting shrimp irregularly.

b. Improved extensive culture method: A little improved culture management, where shrimp PL 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 shrimp culture are also performed irregularly. Presently, this type of culture management is most commonly practiced in our country and the shrimp production in this method is near about 1 kg / dec annually.

c. Semi intensive culture method: 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 shrimp culture are followed under semi intensive culture system. Under this type of culture management, per decimal annual shrimp production may reach 1.5 kg or little more than that.

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

Comparison among different culture systems

Culture system	Different activities of Shrimp culture					
	Pond preparation	Stocking density	Fertilizer application	Feed application	Water / oxygen supply	Shrimp 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	Shrimp 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	Shrimp are partially harvested with irregular restocking
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	Shrimp are partially harvested with restocking based on gher preparation

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

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

The presently practiced different culture methods in Bangladesh

a. Traditional culture method : Under this method, the predatory and unwanted fish of gher are not removed. Generally feed and fertilizer are not used. However, many farmers apply lime in the gher. Shrimp PL are stocked at the rate of 10,000 – 15,000 per ha and fry of other fishes also enter in to the gher with tidal water. Under this culture system, the survival of shrimp is 30 and per ha production is 150 kg. Presently shrimp have been cultured in 80 % of the total farms of Bangladesh following this method.

b. Improved extensive culture method : Under this method, the bottom of the farm is flat with water drainage system. The bottom of the farm is ploughed and regular lime, fertilizer and supplementary feed are applied. During the filling of farm with water small meshed net is used as filter in the water inlet to resist the entrance of unwanted fry of fishes. The per ha stocking density is 15,000 – 30,000 and per ha shrimp production is 400 – 500 kg. In the case, the survival of shrimp PL is 50 – 60 %. Many farmers are getting high profit from shrimp culture in this method.

c. Modified traditional method : Under this method, the water of shrimp nursery is treated to free of germs and then disease free PL are stocked and regular feed are applied in the nursery. After 15-20 days, the PL are released in the gher. Under this method, the culture management is easy and relatively less expensive (low cost), therefore it is more popular to the farmers. Under this culture method, per ha stocking density is 9,000 – 10,000 and per ha production is 450 – 500 kg. In the case, the survival of shrimp PL is 70 %.

d. Closed system technology : Under this system diseased free PL are stocked in treated (germ free) water, regular feed are applied and the optimum ranges of water quality are maintained. In this system per ha stocking density is 50,000 – 60,000 (if there is no aerator) and 100,000 (if there is aerator). The per ha shrimp production is 1200 – 1500 kg. In the case, the survival of shrimp PL is 80 - 90 %.

Presently fish farmers of south are culture shrimp and fish following different methods and getting profit. Such as –

- Only shrimp PL stocking several times with multiple harvesting
- Several time shrimp PL stocking and culture with other fin fishes with multiple harvesting
- Poly culture of shrimp with other fin fishes and giant fresh water prawn
- Poly culture of shrimp with giant fresh water prawn and other fresh water fishes
- Poly culture of shrimp with tilapia and other fresh water fishes
- In some areas poly culture of shrimp with other shrimp / prawn and fin fish followed by rice farming

The management farmers practice are as follows –

- During gone (full moon) farmers enter tidal water to the gher and directly stock shrimp PL purchased from the market. No feed are applied.
- Some farmers start applying feed after one and half month
- Some farmers raise the dyke and set net filter in the passage of incoming water.
- Some farmers stocked huge number of low priced PL and do not apply any feed
- Very few farmers prepare the gher properly, maintain right stocking density and apply feed

Due the listed reasons, the average per ha shrimp production remain low, only 100 – 150 kg. Nevertheless, by improving some management of these ghers, shrimp production can be increased to more than three times.

Considering the increasing prospects of shrimp farming, WorldFish Center gives priority of proper management of different steps of traditional culture method to reduce the risk of farmers. It encourages farmers to increase their production through the stocking of virus free shrimp PL (PCR tested).

Soil and water quality in shrimp culture

Gher and its environment : Shrimp farmers can get good production by stocking virus free shrimp PL (PCR tested) only and improving the activities of traditional culture management. Shrimp and fish live in the same water. Accordingly, if the aquatic environment is not good enough, neither shrimp nor fish survive and grow well. Therefore, to earn profit from shrimp farming, one should know the condition of the soil and water of the gher, i.e., organic, chemical and physical parameters very well and should maintain the optimum range of those parameters.

If the soil and water parameters of gher are not in the optimum range –

- Gher can not hold sufficient water
- Natural food for shrimp will not be produced in sufficient quantity in gher water
- Supplementary feed will be wasted
- Shrimp / fish growth rate will not be as expected
- Shrimp / fish may die from disease and other pest
- There will be low shrimp production resulting financial loss of farmers

Soil qualities: Ghers in loamy soil are best suited for shrimp culture. Water holding capacity of loamy soil is very high. Water is always turbid in the ponds with red soil and water holding capacity is very low for sandy soil. As the loamy soil is very fertile, abundant natural foods are produced in water. However gher can be built in muddy, sandy and red soil as well.

The suitability of water depends on degree of soil pH, phosphorus, nitrogen and organic matters etc. The parameters are described briefly below –

pH : The best pH of the soil for shrimp culture is 6.5 – 8. The availability of phosphorus increases in optimum pH. pH less than 6 makes the soil highly 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: Aerial 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. Turbidity of water due to floating organic particles can be removed by applying organic matters. Generally 1.0 – 2.0 % organic matters present in the soil of ponds and water bodies increase the production capacity of water.

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 for fish
Brownish green	Sufficient quantity of phyto- and zooplankton	Best suited
Yellowish green	Low phytoplankton 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 shrimp – plankton and for photosynthesis. Water can be very hot if the pond is shallow. Harmful aquatic plants may grow at the pond bottom as well. If the water body 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 layer of the water. The water depth of the gher may be 1 m - 2 m. The best water depth for shrimp culture is 1.5 m.

Transparency and turbidity of water: The production of natural food for fish, that is, phytoplankton drops in turbid water. Again the excessive growth of phytoplankton at the upper layer of water may reduce the transparency of water. Resulting oxygen scarcity may hamper the normal life of fish. The 25 cm (10 inches) of transparency indicates sufficient amount of natural 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 and loss appetite.

Sun light: If there are large trees at the pond dyke, the whole trees or 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 types 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.

Temperature: Due to the difference in water depth at the different parts of the gher, temperature also is different. The optimum temperature range for the growth of shrimp is 28 oC – 32 oC. At every 10 oC increase in water temperature, the growth and metabolism process of shrimp become double. For example, in an experiment it has been observed that the growth rate of shrimp at 30 oC is just double than its growth at 20 oC. If shrimps are stocked at a temperature lower than 25 oC, shrimps become disease infected due to stress. On the other hand temperature more than 35 oC makes the shrimp weaker and eventually they die. Due to low water depth, temperature fluctuates very fast and shrimps become infected due to this sudden change in temperature. In this condition, risk can be reduced by creating drain at the different part of the gher

Chemical properties of water

Salinity of water :

The water salinity controls the metabolic process, migration, reproduction etc. of shrimp. The optimum salinity range for shrimp culture is 10 – 25 ppt (parts per thousand). Salinity more or less than this hampers the growth of shrimp. However, shrimp can be cultured in a salinity range of 0 – 50 ppt.

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 shrimp / fish in the gher including other aquatic animals and plants breathe using the dissolved oxygen. The oxygen is not produced at night as there is no sun light. Oxygen is used in the decomposition of organic matter at the bottom of the gher as well. As a result, there is very low oxygen content in the gher water at the morning. The oxygen content reaches highest after the noontime. Shrimp can not continue their normal physiological activities, if dissolved oxygen content in gher water drops below 2.0 mg / L. High shrimp growth is obtained in gher water with dissolved oxygen content 5.0 – 8.0 mg / L. However, dissolved oxygen content in gher water should always be more than 3.5 mg / L. Food conversion ratios of shrimp increases if appropriate oxygen content is present in the water. That is comparatively lower amount of food can produce higher amount of shrimp. Shrimp appetite increases when dissolved oxygen content increase and shrimp loose appetite when dissolved oxygen content drops.

The causes behind low dissolved oxygen content in 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 gher
- Cloudy sky
- Excessive turbidity in water
- Stocking at high density

Alkalinity of water: Alkalinity of water depends on the dissolved content of calcium carbonate (mg / L) in water. The average alkalinity of water should be more than 120 mg / L. The alkalinity of water is low in acidic water of gher. Low salinity is also another reason for low alkalinity of water. It is better to maintain 80 – 120 ppm alkalinity in shrimp gher. To ensure this, lime or dolomite should be applied. As good quality dolomite is not always available, lime stone powder should be mixed with water and applied to the gher at the rate of 100 kg / ha.

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 (1 – 6.9).

Abrupt fluctuation of pH is not good for shrimp culture.

If pH becomes low -

- Sodium and chloride of shrimp body come out. As a result, weak shrimp die.
- The immunity shrimp and fish decreases and they lose appetite
- The natural gher productivity drops.
- Reproductive capacity of shrimp decreases.

If water becomes high -

- The gill and eye of shrimp become damaged
- The osmoregulatory capacity of shrimp decreases
- The shrimp stop feeding

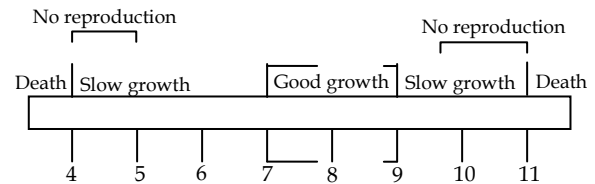


Figure: The effect of pH in shrimp culture

The optimum pH range in shrimp culture is 7.5 – 8.5. If Ph reaches to below 4 or higher than 11 fish may die.

Carbon di oxide: Carbon di oxide is used in photosynthesis, so content is low during day and high during night. Shrimp survive if the carbon di oxide content of water is 60 mg / L. If carbon di oxide content increases, dissolved oxygen content decreases in water. For that reason, in cloudy weather, carbon di oxide content increases.

Ammonia : Ammonia is available in water in two forms – ammonium ion (NH₄⁺) and unionized ammonia (NH₃). Ammonia content less than 2 mg / L is good for shrimp gher. Although shrimp do not die at the ammonia level higher than this, they feel stressed. However except improved nursery, dissolved ammonia hardly reaches at higher level in the gher. Because, regular feed and fertilizer are applied in the nursery. Ammonia content can be reduced by water exchange or harra pulling. Through geolite application or by increasing the number of beneficial bacteria, optimum ammonia level can be maintained.

Nitrate : The nitrate content of water should be less than 2 mg / L for shrimp culture. Although, it has never been heard that shrimp in the gher becomes damaged due to the high or low nitrate content. However excess nitrate may mix with the blood of shrimp and hinders the oxygen flow.

Hydrogen sulfide : Whatever the level, the presence of hydrogen sulfide in water is harmful for the shrimp. Particularly at low pH, hydrogen sulfide is toxic for shrimp. Through the water exchange and the application of lime, hydrogen sulfide in gher may be reduced.

Exchange of water : Gher water becomes polluted with high amount of organic and inorganic matters due to the accumulation of unused feed, plankton and excreta of different fishes at the bottom of the gher. In this condition by exchanging the water, the physico chemical parameters of water can be improved. During the first 30 days of PL stocking the optimum water quality may be maintained only by pumping or adding water in to the gher. However at the later stages of the culture, 10 – 20 % water should be exchanged regularly at every 10-15 days interval. The gher where feeds are applied the quantity of exchanged water should be 30 – 40 %. If tidal water does not enter in to the gher, water can be exchanged using a pump. Water should be exchanged marinating the equal depth of water. The benefit of shrimp gher due to water exchange –

- The oxygen content increases in gher water
- New natural feeds are added
- Toxic materials of gher are removed
- It helps in the moulting of shrimp

As shrimp farming is comparatively risky and costly, optimum water quality should be maintained with a little extra care under traditional culture method. As a result the risk during culture reduces substantially and yield increases. The survival, growth, feeding and moulting etc of shrimp largely depend on the aforesaid parameters.

Good Aquaculture Practice and Implementation of Principle of HACCP at the Farm Level

No one among the farmers, retailers, processors or overseas consumers is solely responsible to ensure quality of farm produced shrimp and food safety. To ensure the quality aspects and food security, from the production at farm level to the export to overseas buyers, all involved at their own levels more or less perform their duties. The control is necessary and the maintaining of chronology by coordination of different steps is equally important at all levels of shrimp culture, shrimp harvest, processing for marketing, transport, processing for export, export of processed shrimp to overseas buyers. Here, the close communication among shrimp farmers, marketing people and processors is essential to maintain the quality of safe food. Processors should be aware about his duties and responsibilities to ensure quality of shrimp and safety of food. Accordingly shrimp farmers should know about the different steps of Good Aquaculture Practice (GAP) and will ensure all the activities to maintain safe food quality at post harvesting stages.

Although from many days, post harvest care of fish and fishery products in Bangladesh have been getting priority to ensure quality and food safety, the reality is giving emphasis only in post harvest care can not ensure the quality and food safety aspects of shrimp. Along with post harvest care, GAP should be properly followed at production level to ensure shrimp as a safe food.

Good Aquaculture Practice is an internationally recognized topic and it is part of the associated act in Europe, USA and other countries of the world. Still it is not obligatory in our country, however, it is hoped that soon compliance with GAP will be compulsory under an act.

Good Aquaculture Practice and HACCP in fish culture

Although HACCP in fish culture is a different topic, to comprehend the gravity of GAP, the topic should be explained. It is true that HACCP or 'hazard analysis critical control point' is an indispensable and modern method to ensure quality of food

In 60s, the process is successfully applied to prepare 100 % flawless food for the astronauts taking part in space expeditions. Later, as the multifaceted use of the process is proved to be effective, the process has been established as a universal method globally. IN this chronology, it has already been successfully applied in fish culture.

materials. It is a scientific, well structured, perfect and advanced method. In fact to avoid errors and inaccuracy of traditional method of determining food quality, from an obvious necessity, this internationally recognized method has been evolved.

Our neighbouring counties applied HACCP process at the farm level to combat the challenge of the presence of harmful germs, antibiotic residues and other harmful chemicals to ensure the quality and food safety of farm produced shrimp. As a result, the countries are able to maintain international standard and their shrimp are now in the upbeat and advantageous position in the international market.

We know that HACCP is not any isolated process. To implement this, some activities should be performed at the beginning as prerequisite to fulfill the fundamental standard, such as, Good manufacturing Practice (GMP) or Standard Operating Procedures (SOP) and Sanitation Standard Operating Procedures (SSOP), etc. In this chronology, Good Aquaculture Practice is the pre condition of the implementation of HACCP at the culture stage of shrimp. That is, to implement HACCP at shrimp culture stage, farmers should have prior knowledge on good aquaculture practice and comply with that.

If good aquaculture practice is not followed in fish culture, the facilities of hygienic drainage and other activities of the production of safe food will be of lower standard and this will increase the risk of the production of unsafe food. In this condition, the implementation of HACCP at farm level will not be possible at all. Therefore to implement HACCP at culture stages, an acceptable condition should be established by practicing GAP from the beginning. To fulfill the objectives, Good Aquaculture Practice is discussed to give an overall idea to the fish farmers.

Good Shrimp Culture Practice

Good Shrimp Culture Practice is internationally standard activities of shrimp farming to ensure the quality and food safety aspects of shrimp as a consumable product which must be followed. International standard activities that should be followed and implemented from the beginning to the end of the shrimp culture are known as Good Aquaculture Practice or GAP. The Good Aquaculture Practice or standard culture activities for the important aspects and activities pertinent to culture are discussed below –

1. Location of the farm : In selecting water bodies for shrimp culture the farmers should particularly consider the history of prior use of the water body and its surrounding environment. Because the prior use of land has crucial impact on chemical properties of the soil. If the shrimp farm is built on a land that was earlier used in agricultural purpose, that indicates there are still residues of different insecticides and pesticides in the land. The residues of harmful chemical have negative impact on the growth of shrimp and they make the produced shrimp unsafe for the consumers. Same way, surrounding environment through different activities like water supply facilities, movement of animals and birds or aerial pollution (such as chemical spray) also affect the shrimp farm. Many people build their shrimp farm close to the dangerous places like livestock and poultry farms, and drainage of mills and factories. The farm site should be selected after necessary observation and careful monitoring of the possible harmful impact of the surrounding agricultural land, livestock and poultry farms, localities and slums etc. The agricultural land where pesticides and fertilizers are used regularly under intensive farming may create negative impact on the growth and food safety of shrimp. The shrimp produced in the contaminated water with chemical pollutants may be of high risk for the health of the consumers.

2. Water used for culture : The water quality of shrimp farm is a crucial aspect for the health, quality and food safety of the produced shrimp. The polluted water can be a reason of shrimp mortality and also create negative impact on the growth of shrimp. Harmful chemical residue accumulate in the body of the shrimp produced in the polluted water and may cause unsafe microbial contamination. Eventually the residue and harmful microorganisms become serious hazards for the health of the consumers. The contaminated water source makes the farm water polluted. Therefore, during the selection of the location of shrimp farm, the source of good water should get the priority. The most common reasons of water pollution are heavy metals, different pesticides and agro chemicals, chemical wastage of mills and factories and bacteria of coliform and salmonella group. Nature is one source among several sources of heavy metals. The most dangerous source of heavy metals is industries (such as tannery, paper mill etc.). Some heavy metals are seen to be used in agriculture as well. Therefore, the possibility of heavy metal pollution (if any for sure) in the farm water can easily be known from a survey in the surrounding areas.

3. Surrounding environment : If the surrounding of the shrimp farm is neat and clean and in a good condition, not only financial loss can be avoided, it will reduce the danger of food safety substantially as well. At culture level, many times, the land erosion or land slides may cause financial loss for the farmers with the possibility of chemical and microbial pollution. Planned tree planting in the periphery of shrimp farm stops the land erosion or slides along with chemical and microbial pollution. In addition, the bushes and hedges, excess aquatic weeds and filth and waste materials in and around the shrimp farm should also be removed. Controlling the movement of wild animal in and around the shrimp farm is a difficult job and therefore, to establish an effective control measure is very challenging for the farmers. Rat, mole, mongoose, otter different birds and different wild animals can be a potential and risky source of the infestation of different harmful micro organisms like Salmonella and E. coli etc. If stool and urine are disposed of in the water body or near the water body or near the shrimp food production and preservation facilities, different hazardous microbes (Salmonella and E. coli etc.) get the opportunity to mix with water and finally contaminate the produced shrimp. This contamination of farm produced shrimps eventually reach to the consumers through different steps of post harvest activities and processing and cause the health risk of the consumers. Rat types of animals are the vectors of a number of disease producing microbes and if not controlled properly may contaminate the food easily. Controlling them is essential in the areas where food are produced, processed and preserved.

4. Hygiene practice : The hygiene practice in shrimp farm means to control the micro organisms produced by human excreta or other hazardous activities and to limit the use of livestock and poultry dung and other excreta as fertilizer. In this case the serious aspects is that the excreta of mammalian or warm blooded animal carry dangerous disease producing micro organisms which multiply in shrimp farm. By following hygiene practice in shrimp farm particularly in water body and surrounding areas, the contamination from excreta can be maintained at the lowest level. The people working in the shrimp farm should not be allowed by any means to defecate or to urinate in the water of gher, gher dyke, associated areas, the source of gher water (e.g., river, canal etc.) and such places from where excreta can be washed down to the gher. The sanitary latrine should be built in safe distance from the shrimp farm and the source of water. The sanitary latrine should be kept neat and clean and care should be taken so that by no means excreta from latrine enter in to the gher due to seepage. The excreta of human and other mammalian and warm blooded animal carry dangerous disease producing micro organisms. Therefore the use of untreated excreta and dung has negative impact on the shrimp quality and food safety. In view of that, it is better not to use organic fertilizer of those sources in the shrimp gher.

5. Care and caution pertinent to shrimp feed : As shrimp is a valuable product, the farmers are very conscious about the application of supplementary feed at culture phase to ensure proper growth of shrimp. However, expecting high growth, farmers many times apply feed in the gher not following the guide line. As a result, low quality feeds are applied and overall feed management can not be controlled. Low quality feed and uncontrolled use of feed are not only harmful for shrimp, it can also be a potential reasons for the health risk of the consumers. Not only that unacceptable and harmful ingredients uses in shrimp feed and their erroneous and unhygienic storing management at culture stage can make the feed dangerous both for shrimp and its consumers. At culture, shrimp are fed with locally available and easily accessible raw feed like snail and mussel meat, dead fish, meat and offal of dead animals, squid, and crushed crab etc. However, in most cases this type of raw feeds are contaminated with germs and microbes like Salmonella, V. cholerea and E. coli and with the feed they easily transmit to the shrimp. Besides, this type of raw feed easily makes the water polluted and destroys normal properties of water. As a result shrimp in the gher may face mass mortality or epidemic. Nonetheless, through boiling of the raw feeds, probable contamination of germs and microbes can be controlled.

6. Use of medicine : Though many drugs are discovered to treat the diseases of animals, their misuse can create dangerous situation for the animals. For example, use of different antibiotic at culture phase can be acknowledged. Though use of antibiotic is helpful to control the disease of shrimp at culture stage, the uncontrolled use of these drugs eventually may create greater danger for the farmers. Due to long and uncontrolled use, antibiotic residues accumulate in the shrimp body and with the consumption the harmful residues enter in t the human body resulting a dangerous consequence. As some antibiotic used in past for shrimp culture are proved to be responsible for cancer like fatal diseases in human, there usage has recently been banned. In addition necessary laws have been enforced to ensure the limited and controlled use of authorized antibiotic and drugs in shrimp culture. Instead of doing good, the unrestrained use of drug in culture may be a cause of lost revenue for the farmers. To minimize the harmful impact of drug on cultured shrimp, workers employed in the farm, environment and the health of consumers, special caution should be taken in antibiotic application, determination of doses and comply with withdrawal time along with careful consideration of antibiotic storing and throwing out the unused portion and the empty packet or container. A unified and internationally recognized list of antibiotic for shrimp culture is yet to be developed. In this case different drugs are used based on the countries. The shrimp produced in Bangladesh are exported to different developed countries, such as Countries under European Union, USA, Canada, Japan and other countries. Therefore, in case of antibiotic use in shrimp culture, authorization of the listed countries should be taken in to consideration.

7. Pre harvest evaluation of shrimp : During culture, every farmer, observe the size and weight of shrimp and their health condition at a particular interval. This is kind of a routine check which is essential for good culture management. This routine check before the shrimp harvest creates an additional opportunity to evaluate the shrimp quality and food safety aspects. It is crucial to ensure the expected standard of quality and food safety of the produced shrimp before the harvest. For this reason, a pre harvesting evaluation procedure should be carried out 7-10 days before the shrimp harvest. Because, even the difficulties pertinent to shrimp quality and food safety are observed after harvesting, farmers or processors can do nothing to minimize the problem. On the other hand, if the difficulties are observed in pre harvesting evolution, that can be solved applying some measures.

8. Practice need to be followed during harvesting : A number of useful steps should be followed in shrimp harvesting that may positive influence quality and food safety of the final product. Important steps are as follows –

- Reduce feeding / stop feeding
- Prepare necessary gears, tools, component (ice, basket) and manpower
- Harvesting
- Handling and transport

To control the microbial contamination and maintain the quality of the shrimp, listed steps should be accomplished following proper guideline. To synchronize the harvesting and selling of the shrimp, farmers should fix the date and timing of harvest after necessary discussion with likely buyers. Though harvesting of shrimp is done in a dirty situation, the containers / bucket used to keep shrimp should be thoroughly cleaned and made germ free. Because filth and dead shrimp form an earlier catch attached with the containers can contaminate the newly harvested shrimp. All the plastic basket, tub, and other containers used to store and transport shrimp should be properly cleaned and germ free. Required quantity of flake ice made from drinkable water should be arranged.

The people employed for shrimp harvest should be healthy and disease free. Particularly those persons should not have any cut, lesion, injury or wound on their hands. After harvest, shrimp should not be handled with naked hand. It is better to handle harvested shrimp with gloves.

9. Care and preparation for transport : Proper pre transport management of shrimp is very important. Because starting from this time until the shrimp reach the processing factory, the actual deterioration of quality continues. Therefore, many factors should be considered at this stage of preparation. Farmers should do the following activities at this stage –

Previously temporarily stored shrimp should be preserved with flake ice made from drinkable water. In a clean germ free plastic container at first a layer of ice should be put then a layer of shrimp followed by another layer of ice and this way shrimp should be arranged.

The ratio of ice and shrimp should be determined on the basis of time needed to transport and aerial temperature of that time. Generally the ratio of shrimp and ice is 1 : 1 with a ice layer at the bottom and another layer at the top of the container. The amount of ice should be increased based on the day temperature and distance of transport.

To ensure the shrimp do not get pressed, the transport should be done in hard plastic box with apposite design. The shrimp kept in the lower boxes do not feel pressure, if the right kind of boxes are used and arranged one after another.

Shrimp should be transported to depot / arot / service center / direct to processing plant as immediate as possible in an insulated temperature resistant van or using other means.

After transport, the transport vehicle and boxes should be properly washed with detergent and antibiotic and be dried. The particular emphasis on post harvesting care of shrimp proves that the quality of food safety of shrimp largely depends on post harvesting care. In fact the quality and food safety of farm produced shrimp depend on the environment of shrimp culture (feed, water etc.) Considering safe food that is to fetch good market price, the culture environment of shrimp should be carefully watched. In shrimp culture, through Good Aquaculture Practice, implementation of HACCP principles will be easier.

Hazard Analyses

Production steps	Associated Hazards	Prevention measures
Location of farm	Chemical hazards : Contamination by Insecticide, weedicide and heavy metals (mercury, lead and cadmium etc)	<ul style="list-style-type: none"> • To carryout farming activities in a healthy environment • To test the soil and water
	Biological hazards : Contamination by harmful bacteria, parasites and virus	<ul style="list-style-type: none"> • To carryout farming activities in a healthy environment • To test the soil and water
Source of water	Chemical hazards : Contamination by Insecticide, weedicide and heavy metals	<ul style="list-style-type: none"> • To carryout farming activities in a healthy environment • To test the soil and water
	Biological hazards : Contamination by harmful bacteria, parasites and virus	<ul style="list-style-type: none"> • To carryout farming activities in a healthy environment • To test the soil and water
Collection of Shrimp PL / Fish fry	No important hazards are associated with this step	
Feed application	Biological hazards : Contamination by harmful bacteria and molds	<ul style="list-style-type: none"> • Use of right quality feed • Hygienic feed preservation • To test the feed
	Chemical hazards : Contamination by antibiotic, growth hormones and insecticide	<ul style="list-style-type: none"> • Use of right quality feed • To test the feed
Drugs and antibiotic use for disease treatment	The residue of drugs and antibiotics	<ul style="list-style-type: none"> • Application of medicine at proper doses • Harvest of shrimp / fish after a particular time of medicine use • To test shrimp / fish
Application of Pesticide and weedicide	Pesticide and weedicide residues	<ul style="list-style-type: none"> • Only authorized Pesticide and weedicide use at right time and right doses • To test shrimp / fish
Harvesting of shrimp / fish	Material hazards : broken shrimp shell, soft shell	<ul style="list-style-type: none"> • harvest using proper methods and tools • Not harvesting soft shell shrimp
Temporary preservation	Material hazards : Piece of glass, iron, body part of mosquito, fly and other insects, hair from dog, cat, cow, goat, rat, mole, part of chicken and duck feather, part of bamboo basket, mat of <i>hogla</i> leaves, fiber of jute bag, sand etc.	<ul style="list-style-type: none"> • Shrimp / fish preservation in properly build room and in hygienic container
	Chemical hazards : Contamination by insecticide, weedicide, detergent, kerosene, petrol and lubricant	<ul style="list-style-type: none"> • Not keeping insecticide, weedicide, detergent, kerosene, petrol, lubricant and other harmful chemical in the area of preservation

Step by step activities in shrimp culture management

In shrimp management, some activities should be carried out step by step. If the steps are followed sequentially, shrimp farming gives good profit. The shrimp management activities are described below –

- Nursery management
- Gher preparation
- Pre stocking fertilizer management
- Stocking management
- Post stocking feed and fertilizer management
- Water quality management
- Health management
- Shrimp harvesting and post harvest management
- Shrimp marketing

The crop rotation of the land used in shrimp farming



Calendar of shrimp farming

Activities	J	F	M	A	M	J	J	A	S	O	N	D
Nursery preparation				2				3				2
PL rearing in nursery	1				2				3			
Stocking gher preparation	1				2				3			
Rearing of Juvenile shrimp in gher			1			2					3	

1 – 1st crop

2 – 2nd crop

3 – 3rd crop

The listed aspects will be discussed in detail in the next chapter

Necessary capital for shrimp culture

The main principle of successful fish culture is doing right work / activities in right time. This needs necessary capital / investment which in most cases, farmers of our country cannot ensure. The two main reasons behind this are lack proper on the investment needed and inability to come up with the investment needed. The table below will give the farmers clear idea about the item wise money necessary for shrimp farming per decimal water area :

Type of culture	Step wise investment needed (Taka / dec)					Total money
	Lease	Pre stocking	Stocking	Post stocking	Harvesting and marketing	
Shrimp culture (one cycle)	80.00	116.00	31.00	145.00	20.00	392.00

Shrimp nursery can be set up in same gher, therefore there is no need of extra space. Depending on the management, the cost can be higher or lower

Group Session Planning

Day – 01

Time – 12.00

Duration – 60 min

- Target Group : Shrimp Farmers
 Title of the Session : Shrimp nursery management
 Goal : The trainees will get clear ideas on the importance of shrimp nursery, setting up of nursery and its different stages, stocking of post larvae (PL), application of supplementary feed etc. so they will be able to produce more shrimp juveniles in their ghers following the activities properly
- Objectives : **At the end of the session**
- Trainees will be able to speak about the importance of setting up of shrimp nursery in gher
 - Trainees will be able to speak about the selection criteria of shrimp nursery, and its size and shape etc.
 - Trainees will be able to explain different stages of preparation of shrimp nursery
 - Trainees will be able to stock and transport of shrimp PL
 - They will be able to determine the amount of supplementary feed needed and to apply the supplementary feed.

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 the earlier session 3. Linking with present session 4. Explaining the objectives of present session and words of encouragement	Discussion Question answer	
Subject matter		45 min
1. Importance of shrimp nursery 2. Site selection and size of shrimp nursery 3. Setting up of shrimp nursery, preparation, water hauling, treatment of water, lime application, fertilizer application and setting up of shelter materials 4. Stocking of shrimp PL 5. Application of supplementary feed	Question answer Speech Flip chart	
Summary		10 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, marker and handout

Planning of flip chart

(Please follow the handout for detailed description)

<p>Nursery Management of Shrimp :</p>	<p>Introducing water in the nursery :</p> <p>Shrimp nursery should be filled with water after 2 – 3 days of the application of lime. Generally during goone (full moon and new moon) , shrimp nursery should be filled with water</p> <p>Water from canal or ditch should be used</p> <p>Water depth should be 3 – 4 feet or a meter.</p>
<p>Importance of shrimp nursery :</p> <ul style="list-style-type: none"> • PL can easily acclimatize with gher environment • PL can be fed properly • Survival of PL increases • PL grow properly and gradually become strong • Shrimp juvenile can be stocked in the stocking gher at appropriate stocking density • High production is obtained after releasing in stocking gher 	<p>Treating of nursery water :</p> <p>After 3 – 4 days of introducing water in the nursery, water should be treated. The reason is - if the water of nursery is treated, the harmful worms and insects, large animals, and diseases and pest are destroyed and the survival of PL is increased.</p> <p>Ingredients : Bleaching powder – 2.5 – 3 kg / dec / 3 feet water</p> <p>Detergent – 60 g /dec / 3 feet water</p> <p>Sumithion – 9 ml /dec / 3 feet water</p> <p>Rotenone – 9.1 % power (active ingredient) 60 - 70 g /dec / 3 feet water</p> <p>7 % power (active ingredient) 70 – 80 g /dec / 3 feet water</p> <p>Application method</p> <p>Caution in water treatment :</p>
<p>Site of shrimp nursery :</p> <p>One corner of the gher</p> <p>The size of nursery :</p> <p>In general, for each bigha (33 dec) production gher, the size of nursery should be 0.5 dec to 1.0 dec.</p> <p>Preparation of nursery :</p> <p>Application of lime :</p> <p>Dose : Burnt lime or Quick lime 1 – 2 kg / dec and Slaked lime 2 kg / dec</p> <p>Method of application</p> <p>Cautions :</p>	<p>Preparation and setting up of shelters for the PL in nursery :</p> <p>Ingredients: With bamboo branches, coconut branches with leaves and date / palm branches with leaves</p> <p>Shelters should be created by inserting the base (one end) of the leaves or bamboo branches with a slide in the bottom of the nursery. Coconut / palm / date branches (1-2) or bamboo branches (8 -10) should be loosely tied together and placed in the nursery water.</p> <p>Stocking density of PL in nursery :</p> <div style="border: 1px solid black; width: 150px; height: 20px; margin-left: 100px;"></div> <p style="text-align: center;">Stocking density</p>

Size of shrimp nursery

The size and area of nursery depend on type of nursery, number of PL to be stocked, the area of stocking gher and the duration of PL nursing (days). In general, for each bigha (33 dec) production gher, the size of nursery should be 0.5 dec to 1.0 dec. About 50 – 100 PL can be stocked per square meter of water area of nursery.

Setting up or preparation of shrimp nursery

- If nursery is an old one, water should be dried /drained and bottom mud should be removed.
- If a new nursery needed, that should be built in a corner of the gher with new compact and high embankment (like pond dyke). So there is no crack or hole and out side water does not enter in to the newly built nursery.
- Nursery should be protected from crab, snake, frog with fencing of densely meshed nylon net on the dyke of nursery.
- At the inlet of shrimp nursery, filter made from densely meshed nylon net.

Management of Shrimp Nursery

To get good profit from shrimp farming, virus free, healthy and strong PL must be stocked in the gher after growing them to juveniles. Most cases, the mortality of naturally collected or hatchery produced PL is very high if directly stocked in the gher. PL die to a number of cases like fluctuations in environmental parameters, stress and pressure on PL, stress due to transport, lack of proper acclimatization etc. For this reason, collected PL should be released in the gher after 5 – 20 days rearing

However, it is better to create a nursery inside the gher by making dyke.

in the nursery. As a result, the mortality rate decreases substantially and production increases. With this objective, before directly releasing PL to gher, setting up of shrimp nursery is essential. Taking proper care and nurture and producing healthy and quality shrimp juvenile is possible in nursery.

Importance of shrimp nursery

- PL can easily acclimatize with gher environment
- PL can be properly cared and nurtured in the gher
- PL can be fed properly
- Survival of PL increases
- PL grow properly and gradually become strong
- Shrimp juvenile can be stocked in the stocking gher at appropriate stocking density
- High production is obtained after releasing in stocking gher



চিত্র বাগদা চিংড়ি চাষের

Site of shrimp nursery

- In a corner of gher – forming small pond with the help of dyke (bheri) or any other pond closed to gher.
- Or in a conventional place inside the gher through fencing densely meshed nylon net (Hapa made by nylon net)
- Or a concrete tank can be used as shrimp nursery to rear the PL.

Setting up or preparation of shrimp nursery

- If nursery is an old one, water should be dried /drained and bottom mud should be removed.
- If a new nursery needed, that should be built in a corner of the gher with new compact and high embankment (like pond dyke). So there is no crack or hole and out side water does not enter in to the newly built nursery.
- Nursery should be protected from crab, snake, frog with fencing of densely meshed nylon net on the dyke of nursery.
- At the inlet of shrimp nursery, filter made from densely meshed nylon net.

Water introducing in shrimp nursery

Shrimp nursery should be filled with water after 2 – 3 days of the application of lime.

Generally during goone (full moon and new moon), shrimp nursery should be filled with water. Here water from canal or ditch should be used instead of using gher water. Water should be filter through densely meshed nylon net before filling the gher so unwanted animals or their eggs can not enter into the gher. Water depth should be 3 – 4 feet or a meter. Therefore, at the beginning, nursery should be filled with required water.

Treating of water of shrimp nursery

After 3 – 4 days of introducing water in the nursery, water should be treated. The reason is - if the water of nursery is treated, the harmful worms and insects, large animals, and diseases and pest are destroyed and the survival of PL are increased.

Generally nursery water is treated with bleaching powder or dipterex or rotenone. The procedures are discussed below –

Ingredient	Quantity (/dec / 3 feet water)	Procedure
Bleaching powder	2.5 – 3 kg	Required quantity of bleaching powder should be mixed with double amount of water and should be sprayed in the entire gher at the evening or during night
Dipterex	60 g	Better result is obtained if mixed with water and sprayed at the evening or during night
Sumithion	9 ml	Better result is obtained if mixed with water and sprayed at the evening or during night
Rotenone	9.1 % power 60 - 70 g 7 % power 70 - 80 g	<ul style="list-style-type: none">• At first, 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 nursery. Then the rest two portions should be mixed with water and should be distributed to the entire nursery• Rotenone should be applied during the time of strong sunshine and should never be applied during night.• It is better to stir the water by pulling net after rotenone application for better result. During rotenone application, water depth should not be more than 3 feet.

Cautions :

- During mixing and spraying of bleaching powder, dipterex and rotenone entire face should be covered with a piece of cloth (gamchha), so the chemicals do not enter in to the mouth and nose.
- For treating water, bleaching powder is enough. Dipterex and rotenone can also be used. It is mentionable that only dipterex or rotenone can not be sued.
- After the application of bleaching powder, lime should not be used in the same gher at the same time
- After the application of bleaching powder, harra pulling reduces the risk of extra growth of algae.
- However, if the gher is properly dried, rotenone application is not necessary. In that case water must be treated with bleaching powder



চিত্র: ঘেঁরে চুন প্রয়োগ

Lime application

The main objectives of lime application in shrimp nursery are to maintain the pH of nursery water suitable for natural feed production, to destroy different types of germs and parasites and to improve the efficiency of applied fertilizer. The normal dose of lime is - for burnt lime or quick lime 1 – 2 kg / dec and for slaked lime 2 kg / dec. However, the doses of lime depend on the pH of water.

Importance of lime application :

It helps in maintaining pH at a level suitable for culture.

It removes turbidity of water.

It increases the efficiency of fertilizer.

It creates necessary environment for the growth of plankton.

It supplies calcium.

It increases the supply of carbon di oxide for photosynthesis.

It makes the decomposition of organic matters fast so nutrient supply increases in water.

It destroys the parasites, diseases, pests and bacteria.

Types of lime and application doses :

Types of lime	Dose (per dec)	Method of application
Lime stone	3 – 4 kg	If water pH is less than 7.0, lime should be applied in the farm. It is better to apply slaked lime in the soil. After drying out the gher, powdered lime (crushed) should be sprayed on the bottom, dyke and slope. More lime should be applied on the places where shrimp take the feed from and the places that remain awash even after drying. Powdered (crushed) lime should be applied on the soil and during culture cycle, lime mixed with water should be applied on the water of entire gher.
Slaked lime	2 kg	
Burnt lime or Quick lime	1 – 2 kg	
Dolomite	3 – 4 kg	

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.



Figure. Application of lime in gher

Pre stocking fertilizer application in the shrimp nursery :

The presence of ample natural feed in nursery is a prerequisite for PL growth. The supply of nutrient material is necessary for the production of the natural feed. The supply of the nutrient materials is ensured through the application of particular fertilizers in the nursery. Therefore, after 3 – 4 days of treating the water fertilizer should be applied according to the following doses and procedures –

Ingredient of fertilizer	Amount (dose) / dec	
	1 st time – 2 nd time	from 3 rd time
Molasses	200 g	100 g
Rice bran (auto polish)	100 g	50 g
Yeast	1 table spoon	Half table spoon

N. B. Fertilizer may be used after 4 – 5 days. Please continue the fertilizer application following the dose until water turns to expected colour (light green, green or brownish green etc.). It is better not to use any other fertilizer than the listed ones here.

Method of application :

Molasses, auto polish and yeast should be mixed with double quantity of water overnight and only the water (supernatant) after filtration should be sprayed to the nursery next morning.

Testing of natural feed in water :

Before PL stocking in shrimp nursery, presence of natural feed in the water should be tested. Only after observing the presence of sufficient natural feed, PL should



Figure. Testing of natural feed using hand / palm

be stocked. Natural feed in the water can be observed by naked eye. Greenish, green or brownish green water indicate the presence of natural feed. Deep green, coppery green or transparent water is not good for nursery. Therefore the water should be examine first to see if the colour of water is right or not. Appropriate or right amount of natural feed in water can be tested by following methods -

a. Hand method: After plunging the hand up to elbow, palm should be observed. If the palm is not seen and water colour is green or brownish green, 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.

b. Secchi disk test: Secchi disk is special plate made from iron. The diameter of secchi disk is 20 cm or 8 inches and colour is black and white. It is hanged by a three successive coloured (red, green and white) nylon thread. From the base of the plate up to 20 cm (8 inches) is red coloured, next 10 cm (4 inches) is green and rest portion normally held by hand is white coloured.

Dried leaves or dried branches of bamboo must be used in making shelters

Using protocol:

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

Green thread - 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, PL can be stocked and no need to fertilizer application. However, to maintain this condition, fertilizer and food should be applied at regular basis.

ভাইরাস মুক্ত ব্রুড (বাবা-মা) চিংড়ি সংগ্রহ করা থেকে ধাপে ধাপে পিসিআর পরীক্ষার মাধ্যমে ভাইরাস মুক্ত পিএল উৎপাদন করা হয়। এ পদ্ধতিতে উৎপাদিত পিএল পিসিআর পরিক্ষীত পিএল হিসাবে পরিচিত। সঠিকভাবে ঘের তৈরি করে শুধুমাত্র ভাইরাস মুক্ত পোনা মজুদ করেই চাষীরা ভাল উৎপাদন পেতে পারেন।

It is noteworthy that, to get virus free PL, known hatchery or dealer should be contacted from the beginning

White thread - After plunging the thread of secchi disk up to white 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 PL are stocked in the nursery, supplementary feeding should be continued.

Time of secchi disk testing: Secchi disk should be used between 1 am to 11 am in the morning.

c. 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 or a piece of cloth. 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 water. This will not work if water is tested in a coloured, printed / stained or opaque glass.

Preparation and setting up of shelters for the PL in nursery :

Shrimp generally grow through a number of moultings in their life time. During moulting, the shrimp body remains soft and they can be attacked by other shrimps and fishes. Accordingly shrimp need secured shelter. The shelter in the nursery can be prepared with bamboo branches, coconut branches with leaves and date / palm branches with leaves. Shelters should be created by inserting the base (one end) of the leaves or bamboo branches with a slide in the bottom of the nursery. Coconut / palm / date branches (1-2) or bamboo branches (8-10) should be loosely tied together and placed in the nursery water.

Virus free shrimp PL

Shrimp PL or shrimp may be attacked by the viruses due to many reasons, such as entrance of water from outer sources, stocking of diseased PL in gher, PL produced from virus infected parents (brood), presence of virus in the natural water where the PL collected from, etc. There is high possibility of financial loss if farmers culture shrimp using virus infected PL. Therefore, at the initial stage of farming, stocking of virus free PL (which are tested by PCR) in the nursery is very important.



Figure: Testing of natural feed using secchi disk

Timing of PL stocking in nursery

- PL should be stocked after 8-10 days of the application of bleaching powder, after 15 days of dipterax application and after 5 – 6 days of rotenone application.
- PL should be stocked after water turns to green or brownish green.
- Before PL stocking, a few PL should be released in a little water collected from the nursery and should be observed for 24 hours
- Generally it is better, to stock the PL within 10 AM in the morning or at late afternoon when temperature is not very high
- PL should not be released in the pick of the noon when the water temperature of the gher is at its highest.

Stocking density of PL in nursery :

It has been observed at the field level that most of the farmers stock excessive PL without any calculation. As a result, many PL die results in the wastage of money. How many PL need to be stocked in the nursery should be calculated beforehand. The table below may be followed to estimate the necessary quantity of PL for nursery.

Stocking density	
Per square meter	Per dec
50 - 100	2000 - 4000

Identifying techniques of healthy and strong PL :

- The colour of shell is bright, transparent and normal
- Movement is normal in the patil / box
- If disturbed, PL move to other direction / way by a quick jump
- PL swim against the current
- PL do not aggregate at the bottom of the patil / box
- The appendages of PL look strong and normal

Transport of Shrimp PL

The shrimp PL produced in the different hatcheries of Cox'e Bazar come to the southern part of the country by plane or truck / lorry. During transport, all PL are generally packaged in oxygenated polythene bag within cork sheet box. As the quality of packaging differs from hatchery to hatchery so the do the quality of PL. At field level, farmers generally buy the PL from local depot and bring to their gher. At this time, farmers should observe the quality of PL after bringing out the polythene bag from cork sheet box. Based on the size of shrimp PL and transport distance, the transport density should be as follows –

Type / size of PL	transport density / Liter	Transport time (hours)	Mode of Transport
PL 20	500 - 1000	12 - 16	Oxygenated polythene bag
PL 30 - 35	500 - 350	6	Oxygenated polythene bag

Aspects need to be considered during the transport of PL

- To maintain the temperature during transport as low as possible
- To take care so the transport bag do not get pressed from anything
- No to transport PL at excess transport density
- Better to cover the bag or box with wet cloths or chat (jute mat)
- To reduce the density if PL are large sized

Causes of PL mortality during transport

- Lack of oxygen
- Lesions / wounds on the body
- Toxicity of water due to the production of excess ammonia in the water of transport bag
- Increased water temperature during transport
- Long transport distance
- Transport of PL without acclimatization
- Transport of diseased or weak PL

Acclimatization of PL

Importance

- The PL will not face physical stress during stocking. As a result, most of the PL will remain healthy with a substantially low mortality rate.
- The increased survival of PL eventually will have a positive impact on the yield at the year end
- The increased survival of PL will reduce the stocking cost of PL
- As PL come for long distance, care should be taken at the every stages of the transport.

The things should be done

- Float the top-tied polythene bags in the nursery water and shower from the top like rain water for at least 10 minutes.
- Open the bags and fold. Shower the open bags with two hands from the top like rain water for at least 30 minutes.
- Check the temperature of water of the bag with hand and test the water salinity with tongue.
- As the temperature and salinity of the water of the transport bags gradually become similar to that of the water of the nursery, the PL become acclimatized.
- It the gaps of showering, take one or two PL with water in your two hands and check their movement
- Release the PL to the nursery from the open bags with a slight angle and be careful so that the water in the place of PL releasing does not turn to very turbid

Prepare to release the PL in the relatively deeper part of the nursery. After getting down to the nursery, water should be stirred vigorously. As a result, the water of the bottom with relatively low temperature will come to the top and water temperature will gradually be normal.

At the field level, the practice of PL releasing followed by the acclimatization is not very common. Therefore the mortality is very high, in some cases 50 – 60 % . As a result, farmers spend 2 – 3 times extra money for PL purchase and become financially looser. Therefore, acclimatization should be given special priority.

Special emphasis should be given to the following aspects before stocking PL in the nursery

- Fill the nursery with enough water at a time.
- Treat the nursery water with bleaching powder one week before the PL stocking
- If water treatment is not possible, set a fine meshed filter at the water inlet so that unwanted fish or fish eggs can not enter in to the nursery.
- After filling the nursery with water, keep this way for 7 days so that the dirt and particles precipitate in the bottom and water become clearer.
- Size of PL should not be less than PL 17.
- PL should be stocked in nursery by 9.00 am in the morning.
- During the acclimatization of PL, salinity should be reduced at a rate of 2 PPT per 30 minutes
- At the direction of air flow and in the deepest part of the nursery, PL should be released.
- Care should be taken so that the bottom mud is not stirred during PL releasing

Application of supplementary feed in the Nursery

To obtain healthy and strong PL, feed must be applied everyday in the nursery. And healthy and strong PL means going ahead of one step in shrimp farming. For shrimp PL, commercial feed – ‘Starter – 1’ is available in the market which should be applied by the dose detailed in the manual of manufacturer / company. Besides, the general doses of easily available home made supplementary feed are given below -

Feed ingredients	For 1 kg feed	1 st week followed by PL stocking	2 nd week followed by PL stocking	3 rd week followed by PL stocking
Mustard oil cake	250 g	80 % of the body weight of PL	50 % of the body weight of PL	30 % of the body weight of PL
Rice bran	450 g			
Fishmeal	300 g			

However, supplementary feed should be applied based on the number of PL stocked in the nursery. The amount of supplementary feed needed for 1000 PL and timing of feed application are given below

Age of PL (days)	Amount of feed / day	Time of feed application	Amount of feed per application
1 - 5	10 - 20 g	Morning - 6 and 11 am; Afternoon - 5 pm and Evening - 9 pm	One portion of 4 divided portions of the total (20 %, 20 %, 25 % and 35 %)
6 - 10	20 - 30 g	Morning - 6 and 11 am; Afternoon - 5 pm and Evening - 9 pm	One portion of equally divided 4 portions of the total (20 %, 20 %, 25 % and 35 %)
11 - 15	30 - 40 g	Morning - 6 and 11 am; Afternoon - 5 pm and Evening - 9 pm	One portion of equally divided 4 portions of the total (20 %, 20 %, 25 % and 35 %)

This way PL should be reared 15 – 20 days in the nursery before stocking in the gher.

Group Session Planning

Day – 01

Time – 13.00

Duration – 60 min

Target Group : Shrimp Farmers
 Title of the Session : Shrimp production or stocking gher management (Pre stocking and stocking)
 Goal : The trainees will get clear ideas on the pre stocking and stocking activities (bottom and dyke preparation or repair, control of weed and unwanted fish, lime application, application of pre stocking fertilizer, testing of natural feed, setting up of shelters, transport of shrimp PL, acclimatization and stocking) of shrimp gher so they will be able to produce more shrimp in their ghers following the activities properly

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

- Trainees will be able to select the site of gher, prepare or repair the bottom and dyke
- Trainees will be able to apply lime and pre stocking fertilizer
- Trainees will be able to test natural feed
- Trainees will be able to set up the shelters
- They will be able to transport of shrimp PL, acclimatize and stock

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 the earlier session 3. Linking with present session 4. Explaining the objectives of present session and words of encouragement	Discussion Question answer	
Subject matter		45 min
Pre stocking management - Site selection and bottom and dyke preparation or repair - Control of aquatic weed and predatory fishes - Application of lime - Filling the gher with water and exchange of water - Pre stocking fertilizer and testing of natural feed - Preparation of shelters for shrimp and setting up Stoking management - Stocking density - PL releasing at nursery gher - Transport of shrimp PL and cautions	Question answer Speech Flip chart	
Summary		10 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, marker and handout

Planning of flip chart

(Please follow the handout for detailed description)

<p>Shrimp production or stocking gher management (Pre stocking and stocking)</p>	<p>Application of Lime</p> <p>Importance of lime application Doses of lime application</p>																												
<p>Activities under pre stocking management</p> <ul style="list-style-type: none"> - Bottom and dyke preparation or repair - Control of weed - Filling of gher with water and control of predatory fish - Lime application - Application of pre stocking fertilizer and testing of natural feed - Setting up of shelters 	<p>Application of fertilizer</p> <p>Importance Dose of fertilizer application Methods of application Cautions in fertilizer application</p>																												
<p style="text-align: center;">Stocking management</p> <p>Stocking density :</p> <table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <tr> <th colspan="4">Stocking density</th> </tr> <tr> <th>Per square meter</th> <th>Per dec</th> <th>Per bigha</th> <th>Frequency of annual stocking</th> </tr> <tr> <td>1 - 1.5</td> <td>40 - 60</td> <td>1320 - 1500</td> <td>4 - 5 times</td> </tr> </table> <p>PL/ juvenile stocking activities :</p>	Stocking density				Per square meter	Per dec	Per bigha	Frequency of annual stocking	1 - 1.5	40 - 60	1320 - 1500	4 - 5 times	<p>Transport of shrimp PL and juvenile</p> <table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <thead> <tr> <th>PL/ juvenile types/ size</th> <th>Transport density / L</th> <th>Transport duration (hour)</th> <th>Mode of transport</th> </tr> </thead> <tbody> <tr> <td>PL 20</td> <td>500 - 1000</td> <td>12 - 16</td> <td>Oxygen polythene bag</td> </tr> <tr> <td>PL 30 - 35</td> <td>500 - 350</td> <td>6</td> <td>Oxygenated polythene bag</td> </tr> <tr> <td>Juvenile (5 - 7 cm)</td> <td>20 - 10</td> <td>6 - 3</td> <td>Oxygenated polythene bag</td> </tr> </tbody> </table>	PL/ juvenile types/ size	Transport density / L	Transport duration (hour)	Mode of transport	PL 20	500 - 1000	12 - 16	Oxygen polythene bag	PL 30 - 35	500 - 350	6	Oxygenated polythene bag	Juvenile (5 - 7 cm)	20 - 10	6 - 3	Oxygenated polythene bag
Stocking density																													
Per square meter	Per dec	Per bigha	Frequency of annual stocking																										
1 - 1.5	40 - 60	1320 - 1500	4 - 5 times																										
PL/ juvenile types/ size	Transport density / L	Transport duration (hour)	Mode of transport																										
PL 20	500 - 1000	12 - 16	Oxygen polythene bag																										
PL 30 - 35	500 - 350	6	Oxygenated polythene bag																										
Juvenile (5 - 7 cm)	20 - 10	6 - 3	Oxygenated polythene bag																										
<p>The common causes of PL/ juvenile mortality</p> <ul style="list-style-type: none"> • Pouring the PL / juveniles directly in to the gher after bringing from market or nursery • PL / juveniles are stocked at excess stocking density • PL / juveniles are not acclimatized properly • Most cases, PL / juveniles are 	<p>Some precautions during transport :</p>																												

Shrimp gher management (Pre stocking and during stocking)

Pre stocking management

To obtain high yield and to reduce risk in shrimp farming, proper preparation of gher including selection of the site is essential. The steps of gher preparation are as follows –

- All the dykes should be prepared or repaired as strong and firm.
- If there is smelly black mud present in the pond, should be removed as possible at the beginning of the culture season and bottom should be dried as necessary.
- If necessary the bottom of gher should be ploughed.
- 2 – 3 drains / canals can be dug inside the gher, if necessary.
- If excess algae are present, should be cleared out.
- Many times, the part of the base of the paddy (portion of shoot and root) remain in the gher. If possible these should be removed or after a few days of filling the gher with water, lime should be applied.
- Palm, or coconut or nipa palm leaves (1-2) or bamboo branches (5 – 6) should be loosely tied and placed in the per dec gher water.

Site selection for the gher

Gher should be established in a relative high, flood free area with easy access of saline water.

Repair of bottom and embankment of gher

To allow water of outer sources directly to the shrimp gher is not safe, because with the water, harmful germs like virus, bacteria and many unwanted fish may enter in to the gher. Toxic gas is produced, if decomposed mud and filth are present at the bottom. To maintain the right depth of water in the gher and to protect it from overloading during high tide of full moon and new moon, the dykes and bottom should be repaired.



Figure. Gher preparation for shrimp farming Time

- At the beginning of culture season
- During culture cycle, if necessary

Height of dyke

About 1 foot higher than the maximum high tide level so that water depth in the gher becomes 1 – 1.5 m (3 – 5 feet).

Control of aquatic weed

All the weeds of gher should be cleared out after cutting with machete, scissors or clippers. Sometimes weeds can be uprooted by pulling a rope in the gher and cleared out.

Removal of unwanted and predatory fishes

- Unwanted and predatory fishes spread diseases in the gher
- Unwanted fishes compete for feed, space and oxygen with shrimp
- Predatory fishes predate on fry, fingerling, juvenile and PL of cultured fish and shrimp
- Unwanted fishes can be removed by drying out the gher during January (Falgun – Chaitra)
- After draining out and well drying, the gher can be ploughed, if necessary

If water is present in gher or drain or canal, by applying rotenone or tea seed oilcake, unwanted and predatory fishes can be removed

Doses and methods of application of rotenone or tea seed oilcake are given in the table below –

Ingredient	Power (active ingredient)	Dose (per dec per foot water)	Duration of toxicity	Methods of application
Rotenone	9.1 %	20 - 25 g	7 days	At first, the necessary quantity 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 water. Then the rest two portions should be mixed with double quantity of water and should be distributed. After 20 - 25 minute the affected fish should be caught by netting at once. Efficiency of rotenone increases if applied during the time of strong sunshine and water is stirred followed by the application
Tea seed oilcake		150 g	3 days	Necessary amount of oilcake should be soaked in water for 12 hours. The soaked oilcake should be further mixed with water and the solution should be spread to the entire water body. However, tea seed oilcake is not easily available in our country.

N. B. Rotenone and tea seed oilcake are very effective if applied in strong sun shine. If drying out of gher or poisoning are not possible, predatory and non target fishes can also be removed by thorough netting.

Application of lime

The decision of lime application should be taken considering the soil and water quality and if possible after measuring the pH of soil and water. Generally lime means burnt lime. The efficiency of burnt lime is double of that of the lime stone and 1.5 times of that of the slaked lime.



The significance of lime application

- Maintain water pH suitable for shrimp culture
- Remove the turbidity of water
- Increase the efficiency of fertilizer
- Create necessary environment for the growth of plankton
- Supply calcium
- Increase the supply of carbon di oxide for photosynthesis
- Enhance the rate of decomposition of organic matters results in the increase of nutrient supply in water
- Destroy the parasites, germs and bacteria

Types of lime and doses of application

Name of lime	Dose per dec	Method of application
Lime stone	3 - 4 kg	If only soil pH is less than 7, lime should be applied in the farm. It is better to apply slaked lime in the soil. After drying the gher, powdered lime (crushed) should be sprayed on the bottom, dyke and on the slope. More lime should be applied on the places where shrimp take the feed from and the places that remain awash even after drying. Powdered (crushed) lime should be applied on the soil and during culture cycle, lime mixed with water should be applied on the water of entire gher.
Slaked lime	2 kg	
Burnt lime or Quick lime	1- 2 kg	
Dolomite	3 - 4 kg	

Filling of gher with water and exchange of water

- Generally gher is filled with tidal water. It is better to use water from canal or ditch rather than the discarded water of other ghers. In the inlet of water, filter should be fine (small meshed) and two layered. The mesh of the net of the first filter should be 1.5 mm and mesh of the 2nd filter should be 0.5 mm. In the outlet of the water, only a single filter is needed. The mesh of the filter will be 1.5 mm. After the filter, a safety fence should be set up to increase the longevity of the filter.
- The exchange of water assists in keeping the equilibrium of gher water regarding the reaction of waste materials, excessive plankton and germs and bacteria. Water should be exchanged 1- 2 times in first month during jo (high tide during full moon), 3 - 4 times in second month and 4 - 5 times in third and fourth month. Each time, it is better to exchange 20 - 25 % water of the gher. As the shrimp grows, the frequency of water exchanges should be increased for the better production.

Application of fertilizer

To ensure the production of sufficient natural feed, fertilizer application at proper dose is necessary after 5 - 7 days of the application of lime. The decision of fertilizer application should be taken observing the soil condition and the colour of water. The ingredients based on the fertilizer type, dose of application and methods of application are detailed below -

Type of fertilizer	Ingredient of fertilizer	Before PL / Juvenile stocking (kg / bigha)	Method of application
Organic fertilizer	Mustard oil cake	4 - 6	Molasses, auto polish and yeast should be mixed with double quantity of water overnight and only the water (supernatant) after filtration should be sprayed to the water of the gher next morning. This way after using successive two days, the mixture of molasses, auto polish should be thrown away.
	Molasses	5	
	Rice bran (auto polish)	2	
	Yeast	2 - 4 table spoon	

If the above procedure is followed, within 4- 5 days, the water of gher will turn to light green or brownish green and in this situation, PL / Juvenile can be stocked.

To continue the production of natural feed in the gher, and whenever necessary, inorganic fertilizer should be applied following the dose below –

Ingredient	Quantity per bigha (kg)	T S P should be mixed with water and kept overnight. Next morning urea should be added to the mixture and thin mixture should be sprayed to the water of the gher
Urea	2	
T S P	3	

It is better not to exchange water after the application of fertilizer.

Cautions in fertilizer application

- It is better to apply fertilizer during sun light.
- Preparatory fertilizer should be applied 5 – 7 days after lime application and 8 – 10 days before juvenile stocking.
- After treating the water with bleaching powder, sometimes it takes long time for the water to turn to normal colour. When water remains transparent for longer time, aquatic weeds and algae grow fast in the water which destroys the normal environment for shrimp. This problem can be resolved through applying urea and T S P and water will turn to light green or brownish green soon. Farmers should be very careful so water does not become excessive green. If water turns to deep green, there is a high possibility of the mortality of shrimp juveniles.

Before the stocking of juvenile, natural feed in gher water should be tested following the method described earlier

Preparation and setting up of shelters for shrimp:

Shrimp generally grow through a number of moultings in their life time. During moulting, the shrimp body remains soft and they can easily be attacked by other shrimps and fishes. Accordingly shrimp need secured shelter. The shelter in the gher can be prepared with bamboo branches, coconut branches with leaves and date / palm branches with leaves. Shelters should be created by inserting the base (one end) of the leaves or bamboo branches with a slide in the bottom of the gher. Coconut / palm / date branches (1-2) or bamboo branches (8-10) per decimal gher should be loosely tied together and placed in the gher water.

Dried leaves or dried branches of bamboo must be used in making shelters

Management during stocking

In improved method, PL can be stocked in the gher 4 – 5 times and through multiple stocking in the gher, annual production can be increased and production cost can be reduced as well. Different activities under shrimp production or stocking management at the gher are described below –

Stocking density

Gher	Stocking density			
	Per square meter	Per dec	Per bigha (33 dec)	Frequency of annual stocking
Stocking in the main gher	3 - 5	120 - 200	4000- 6500	2 - 3 times

To ensure the expected yield, after first stocking according the table above, all shrimp should be harvested after 3 months and gher should be dried. For second crop, after two months of first stocking of PL in gher, PL again should be stocked in the nursery and the number of PL will be equal to first stocking. For third crop, same way PL again should be stocked after two months.

Particular emphasis should be given on the following aspects to culture virus free shrimp under improved management

Ghers of our country can be graded in to the following types based on their present conditions like bottom mud, water depth, and other parameters. If farmers are aware about the general grade, they can stock necessary quantity of PL and can get the good production.

Nursery / gher preparation activities	Nursery / gher preparation grade			
	A grade	B grade	C grade	D grade
Removal of bottom mud	Full removal	Partial removal	Slight removal	Mud is not removed
Condition of dyke	Strong, firm and good	Medium quality	Bad	Very bad
Water depth (At the middle of the gher or highest depth)	60 – 100 cm (2 – 3 feet)	45 – 60 cm (1.5 – 2 feet)	30 – 45 cm (1 – 1.5 feet)	Less than 30 cm (Less than foot)
How many PL has been / will be stocked in the stocking gher	30,000 / ha (120 / dec)	20,000 / ha (80 / dec)	10,000 / ha (40 / dec)	No PL are stocked

- A. It is essential to consider the soil and water quality of a particular area selected by improved method (as cluster or in a group)
- B. After harvesting two full crops and an additional crop, gher should be dried with an interval of minimum one month (30 days) to protect the gher from viral attack.
- C. Grade D ghers are not suitable for shrimp culture, however, if the farmers like to culture shrimp, they can stock 5000 PL per ha along with other fishes.

The suggestions in juvenile stocking

- Juvenile should be stocked after 8 – 10 days of the application of bleaching powder or after 15 days of dipterex application or 5- 6 days of rotenone application
- Before juvenile stocking, a few juveniles should be released in a bucket with gher water and observed for 12 hours.
- Juvenile should not be released at the mid afternoon or when gher water is very hot
- How much PL / juvenile should be stocked in the nursery and in the main gher – this should be estimated beforehand.
- To calculate the stocking density of juvenile, the table given earlier can be followed.

Juvenile stocking from nursery to gher

If the nursery is located at a corner of the main gher, juvenile can be released in the gher if a channel is dug from nursery to gher. If the nursery is built in side the gher with blue net (mosquito net), then one side of the net can be open to allow the juvenile to enter the gher water. In both cases, it is better to catch the large and strong juvenile with a fine meshed blue nylon net (chot jal) and released in the gher after counting.

- It is not good to stock PL / juvenile of varying size at a time in the nursery /gher
- The mortality of PL is generally higher during monsoon. This time stocking density should be increased a bit more.

If large sized PL (4 – 6 cm) are stocked and gher is well managed, shrimp may reach to 30 – 35 g within three months (considering 70 % survival)

During juvenile stocking to gher from nursery, similar size juvenile must be released after catching with a fine meshed blue nylon net (chot jal) and counting. Relatively small juvenile with poor growth should be discarded. However in reality, farmers do not follow this protocol and as a result they do not get expected yield of shrimp

Shrimp juvenile transport

Base on the size of shrimp juvenile and the transport distance, the stocking density may be as follows –

Size /type of juvenile	Transport density / L	Transport duration (hours)	Mode of transport
Juvenile (5- 7 cm)	20 -1 0	3 - 6	Polythene bag with oxygen

Some precautions during transport

- To minimize lack of food, one eighth (1/8) of the yolk of a boiled egg can be added in the transport bag for 5000 PL. Because if becomes hungry, strong PL can predate on weaker PL.
- To transport large sized PL / juvenile, Polythene bag should be two layered. Shrimp PL / juvenile may tear down or create hole in the bag using rostrum.
- If large quantity of PL / juvenile are transported at a time, transport bags should be kept in a temperature resistant carton.

Acclimatization of PL / Juvenile

In most cases PL / juvenile come from long distance, therefore, they should not be released in to the gher instantly. As the small PL / juvenile are released in the new environment from the controlled environment of hatchery / nursery, they should be allowed enough time to acclimatize. Otherwise, the mortality rate of PL / juvenile will be increased. If PL / juvenile are purchased from outer sources, water should be exchanged between transport bag and gher for first 1 – 2 hour. As a result PL / juvenile gradually become accustomed with pH, salinity and temperature of the gher. Then they should be released in comparatively deeper part of the gher. After opening the top of the transport bag / patil, half of the top should be inundated in the gher water so the PL / juvenile can go to the gher slowly as their wish. If PL / juvenile do not like to go to out they should not be poured down by frantically.

The common causes of PL / juvenile mortality

- Pouring the PL / juveniles directly in to the gher after bringing from market or nursery
- PL / juveniles are stocked at excess stocking density
- PL / juveniles are not acclimatized properly
- Most cases, PL / juveniles are stocking without any calculation
- Stocking of PL / juveniles without testing the water of the gher for natural feed
- Gher associated nursery / mat / doge / pandal etc. are not prepared. If prepared in some places but not properly prepared.

Quality of PL / juveniles is not considered during buying.

To obtain good production, PL / juveniles must be counted every time and stocked at appropriate stocking density. PL / juveniles should only be stocked after necessary acclimatization following appropriate procedure. This will assist in increasing survival by reducing the risk and will increase the production

Group Session Planning

Day – 02

Time – 10.30

Duration – 75 min

- Target Group : Shrimp Farmers
- Title of the Session : Shrimp production or stocking gher management (Post stocking)
- Goal : The trainees will get clear ideas on the shrimp post stocking feed management, Post stocking fertilizer application, common problems in shrimp culture and their solutions, disease and health management of shrimp etc. so they will be able to produce more shrimp in their gher following the activities properly
- Objectives : **At the end of the session**
- Trainees will be able to estimate the amount of feed and apply the feed
 - Trainees will be able to apply post stocking fertilizer
 - Trainees will be explain water management in gher
 - Trainees will be able to speak the common problems in gher and to resolve the problems
 - They will be able to speak about the disease and health management of shrimp

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 the earlier session 3. Linking with present session 4. Explaining the objectives of present session and words of encouragement	Discussion Question answer	
Subject matter		60 min
Feeding management of shrimp Post stocking fertilizer and testing of natural feed Water management in gher Common problems in shrimp culture and their solutions Disease and health management of shrimp	Question answer Speech Flip chart	
Summary		10 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, marker and handout

Planning of flip chart

(Please follow the handout for detailed description)

Post Stocking Management																		
<p>Feed and Feeding habit : The necessary nutrients for shrimp are as follows –</p> <ol style="list-style-type: none"> a. Protein (Enriched with essential amino acids) b. Lipid (Oil and cholesterol enriched with essential ,fatty acids from plant and animal origin) c. Energy (Carbohydrate) d. Vitamin e. Minerals <p>Environment suitable for feed application</p> <ul style="list-style-type: none"> • Water quality should be maintained at the appropriate level • The bottom of the gher should be maintained as pollutant free and clean • The presence of micro organisms in water should be controlled • Other aquatic animals should be controlled • Feed should be applied in shrimp farming, if necessary • The cost benefit of feed application should be calculated • Diseased shrimp do not consume feed • Feed demand and size of feed particle vary according to the age and size of shrimp. 	<p>Post stocking fertilizer application management After releasing juveniles / PL to main gher from nursery, during each <i>gon</i>, fertilizer should be applied following the doses below -</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="text-align: center;">Type of fertilizer</th> <th style="text-align: center;">Name of the ingredient</th> <th style="text-align: center;">Quantity / bigha</th> </tr> </thead> <tbody> <tr> <td rowspan="5" style="text-align: center; vertical-align: middle;">Organic fertilizer</td> <td>Mustard oil cake</td> <td style="text-align: center;">3 - 5 kg</td> </tr> <tr> <td>Compost fertilizer</td> <td style="text-align: center;">5 - 10 kg</td> </tr> <tr> <td>Molasses</td> <td style="text-align: center;">5 kg</td> </tr> <tr> <td>Auto polish rice bran</td> <td style="text-align: center;">3 kg</td> </tr> <tr> <td>Yeast</td> <td style="text-align: center;">¼ table spoon</td> </tr> <tr> <td style="text-align: center;">Inorganic fertilizer</td> <td>Urea</td> <td style="text-align: center;">2 kg</td> </tr> </tbody> </table>	Type of fertilizer	Name of the ingredient	Quantity / bigha	Organic fertilizer	Mustard oil cake	3 - 5 kg	Compost fertilizer	5 - 10 kg	Molasses	5 kg	Auto polish rice bran	3 kg	Yeast	¼ table spoon	Inorganic fertilizer	Urea	2 kg
Type of fertilizer	Name of the ingredient	Quantity / bigha																
Organic fertilizer	Mustard oil cake	3 - 5 kg																
	Compost fertilizer	5 - 10 kg																
	Molasses	5 kg																
	Auto polish rice bran	3 kg																
	Yeast	¼ table spoon																
Inorganic fertilizer	Urea	2 kg																
<p>Types of supplementary feed</p> <ol style="list-style-type: none"> a. Fresh feed b. Mixed feed prepared at farm level c. Pellet feed / commercial feed manufactured in factories <p>Usage and doses of different ingredients in feed preparation</p> <p>Timing of feed application The daily ration should be divided in to three parts.</p>	<p>Exchange of water Why to do? Increases the dissolved oxygen content in farm water New natural feed and nutrient are added in farm water Increases the fertility of water Remove the pollutant from farm water help in moulting of shrimp</p> <p>When to do?</p>																	

Post stocking management

Feeding management of shrimp

Feed and feeding habit

Shrimp is a nocturnal and bottom dwelling aquatic animal. Shrimp is basically a carnivore, but change the feed habit at different stages of the life cycle and can be called as an omnivore. They prefer feeding at night avoiding sun light. The favourite feeds of shrimp are algae, zooplankton, worms and insects, small prawn / shrimp, small snail and mussel and small fishes. Among zooplankton, shrimp prefer protozoa, rotifer, cladocera and copepod. Shrimp feed on blue green algae (Spirulina, Oscillatoria, Anabaena, Nostoc etc.), green algae (Chlorella, Cladocera, Desmids, Oedogonium etc.) and Diatoms (Navicula, Cyclotella, Chaetoceros etc.). In addition they feed on Najas, periphyton and decomposed organic matters as well. Shrimp is a cannibalistic animal. Their feed habit changes with age, season and habitat. Generally at young age they prefer, phytoplankton and zooplankton and as adult like the feed of animal origin.

The presence of necessary nutrient in the feed is essential for proper growth of shrimp. The nutrients are vital to maintain the growth and movement and to keep the appendages of shrimp normal. The feed those can be considered as shrimp feed that shrimp can easily consume and digest, and feed nutrient can reach to the cellular level to keep the cells active. The necessary nutrients for shrimp are as follows –

- a. Protein (Enriched with essential amino acids)
- b. Lipid (Oil and cholesterol enriched with essential ,fatty acids from plant and animal origin)
- c. Energy (Carbohydrate)
- d. Vitamin
- e. Minerals

Environment suitable for feed application

If feed is not applied in a suitable environment, that can be harmful rather than useful. Before feed application the following aspects need to be considered –

- Water quality should be maintained at the appropriate level
- The bottom of the gher should be maintained as pollutant free and clean
- The presence of micro organisms in water should be controlled
- Other aquatic animals should be controlled
- Feed should be applied in shrimp farming, if necessary
- The cost benefit of feed application should be calculated
- Diseased shrimp do not consume feed
- Feed demand and size of feed particle vary according to the age and size of shrimp

Shrimp consume the necessary feed from their environment. Nonetheless, to obtain high production in shrimp farming, supplementary feed should be applied along with natural feed.

Natural feed

As a result of proper gher preparation and fertilizer application algae grow in the gher. Side by side, if the water depth is low lablab, lumut and Digman (in Filipino language) are produced in the gher as well. Lab lab is a group of microscopic plants and animals at the bottom. They grow in the water with salinity more than 28 ppt. If they grow in excess, ammonia (NH₃) and hydrogen sulfide (H₂S) are produced from their decomposition and create pollution at the bottom of the gher. The gher where feeds are applied, this type of production is undesirable.

Lumut is one kind of green filamentous algae and a group of microscopic plants and animals grown at the bottom. They are produced at the low salinity (4 – 10 ppt) at the bottom of the farm. This kind of algae create obstacle for the movement of shrimp and can be a cause of the mortality of small shrimp. Besides many different types of aquatic plants (Macrophytes) grow at the bottom of water body. Large shrimp feed on the minute animals grown on the marophytes and the soft branches of marophytes. However this type of plant affect the water quality and their presence create harm rather than help the shrimp.

Supplementary feed

At the beginning of the stocking or at the starting of culture, though natural feeds are available as the shrimp grow, demand of supplementary feeds is observed. If different types of supplementary feed are used for the growth of shrimp, farmers should be watchful about nutritional quality of the applied feed and if the feeds create any pollution in the gher or not.

The supplementary feed of shrimp can be divided into the following groups -

- Fresh feed
- Mixed feed prepared at farm level
- Pellet feed / commercial feed manufactured in factories

If relatively higher production by traditional method is expected, along with the application of improved quality pellet feed in nursery, supplementary feed should be applied in the gher to ensure the growth of shrimp. For this, farmers can prepare supplementary feed at home.

The dose of different ingredients in feed formulation

Name of the ingredients	Sample 1		Sample 2	
	% of use	g / kg feed	% of use	g / kg feed
Fishmeal	30	300	30	300
Mustard oilcake	40	400	30	300
Mussel powder	-	-	5	50
Police rice bran /wheat bran	20	200	20	200
Flour	9	90	10	100
Molasses	1	10	5	50
Minerals / vitamins	-	1 table spoon	-	1 table spoon
Total	100	1000	100	1000

Feed application method

Farmers must know the following things before application of feed in the gher -

- The size and age of shrimp
- The mean weight of shrimp
- Water quality parameters
- The physical fitness of shrimp

Required quantity of feed can be sprayed in a particular location of the gher or feed can be placed in feeding tray. It is better to apply feed in feeding trays. Through using feeding tray, the tendency of feed intake of shrimp can be checked and the appropriate quantity of feed needed can be estimated.

Shrimp are genetically nocturnal in habit and do not like light. That's why they intake feed during night or early morning. Shrimp intake feed slowly by gnawing with teeth after catching with legs. That's why the feed pellet for the shrimp must have the ability to be intact in water at least for an hour.

The doses of supplementary feed

First 4 - 5 weeks (average individual weight of shrimp – 5 g) – feed application should 5% of body weight of shrimp and for the next weeks - 3 - 4 % of body weight. Besides, applied feed should be observed at the different locations of the farm after 1 hour of the application. Based on the left over feed, the appropriate amount of feed should be determined. If there is no feed in the feeding tray, then the amount of feed should be increased from the next time. On the other hand, if there is still left over feed in the feeding tray, the amount of feed should be reduced from the next times. If there are other fishes and shrimps present in the gher, additional feed should be applied for them. Generally farmers apply additional rice bran for the other fishes present in the gher. In addition , every week, a few shrimps should be caught, total weight should be calculated based on the mean individual weigh and amount of feed needed should be adjusted accordingly.



Time of feed application

The daily ration should be divided in to three parts.

6.00 AM in the morning - one part of total feed should be applied

18.00 – 19.00 pm – rest two parts of total feed.

Amount of supplementary feed

The amount of feed during 15 - 51 days (for 1000 PL / juveniles)		The amount of feed during 52 - 120 days		
Age (day)	Quantity (g)	Mean weight of shrimp (g)	Rate of daily feed intake (% of total body weight)	Type of feed
16 - 21	60 - 70	6 - 8	5.5 - 5.0	Home made feed / commercial feed
21 - 26	70 - 80	9 - 11	5.0 - 4.5	
26 - 31	80 - 90	12 - 14	4.5 - 4.0	
31 - 36	90 - 100	15 - 17	4.0 - 3.5	
36 - 41	100 - 110	18 - 20	3.5 - 3.0	
41 - 46	110 - 120	21 - 24	3.0 - 2.5	
46 - 51	120 - 130	25 - 30	2.5 - 2.0	

Approximate quantity of daily feed applied for 1000 PL / juveniles (16 - 120 day) :

Week	Age of shrimp (day)	Quantity of daily feed application (g)	Quantity of weekly feed application (g)
3	16 - 22	70	0.490
4	23 - 29	85	0.595
5	30 - 36	100	0.700
6	37 - 43	115	0.805
7	44 - 50	130	0.910
8	51 - 57	170	1.190
9	58 - 64	250	1.750
10	65 - 71	300	2.100
11	72 - 78	350	2.450
12	79 - 85	450	3.150
13	86 - 92	600	4.200
14	93 - 99	700	4.900
15	99 - 105	800	5.600
16	106 - 112	900	6.300
17	113 - 120	1000	7.000
Total			42.140 kg

Cautions in feed application

- The quality of feed should be high and appropriate and feed should be tested
- Rotten / decomposed feed with fungal infection should not be applied
- Feed consumption by the shrimp should be observed on the feed tray
- Using growth hormone or any kind of antibiotics is prohibited / banned

At the farmer's level, generally the feed habit of shrimp has not been considered, and once in while, farmers apply pellet or powder feed to the entire gher during day time irregularly. As a result they do not get the expected yield. That's why appropriate quantity of feed pellet should be applied at the evening and in the morning according to the feed habit of the shrimp

Post stocking fertilizer application

After releasing juveniles / PL to main gher from nursery, during each gon, fertilizer should be applied following the doses below –

Type of fertilizer	Name of the ingredient	Dose per dec	Method of application
Organic fertilizer	Mustard oil cake	100 -150 g	The fertilizer should be applied before or immediately after filling the gher with water
	Compost fertilizer	150 - 300 g	
	Molasses	150 g	The fertilizer should be applied during culture cycle, if necessary
	Auto polish rice bran	100 g	
	Yeast	0.05 g (2 table spoon / ha)	
Inorganic fertilizer	Urea		The fertilizer should not be applied if not necessary
	T S P		

In traditional method, after stocking of shrimp PL / juvenile in gher, no fertilizer or feed is applied. However, using virus free PL / juvenile and following a few management including fertilizer and feed application, farmers can increase the shrimp production in their gher.

Water management in gher

Immediately after shrimp stocking in the gher, organic and inorganic matters increase in the gher water due to feed, plankton and excretory materials of shrimp and other fishes. At this situation, the physico-chemical parameters of the water can be improved through exchange of water. During the first 30 days of the culture, water quality can be maintained only by water addition / filling the gher. For the next period of time, during culture cycle, appropriate quantity of water (10 – 20 %) should be exchanged regularly at 10 – 15 days interval. 30 – 40 % water should be exchanged from the locations where feeds are applied. If tidal water does not enter in to the gher, water can be exchanged using a pump. It is better to exchange the water keeping the water depth as it was before. Exchange of water has the following positive impact on shrimp and gher -

- Increases the dissolved oxygen content in farm water
- New natural feed and nutrient are added in farm water
- Increases the fertility of water
- Remove the pollutant from farm water
- Help in moulting of shrimp

The following water quality parameters should be observed

- After every 15 days, measuring salinity of gher water is essential. The 5 – 30 ppt salinity of water is suitable for shrimp culture.
 - pH measurement at every 7 days interval is important. The right time of pH measurement is from 5.00 am morning to 15 pm in the afternoon. If pH varies at a rate of more than 0.5 / day, lime or dolomite should be applied at a rate of 100 kg / ha.
 - Please stop the application of urea if gher water turns to excess green
- During heavy rain / downpour, apply 100 – 150 kg lime / ha to protect shrimp from mass mortality.

Common problems in shrimp culture and their control measures

There are many problems in shrimp culture. Often our shrimp farmers face difficulty with these problems. To analyze all the problems, mainly two types of problems can be identified. Those are -

1. Social problem : Theft, poaching, lease, troubles regarding payment of lease money, poisoning, difficulties pertinent to water supply and drainage, encroachment of gher, case / lawsuit related to ownership dispute etc.

Management problem : Farmers come to the office of fisheries officer with problems related to epidemic (mass mortality) of shrimp, floating of shrimp, gathering at the periphery, uncontrolled movement, stunting of growth, soft shell, damaged or detached appendages etc. Mainly farmers consider the mass mortality of shrimp as the major problem. However they do not agree with the matter that depth of farm, water temperature, salinity, dissolved oxygen content in water, pH of soil and water, alkalinity, excessive aquatic weed and algae, unusual rotten mud at the bottom and organic decomposition, use of turbid, dirty and polluted water in gher, faulty exchange of water, infection and infestation of disease and pests, and numerous mistakes in farm management are the main causes of the mass mortality of shrimp, their abnormal movement and other unusual situations of the gher during culture cycle. Behind these problems there are one or more causes responsible

2.1 Lab lab (bhotka) decomposition: At one time decomposed lab lab are seen to float on the top of the gher water. Due to this decomposition, the activity of microorganisms at the bottom of the gher enhances. As a result the pH of water drops and acidity increases. The content of harmful gases including ammonia, hydrogen sulfide etc. increases in the water. This situation reaches its peak when it rains after prolonged drought or hot weather. Floating lab lab precipitate at the bottom of the gher and degree of decomposition even further aggravates. At this situation the soil and water of gher do not remain apposite for shrimp. Then the abnormal movement of shrimp is observed in the gher.

Control measure

- Water should be exchanged, if necessary
- Water depth should be increased
- Appropriate dose of fertilizer and lime should be applied

2.2 Presence of excessive filamentous algae : In most of the shrimp farm, expected water level is not present. At low water depth, excessive Spirulina and other filamentous algae grow. These kinds of algae hinder the movement of shrimp and also reduce the fertility of gher. Due to very hot and humid weather, these algae decompose and normal environment of shrimp is hampered and shrimp become sick.

Control measure

- Extra organic matter should be removed during gher preparation
- Water should be exchanged, if necessary
- Water depth should be increased
- Appropriate dose of lime should be applied

The algae should be removed using labour

2.3 Excess aquatic weeds : The small quantity of aquatic weed in shrimp gher is not much harmful. However, excess aquatic weeds are harmful for shrimp as the weeds hinder the normal movement of shrimps and reduce the primary productivity of gher. The decomposition of these weeds due to prolonged drought or excess hot temperature make the gher water polluted. The shrimps become weak. As a result, the possibility of infection by different diseases increases.

Control measure

- The weeds, sometimes, need to be removed using physical labour
- Extra organic matter should be removed during gher preparation
- Water should be exchanged, if necessary
- Water depth should be increased
- Appropriate dose of lime should be applied

2.4 Excessive decomposition of waste material : Generally, the base / straw of paddy or other waste materials remain in the gher. At right depth of gher water and if the water is exchanged properly at regular basis, this type of materials are not that harmful for shrimp, rather they act as shelter for shrimp and as source of lab lab. However, at a depth of water, during drought or hot temperature, these materials decompose and make the gher water polluted.

Control measure

- The weeds, sometimes, need to be removed using physical labour
- Water should be exchanged, if necessary
- Water depth should be increased
- Appropriate dose of lime should be applied

2.5. Prolonged drought : Most of the gher are not well planned. There is not sufficient water in most of the gher and water exchange facilities is not satisfactory. At this type of situation, prolonged drought may bring disaster in shrimp farming. At an extreme situation, shrimp may face mass mortality.

Control measure

- Water depth of gher should be exchanged

2.6. Heavy rain / downpour : Heavy rain may cause high fluctuation of temperature, salinity and other water quality parameters in the gher. As a result, the suitable environment of shrimp is ruined. Environmental stress for the shrimp increases due to abrupt change in water quality parameters. The symptoms like floating of shrimp, gathering at the periphery, stoppage of feeding etc may be observed. If the situation becomes extreme, shrimp may face mass mortality.

Control measure

- Application of dolomite and exchange of water

2.7 Entrance of immature / young shrimp in goi : The mouth of water inlet and outlet of shrimp gher is locally know as goi. Harvesting shrimp by putting net in the goi is a common practice by the shrimp farmers. The funny thing is, this time generally only the mature shrimp come to the goi with the current. However, sometimes, immature / young shrimp also come along with mature shrimp. These immature / young shrimp stay with large shrimp, crab, mussel, snail, waste materials etc. with speedy current for long time in a compact condition and as a result small immature shrimp become wounded, receive injury and face many different kind of stresses. As the experience of the farmers goes, these shrimp do not survive. Therefore, farmers consider this as a major crisis. If the environment of gher is not suitable for living for the small shrimp, they come to the goi.

Control measure

- Half of the water of the gher needs to be exchanged.
- Application of dolomite. The improvement of physico chemical parameter of water after necessary measurement.

2.8 Crab : In most of the gher, at one stage of culture the abundance of a particular type of crab has been observed. Crab creates many problems in shrimp culture.

Problems the crab create

- Crabs make hole in the embankment and reduce the water holding capacity of gher. Polluted water enters in to the gher.
- They attack soft shelled shrimp and create lesion on the shrimp body
- They compete for feed with shrimp and create feed shortage
- They are the carrier / vector of germs an parasites.

Control measure

- Crab should be filtered out during filling the gher with water
- The embankment of gher should be built as high and if possible the entire gher should be fenced with mosquito net.
- The hole / crack in the embankment should be blocked properly

2.9 Soft shell of shrimp : Shrimp grow by moulting. After moulting, naturally the shell remains soft and becomes hard after some time. However, in some cases the exception has been observed. Shell does not turn to tough in time. As this type of shrimp is not suitable for processing, the farmers do not get the right price of the shrimp. Besides, the growth of the shrimp becomes stunted and eventually they die.

The reasons

- The lack of natural feed in the farm
- Shortage of calcium in feed
- Basically malnutrition is responsible for the problem.

2.9. Moulting of shrimp : Shrimp grow by moulting. If the moultings do not happen timely, which indicates that shrimp are not growing well.

The reasons

- Low water depth in gher
- The pH of water is low
- The water temperature is abnormally high or low
- Total alkalinity of water is high
- The environment of gher is not suitable for shrimp
- Shrimp do not like the feed (lack of appetite)

Control measure

- The depth of water should be increased in the gher
- The natural feed in the gher should be increased
- Application of standard feed enriched with minerals

Health and disease management of shrimp

The proverb "Prevention is better than control" is highly appropriate for shrimp culture. The abnormal condition of body and mind is known as disease. Like other animals, shrimp also become infected with different diseases. When the immunity (disease resistance) of shrimp decreases, they are attacked by different germs and parasites. Among the germs that infect shrimp, the important are parasites, bacteria and virus. Shrimps get infected and eventually die because of polluted environment, lack of nutrition, and out of the optimal range of the water quality parameters like salinity, temperature, pH, oxygen etc.

Every day, the cultured shrimp face environmental fluctuation, mismanagement like unnecessary handling, PL / juvenile transport at excess stocking density, culture at high stocking density, use of different drugs, antibiotics, and chemicals, malnutrition, changes in temperature, water pollution etc. Due to this kind of mismanagement and environmental fluctuation shrimp get attacked by different germs. Mainly, parasitic, bacterial and viral diseases are observed in shrimp. There is no control of viral disease but prevention.

The cause of diseases

1. Environment : Soil and water combinedly are the environment of shrimp. As shrimp live at the bottom, all the parameters of soil affect the survival, growth, colour etc of shrimp. Shrimp do not get infected easily, if the quantity of mud at the bottom, organic matter content, and soil pH remain optimum for shrimp.

The water depth for shrimp should be 3 feet, because depth affects all parameters of water like temperature, pH, oxygen, the production rate of algae etc. One line of attack of disease infection can be blocked if shrimp are cultured at optimum salinity keeping all parameters of soil and water favorable for shrimp.

2. Germs / microbes : Virus, bacteria, fungi and pathogens cause disease in shrimp. Under improved culture method, all microbes are destroyed in shrimp nursery and shrimps are fed here for 20- 25 days following appropriate rate with standard quality feed. Even after releasing PL from nursery to gher, the PL do not get infected easily, although many germs are present in the gher water because the PL have acquired strong immunity from the nursery.

3. Shrimp : Good PL / juvenile are the prerequisite of shrimp culture. Virus free, disease and germ free, strong and large sized PL / juveniles with good quality should be stocked.

A few more of the important diseases of shrimp and their preventive and control measure are described below –

Name of the disease	Symptoms and causes	Prevention and control	Extent of damage
WSSV – White Spot Syndrome Virus	<ul style="list-style-type: none"> • Loss of appetite, Emptiness of digestive tract, Weakness, vigorous movement, come to the tope of the water by shrimp, gathering at the bank of the shrimp gher during day time. • Red or pinkish colour, 0.5 – 2.0 mm white spots at the two sides of carapace, this type of spots also visible on tail. Shrimp start to die when the white spots are observed on whole body. Within 2 – 3 days, all juvenile shrimp die and within 3- 10 days adult shrimp die. Stomach and gills are destroyed due to severe infection 	<ul style="list-style-type: none"> • It is better to sell all the shrimp if CST gher is infected. If MTT gher is infected, shrimp density should be reduced fast by partial harvesting. • Positive in PCR test or virus infected shrimp should not be used in hatchery. Stocking only virus free PL in nursery and gher. generally at the age of 50 – 60, shrimp are attacked by the disease. • Treat the water of stocking gher to make it germ – free and take masurs so that the water or vector from neighbouring gher do not enter. • Application of appropriate dose of bleaching power in the gher water, fence the entire gher with blue nylon net and make the gher embankment strong enough 	may turn to epidemic and 100 % shrimp die
Yellow head disease	Head turns to yellow colour due to the paleness of liver and pancreatic gland. Within 25 – 30 days of PL / juvenile stocking, the disease has normally been observed	The disease can be prevented by good management of the gher. Soil and water should be well-treated after well-drying the gher bottom, followed by ploughing and application of bleaching powder / lime	Dangerous
Black Gill Disease	Shrimp get infection from the disease due to the presence of excess hydrogen sulfide and other organic matter in gher. Shrimp show lack of appetite. Infected shrimp die slowly. The infection is	During gher preparation, the bottom mud should be removed and right dose of lime / dolomite / bleaching powder should be applied. Leafy plants from gher dyke should be cut down	Dangerous

Black Spot / Cell Disease	Shrimp get infection from the disease due to the presence of excess organic matter in gher. Black spots are observed on the shell, tail and gills. Pores are seen on the shrimp shell. Shrimp eventually die from fungal infection	The decomposed bottom mud should be removed and right dose of lime / fertilizer should be applied after well-drying the bottom. During culture, standard feed and fertilizer should be applied with regular exchange of water	Dangerous
White Muscle Disease	The muscle from the tail region becomes white and stiff. This is the main symptom. The infection occurs due to the high stocking density, presence of excess organic matter and high temperature	water depth and stocking density should be maintained at optimum level	Medium
Soft Shell Disease	The disease occurs due to lack of calcium nutrition. This is known as Sponge Disease to many people. If salinity of water decreases, shrimp get infected from the disease. The symptoms, shrimp shell does not turn to tough even after 24 hours of moulting, shrimp grow less and eventually die from weakness.	Gher should be prepared for culture by well-drying and the application of lime. If infections are observed, large shrimp should be harvested. Inlets and outlets of gher should be separated.	Typical
External Fouling of Shrimp	The presence of excess algae due to excessive feed application in closed water may cause this problem. Generally, in the small farms, particularly in the prawn farms, this disease is more observed. Shrimp can not moult, grow less and eventually die.	Water depth should be increased. Stocking density should be reduced. The application of lime / fertilizer and feed should be controlled / limited	Typical
Bacterial Disease	Black spots on the shrimp shell are observed due to bacterial infection. Shrimp shell break, colour change,	Gher should be prepared by well drying and applying lime and fertilizer. Water supply facilities should be improved	Typical

Group Session Planning

Day – 02

Time – 12.00

Duration – 60 min

Target Group : Shrimp Farmers
 Title of the Session : Sampling, harvesting, restocking and marketing
 Goal : The trainees will get clear ideas on sampling of shrimp, harvesting, restocking and marketing so by well – executin g the listed activities they will be able to increase shrimp production in their gher and to market the shrimp timely

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

- Trainees will be able to sample the shrimp in shrimp gher.
- Trainees will be able to harvest marketable shrimp, post harvesting management and restocking
- Trainees will be able to market the shrimp timely

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 earlier session 3. Linking with present session 4. Explaining the objectives of present session and worlds of encouragement	Discussion Question answer	
Subject matter		45 min
1. Sapling of cultured shrimp 2. Harvesting, post harvest management and restocking 3. Marketing of shrimp	Question answer Speech Flip chart	
Summary		10 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, marker and handout

Planning of flip chart

(Please follow the handout for detailed description)

Sampling, harvesting, restocking and marketing	
Sampling <ul style="list-style-type: none">- When to do?- How to do?- How much shrimp need to be sampled?- What to observe?- Estimation of total biomass	Restocking <ul style="list-style-type: none">- When to do?- How to do?- How much to stock?- Where to stock?
Harvesting <ul style="list-style-type: none">- Pre condition of shrimp harvesting- How to harvest?- Post harvest shrimp management	Marketing <ul style="list-style-type: none">- Aspects need to be considered in marketing- Post harvest preservation- Transport

Shrimp sampling, harvesting and marketing

Sampling of shrimp

- Generally sampling is carried out to observe the growth and health of shrimp. Each month after PL / juvenile stocking, i.e., when shrimp grow a bit bigger, sampling should be started from that time.
- Sampling should be carried out once and if necessary twice a month
- To get the accurate result, 5 – 10 % of total shrimp stock should be sampled. If collecting sample from 5 – 10 % shrimp is not possible, minimum 30 – 40 shrimp should be caught for sampling.
- For sampling, cast net may be used
- Care should be taken so that the gher water does not turn to very turbid because of sampling

The probable activities based on the observable aspects in sampling are described in the table below –

Matter of observation		Activities
1	If there is food in the stomach	If there is no food, reasons should be investigated > Feed application should be increased, if necessary
2	Is there any white round spots on the shell	Need to be ensured, if shrimp got viral infection. Shrimp should be harvested, if necessary
3	If gills look black	If the number of this type of infected shrimp is high, <i>harra / pala</i> should be pulled in the gher and 100 g / dec lime should be applied
4	If tail looks swollen and watery	If the number of infected shrimp is high, 1.5 kg medicine grade potash should be mixed with water and should be applied per <i>bigha</i> gher.
5	Are the shrimps strong / weak	If the number weak shrimp is high, reason should be determined. Shrimp should be partially harvested, if necessary
6	Are shell soft / hard	If the number soft shelled shrimp is high, reason should be determined and 100 g / dec lime should be applied
7	Is there any gap between shell and body muscle	Dose of feed should be checked and quantity of feed should be increased, if necessary.
8	Are shrimp growing according to their age	Reasons should be investigated and quantity of feed should be increased, if necessary.

N. B. The problems observed in sampling should be quickly resolved. For this, suggestions should be seek from local fisheries officer.

Estimation of total biomass

How much feed should be applied in the gher depend on the total biomass or total weigh of shrimp in the gher. Total biomass can be estimated from the following formula –

$$\text{Total biomass} = W \times N \times S$$

Here, W (g) = Average weight of shrimp / fish at a particular time

N = Number of stocked shrimp / fish

S = The rate of survival of shrimp / fish

Example

Total fish stocking : 1 ha pond (N) = 10,000

Average weight of fish : after 30 days (W) = 15 g

The survival of fish (S) = 90 %

$$\begin{aligned} \text{Total biomass} &= W \times N \times S \\ &= 15 \text{ g} \times 10,000 \times 0.9 \\ &= 13,500 \text{ g} \\ &= 13.5 \text{ kg} \end{aligned}$$

$$\begin{aligned} \text{The daily amount of feed needed} &= 13.5 \text{ kg} \times 0.05 \text{ (5 \% body weight per day)} \\ &= 0.675 \text{ kg / day} \end{aligned}$$

Harvesting, post harvesting management and restocking

Before marketing, to maintain the quality of shrimp is crucial. The quality and market price of shrimp depend on the harvesting and post harvesting management. Generally harvesting starts after 2 - 2.5 months of stocking under improved traditional methods. Since then, harvesting is done ones or twice a month.

The activities before shrimp harvesting

1. Arrangement of necessary labours / manpower
2. Enquire the market price
3. Arrangement of plastic basket, caste net, ice, measuring balance etc.
4. To know the size and weight of harvested shrimp

Farmers should be careful about the following important aspects during shrimp harvest

- Mode of harvesting should ensure the escape of small and juvenile shrimp and if they are caught by any means, should go unharmed / unwounded
- If the harvesting is synchronized with full moon and new moon, there is less possibility of catching soft shelled shrimp
- Harvesting g shrimp in the morning or during cool weather
- Avoid harvesting gears or tools, where shrimp gets excess blow, appendages damage and lesions are formed on the shell.
- After harvesting, shrimp should be washed in cold water to remove mud or dirt.
- Wounded shrimp or shrimp with broken shell fetch low price in the market.

Different methods of shrimp harvesting

1. Goi method : At a particular location of gher, a wooden get is built for entering and draining the water. Along the get, there is a narrow canal with earthen embankment at the two sides. There is a bamboo made or plastic valve (pata) at the mouth of the canal which is like Bengali alphabet 'V'. Shrimp gradually come inside the valve and from where do not go back to the gher. Harvesting shrimp by this method is relatively easy, need less manpower; however, there is high possibility of catching small and soft shelled shrimp.

2. Trap method : Shrimp are harvested using bamboo made trap. Different sizes (60 – 70 cm) of locally made shrimp catching trap (Atol) are set at the 2.5 – 3 m distance closed to the valve (pata) or net. These traps are set at the deeper part of the gher during gon and closed to the goi (the location of gher through which the tidal water enter and go out go gher). This method is relatively easy and need less manpower. If mesh of expected size is used, there is less possibility of catching small fishes / shrimp.

3. Cast net method : When a few shrimps are caught in goi and trap method, cast net can be used to harvest the shrimp. Small shrimp can be caught more than ones by this method and it requires more manpower than the first two methods.

Most of the complaints raised in the international markets about shrimp produced in Bangladesh are due to the post harvesting mismanagement and carelessness in the shrimp gher and farm. Most cases it happens due to the lack of knowledge on the care of the shrimp by the people involved in harvesting and post harvest management. The quality shrimp is highly damaged during due to the lack of care at different stages during the period starting from harvesting to transport to the processing plant. It should be remembered that, once the shrimp quality is damaged, no way that can be recovered or brought back to the good quality. Therefore, caring shrimp is essential in all the stages between gher / farm and processing plant. Farmers should not only the know post harvest care, but also the care at the late stages.



Fig. Checking og health of shrimp

Marketing of shrimp

At the field level, the following tiers are observed in shrimp marketing –

Post harvest management

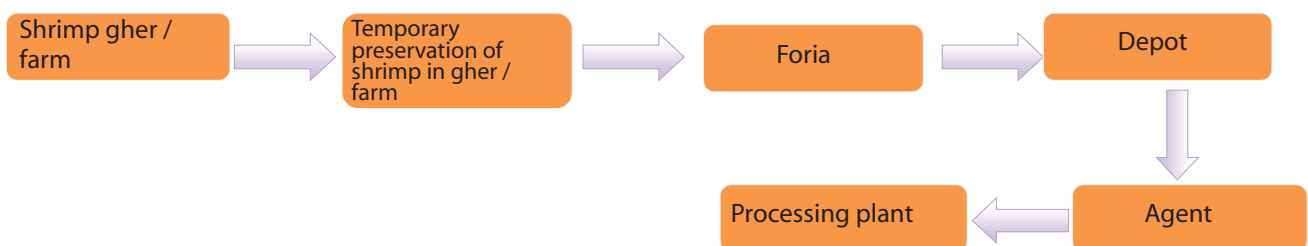
As shrimp are exported to overseas countries, farmers should carry out all the activities of safe food management with enough care at the post harvesting stages –

- Shrimp should be washed with clean water after harvesting
- After cleaning shrimp should be kept in ice or cold water (chilling temperature 4 o C) for 5 minutes
- Shrimp should be preserved in clean plastic baskets mixing with ice
- To send the shrimp to factories maintaining the proper ratio of shrimp and ice (1 : 1)
- As little is the time from harvesting to the factories, is better
- As small quantity of shrimp is harvested in this method, it is better if a number of local farmers in a group send the shrimp to factories in regenerated van.

At the farmer's level, in case of restocking, PL are directly stocked in the gher instead rearing in the nursery. As a result, PL face high mortality and large shrimp predate on small shrimp (PL) and farmers do not get expected yield. Therefore farmers should be encouraged to rear the PL in nursery before stocking in gher

Restocking

Shrimp should be restocked immediately after partial harvest to ensure shrimp farming over the entire culture period and to increase the shrimp production in gher. To do this, planning should be made well ahead and PL should be stocked in the nursery 3- 4 weeks before the shrimp harvest from gher. The stocking and rearing of PL in nursery should be carried out following the usual method. This way through 4-5 times PL rearing in nursery and juvenile rearing in the stocking gher, 900 – 100 kg shrimp can be produced per ha.



All the goods go through a number tiers in its marketing. In case of marketing shrimp, there are a number of tiers as well. Considering the situations between gher / farm and processing plant - physical and infra-structural facilities, necessary ingredients, ice, communication, transport vehicle, transport method etc., it is easily realized that how difficult it is for the farmers to maintain the quality of such a perishable item like shrimp. However, at the farm level, farmers should strictly follow the activities described below –

Short-term preservation in gher / farm

A) Physical infrastructure

1. Arrange hygienic and clean water for cleaning the shrimp well after harvesting
2. Build suitable shade to keep shrimp after harvesting. Be careful so that, fly, worm insects, birds, dogs and cats or other animals can not enter in to the shade.
3. Arrange a concrete, smooth and clean floor or a large plastic sheet for keeping shrimp after harvesting
4. Maintain the supply of hygienic ice and hygienic facilities for preserving the ice
5. Arrange the "ice cool" water in plastic tank
6. Ensure the germ free plastic box for shrimp transportation
7. Ensure the hygienic tools / utensils for the handling of shrimp
8. Arrange the sufficient supply of detergent, germicide (Bleaching powder) for cleaning the plastic baskets, boxes and other utensils



Fig. Post harvest management of shrimp

Activities

- Shrimp should be kept under the shade and not in the sun after harvesting
 - Shrimp after harvesting should be kept in the shade on the clean germ free smooth floor or on a clean plastic sheet
 - Shrimp should be well-cleaned with clean and cold water
 - Cleaned shrimp should be preserved in crushed ice after washing with clear water. Inside the plastic box, shrimp should be arranged with one layer ice and one layer shrimp and covered with one more layer of ice again.
 - Do not de-head the shrimp at farm level (According to HACCP principle, de-heading shrimp at the farm level is strictly prohibited)
 - Shrimp should be sent to depot / arot / service center as quickly as possible
 - Intact shrimp should be transported in temperature resistant plastic boxes with necessary crushed ice in truck or van
 - Estimate the ratio of ice and shrimp considering the transport time and surrounding temperature of that day. Generally the ratio of shrimp and ice should be 1 : 1. Increase the amount of ice considering the day temperature and transport distance.
 - Transport shrimp in box made of strong plastic with appropriate design. Boxes of appropriate design even if arranged one after another, the shrimp in the box do not get pressed. On the other hand, if conventional shrimp baskets are arranged one after another, shrimp of lower basket may be damaged due the basket cover it.
 - Do not use bamboo basket and mat made from Hogla, chot and banana leaves as packaging materials.
 - Try to reach the processing plant as soon as possible after harvesting the shrimp
- After transport, the transport vehicle, shrimp baskets should be cleaned properly with detergent and germicide and dried.



All the activities like receiving beheaded shrimp in the processing plant, de-heading at the depot, inserting water, sagu, barley, flour, cement solution or other trash materials in to the shrimp body to increase the weight of shrimp in any places, to insert iron wire or piece of glass or coconut stick to make the soft shrimp to hard and stiff etc. are dangerous and punishable crime. Due to these illegal activities, there is fear of stoppage of the export of Bangladeshi shrimp to overseas countries. Therefore all should be deterred from these type of activities.

Group Session Planning

Day – 02

Time – 13.00

Duration – 60 min

Target Group : Shrimp Farmers
 Title of the Session : Economic analyses of shrimp culture and record keeping
 Goal : The trainees will be get clear about economic analyses of shrimp culture and record keeping so they will be able to calculate the cost and benefit of shrimp culture accurately and to keep the record

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

- Trainees will be able to calculate cost and benefit in shrimp culture
- They will be able to fill up the record book

Subjects to be discussed in the session	Training method	Time
Introduction		4 min
1. Welcome: Welcoming the participants and exchange of greetings 2. Review of earlier session 3. Linking with present session 4. Explaining the objectives of present session and words of encouragement	Discussion Question answer	
Subject matter		45 min
1. Economic analyses of shrimp culture 2. Filling record book and exercise	Question answer Speech Flip chart	
Summary		6 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, marker and handout

Economic analyses of shrimp culture

Shrimp culture is a profitable business. In comparison to other agriculture activities, shrimp culture can give high revenue in relatively short time and low investment. Moreover, there are fewer risks in shrimp 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



চিত্র: আহরিত মাছ বাজারজাত করা হচ্ছে

To run the fish shrimp culture activities, money is needed mainly for lime, rotenone, fertilizer, feed, PL / juveniles, labour wages, gher renovation etc. The input price varies based on locality, time and situation. Consequently, cost-benefit varies depending on the situation. An analyses of cost and benefit of shrimp culture per acre water bodies is described below –

Cost benefit analyses of shrimp culture (per acre gher) under improved management

Items of expenditure	Cost taka
Lease value (1 year - 22,500 taka)	22,500
Dyke repair (including nursery dyke)	10,000
Bottom mud removal of canal or drain (with machine)	2,000
Water entering and draining out	4,000
Poisoning (Gher, canal)	2,000
Lime application 150 kg	3,000
Fertilizer application (Urea - 6 kg, T S P - 9 kg, Oil cake - 15 kg, Auto rice bran - 6 kg, molasses - 15 kg and yeast - 3 table spoon) Pre stocking	1,440
Fertilizer application (Urea - 72 kg, T S P - 108 kg, Oil cake - 180 kg, Auto rice bran - 54 kg, molasses - 180 kg and yeast - 10 table spoon) Post stocking	17,270
Virus free PCT tested shrimp PL / juvenile stocking - 24,000 (for 2 crops) @500/'000	12,000
Feed application 400 kg (for 2 crops) @45/=	18,000
Other cost	2,000
Harvesting	2,000
Total	96,210

Probable production

Shrimp (2 crops)	Unit price	Total price	Net profit = (Income - cost)
450 kg	500 taka / kg	2,25,000	1,28,790 taka

Maintaining records

To verify the success and failure of running any business, record keeping is very important. Necessary record keeping in fish and shrimp 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 gher / pond
- Water depth
- Description of the activities during gher / pond preparation and the expenses
- Shrimp PL / juvenile collection, transport, stocking and the expenses
- Number of PL / juvenile stocked
- Information on fertilizer application, kinds, weight and expenses
- Information on feed application, kinds, weight and expenses
- Sampling information
- Harvest quantity of fish, shrimp and income etc.

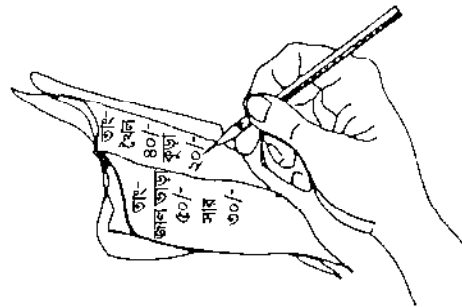


Figure. Record keeping of cost and benefit

There is no set rule for record keeping. Recording necessary information accurately is more important than the way of recording. 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

References

1. Department of Fisheries – DoF (2008) Machh Chas Manual
2. Department of Fisheries – DoF (C B A C C – C F Project 2010): Advance Fish Culture Training Manual
3. Bangladesh Fisheries Research Institute – BFRI (2008) bagdar banijik chaser Kolakoushal - 2003
4. Bangladesh Aquaculture and Fisheries Resource Unit - BAFRU and Department of Fisheries (DoF) (1997) Bagda Chingir Chasabad
5. WorldFish Center (2009) Bagdar Chas Babosthaponna, Gher Project
6. Bangladesh Aquaculture and Fisheries Resource Unit - BAFRU (1996) Pukure Jibbiggan
7. Department of Fisheries – DoF (2005) Proshikkhan Manual Paribesh Bandhob Bagda Chingir Chas Babosthaponna
8. USAID-PRICE (2009) Paribesh Bandhob Bagda Chingir Chas Babosthaponna
9. WorldFish Center Cyclone Affected Aquaculture Rehabilitation Project. Bandhob Bagda Chingir Chas Babosthaponna – Sadharon Padhoti (Chashi Sahayika)
10. Bangladesh Aquaculture and Fisheries Resource Unit - BAFRU (1995) Karigori Nirdeshika, Bagda Chingir Chasabad
11. Department of Fisheries – DoF (2003) Upakuliyo pparibeshe Bagda Chingri Chaser babosthaponna Koushal (Chashi Sahayika) samanitto Matshya KJkarjokromer madhyme Daridro Bimochon Prokolpo (2nd phase)
12. USAID-PRICE () Paribesh Bandhob Chingir Chas Babosthaponna .Chashi Proshikkhan Sahayika
13. Farmer's Experience
14. Ravikumar B. (2011) Consultancy report on Shrimp Culture. WorldFish Center