

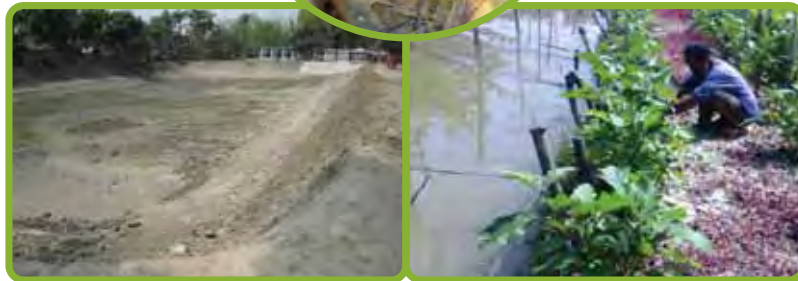


USAID
FROM THE AMERICAN PEOPLE

SEE THE
FEED THE
CHANGE **FUTURE**



**Training Manual
on
IMPROVED PRAWN-CARP POLYCULTURE
AND DYKE CROPPING IN GHER SYSTEM**



SEPTEMBER 2011

**CEREAL SYSTEMS INITIATIVE FOR SOUTH ASIA IN
BANGLADESH (CSISA-BANGLADESH)
WORLD FISH CENTER**



IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE



Training Manual on IMPROVED PRAWN-CARP POLYCULTURE AND DYKE CROPPING IN GHER SYSTEM

CEREAL SYSTEMS INITIATIVE FOR SOUTH ASIA IN BANGALDESH (CSISA-BANGLADESH) Project WORLD FISH CENTER
House # 22B, Road # 7, Block F, Banani, Dhaka – 1213

Editorial Board

W J Collis
Md. Mokarram Hossain
Mahabubul Alam Miah
Asokh Kumar Sarkar
Md. Mazharul Islam (Jahangir)
Shattanarayan Rai
Gopal Chandra Saha
Israt Zahura

Overall cooperation from

Dr Binay Kumar Barman
Dr Manjurul Karim
Dr Benjamin Belton
Dr Khondokar Morshed – e – Jahan
Khonodkar Irshad Mahmud
Bijoy Bhushan Debnath
Khondokar Hasib Mahbub
Bilash Mitra
Afrina Chowdhury
Billal Hossain
Md. Humayun Kabir

Publication directed by

World Fish Center Bangladesh
September 2011

Written by

Md. Mazharul Islam (Jahangir), Md Habibur Rahman, Mashiur Rahman, Kajol Kumar Basak

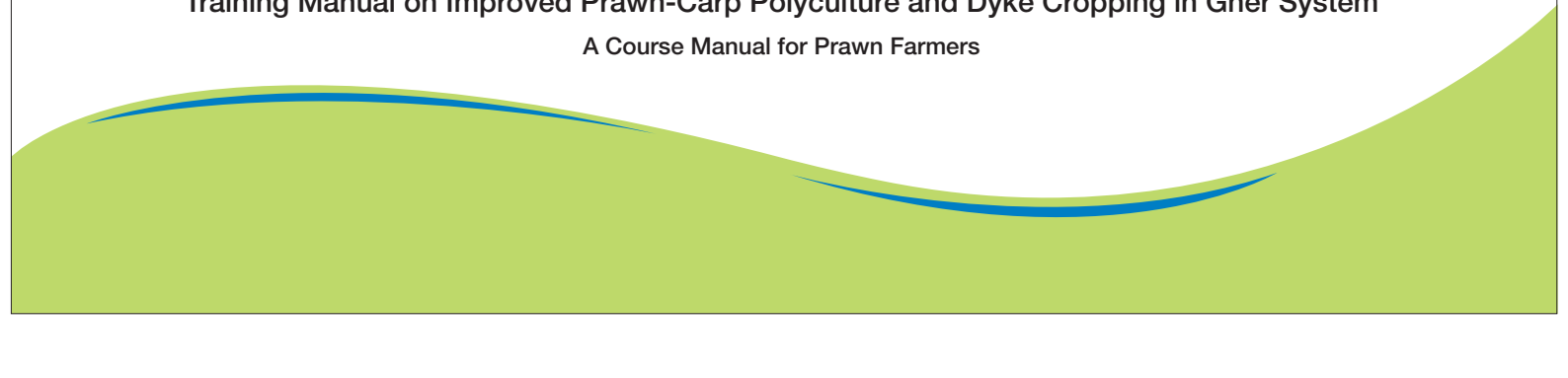
Photographs

World Fish Center, Ambassador Finn Thilstead

Illustrations and Graphics

Sparrow Communications (01711-142520)

Training Manual on Improved Prawn-Carp Polyculture and Dyke Cropping in Gher System
A Course Manual for Prawn Farmers



Preface

Due to limitations in technical knowledge and skills, farmers undertaking prawn-carp polyculture in ghers do not get optimum results. From the beginning of the CSISA-BD project, the World fish Center has initiated dissemination of technical knowledge in carp polyculture. CSISA BD project has felt there is a lack of skilled trainers and training material in this subject. There are some manuals on prawn-carp polyculture developed by the Department of Fisheries, Fisheries Research Institute, WorldFish Center as well as various other government and non-government organizations. Based on field experience and existing training manuals, the WFC has developed training material and manuals on 'Improved Prawn-Carp Polyculture and Dyke Cropping in Gher System' with respect to the environment and socio-economic requirements of the fish farmers.

This manual has been developed for government and non-government training staff and fish farmers. During the project period the training staff and fish farmers, it is expected that the manuals will be beneficial. In future, based on the experience in the field, the manuals will be further developed and enriched. It can be expected that various government and non-government training staff and persons will utilize this manual to assist in the development of human resources as well as fish production and thus contribute to the country's overall economic development.

We acknowledge the contribution of all those who have been directly or indirectly contributed to the development of the manual.

TABLE OF CONTENTS

Session	Topic	Page
	Introduction to training manual	i-ii
Session	Registration, introductions and course inauguration	4
Session	Basic issues about Golda- Carp polyculture in ghers	6
Session	Nursery management of Golda prawns in ghers	26
Session	Gher management of Golda prawns (pre-stocking and stocking)	45
Session	Discussion of previous day's session	51
Session	Gher management of Golda prawns (post-stocking)	52
Session	Sampling, harvesting, re-stocking and marketing	65
Session	Vegetable cultivation on gher embankments	71
Session	Cost-benefit analysis of Golda- carp polyculture in ghers	81
	Necessary information on measurements in fish farming	86
	References	86

IMPROVED PRAWN-CARP POLYCULTURE AND DYKE CROPPING IN GHER SYSTEM

Training Manual

Introduction to the manual and how to use this manual

In southern Bangladesh Golda culture in gher has become very popular, however in there is lack of proper knowledge about this culture method which is why many farmers do not get optimum results. The CSISA-BD project has developed this training manual on 'Improved Prawn-Carp Polyculture And Dyke Cropping In Gher System' which we expect will help Golda farmers manage prawn-carp polyculture using improved technologies.

Training period:

This manual is designed to conduct a 2-day basic training course, however depending on the needs of the trainees, the course time may be adapted within the basic 2-day period. Usually the training will be from 10 am to 2 pm. The training venue is within range of the farmer's gher or ponds so that their participation can be ensured.

Training Process:

Most of the teaching material in this manual is introduced in a practical and participatory manner. The training method takes into consideration the existing practical knowledge of the women farmers and ensures everyone's easy participation. In all the sessions, following methods are included:

- 1) Brain-storming
- 2) group discussion
- 3) open discussion
- 4) analysis of field experiences
- 5) practical demonstration usual existing materials
- 6) speech with discussion and
- 7) question and answer sessions.

Number of trainee participants:

Each training session will cover 25 Golda farmers, since the methods used in this training can ensure proper participation and instruction for 25 trainees. If the number of trainees is more than this, it will create problems in conducting the sessions effectively.

Role of trainer in training:

The main role of the trainer is to create a learning environment whereby the trainees will feel easy and actively participate in the training. The trainer is at the same time a facilitator and a trainee. In the process of enriching the knowledge and practical experience of the trainees, the trainer will at the same time learn from their experiences. In this manner, both trainer and trainees will achieve the objective of learning from each other.

Training topics and supporting manual

The training topics have been developed according to the practical needs of the women farmers which at the same time have been scrutinized by experts and adapted with their advice. For each of the sessions/chapters described in the training manual, handouts have been also developed. These handouts will assist the trainer to better prepare to deliver and discuss the sessions. The sessions are arranged sequentially and before the trainer delivers the training session, the trainer should read the manual fully to prepare well in order to deliver the training properly and effectively.

Use of the training manual

In order to obtain successful results from the training process so that the trainees have efficient and confident skills by the end of the training, it is necessary that the trainer studies the manual properly and delivers the training in the recommended participatory process and not the traditional method of teacher–student delivery. The latter method will not be beneficial and will instead reap negative results. For the trainer and trainee to use this manual efficiently the following tips are given:

1. Before starting the training session, the session plan needs to be read well, which will assist the trainer to conduct the session properly. We need to remember that good preparation and planning contributes to at least half the success of a training session.
2. Handouts given for each session should be read thoroughly. The trainer can then use the materials for the training session in a sequential manner and conduct the discussion similarly.
3. This manual is only a guideline for the trainer to conduct the sessions such that both the trainer and trainees discuss the topics based on practical experience.
4. The process and approach for each session is given in such a manner to ensure the full participation of the trainees. If the given process and approaches are used, the participation of trainees can be ensured wholly and expected results for each session largely achieved.
5. The sessions are arranged sequentially. Each session will be discussed within a given period. If required, the trainer based on his/her experience may change or adapt the session times. However, it is advisable for both trainer and trainee to start and end the sessions timely.
6. It is important to evaluate the success of the training session and therefore while conducting the session, the lessons learnt by the trainees from the session need to be evaluated.
7. This assisting document is a very important material which needs to be kept carefully and may be used later as reference.

Learning environment

One of the primary objectives of the training is to create a learning environment which is especially important for the trainer. In a lively learning environment, every participant will feel comfortable to discuss and share freely their opinions. To enable such an environment the trainer should be interested and take the initiative to know every trainee's expectations, mentality and experience. The trainer has to motivate the trainees to participate in the training practically and give due respect to their experiences and opinions. This will help the trainees work together during the training sessions. Other guidelines are given below to enable a good learning environment and lively training session:

8

Training guidelines

1. To be respectful towards everyone
2. To be objective and have polite behavior
3. Respecting others' opinions so that there is an open and free discussion which will help to make good decisions
4. Everyone must participate especially the more quiet trainees
5. Must take the effort to listen more than speak
6. Take notice of trainees not to talk among themselves while discussions are going on
7. Everyone should have the opportunity to speak up one by one; if everyone talks at the same time, no one will be heard
8. Patience and sensitiveness is required
9. Sensitive issues need to be taken into consideration
10. Need to have respect and trust about the trainee's experience and knowledge
11. Do not hesitate to interact with the trainees as a co-worker/colleague
12. Admit if you have no knowledge about any issue

IMPROVED PRAWN-CARP POLYCULTURE AND DYKE CROPPING IN GHER SYSTEM

Training schedule

Period: 2 days

Day	Time	Discussion topic
1	10.00-10.30	Inauguration, registration, course introduction
	10.30 – 11.45	Basic issues about Golda- carp polyculture in gher
	11.45 -12.00	Tea break
	12.00-13.00	Nursery management of Golda prawns in gher
	13.00-14.00	Gher management of Golda prawns (pre-stocking and stocking)
2	10.00-10.30	Discussion of previous day's session
	10.30 -11.30	Gher management of Golda prawns (post-stocking)
	11.30 – 11.45	Tea break
	11.45 -12.15	Sampling, harvesting, re-stocking and marketing
	12.15-13.00	Vegetable cultivation on gher embankments
	13.00-14.00	Cost-benefit analysis of prawn-carp polyculture and vegetable cultivation on gher dykes; data preservation

If required the trainer in discussion with trainees may change training times

GROUP SESSION PLANNING

Day 01

Time – 10.00

Duration: 30 minutes

Target group :	Golda-carp polyculture farmers
Title of session :	Registration, introduction and course inauguration
Aim :	To inaugurate training session on 'Improved Prawn-Carp Polyculture and Dyke Cropping in Gher System' where trainer and trainees are introduced with each other and will have a basic understanding of the training
Objective :	At the end of this session, the participants - <ul style="list-style-type: none"> • The trainer and trainees will be introduced with each other • Will have a basic understanding about the training course • Will register their names in a given form • Will be able to articulate the objectives and aim of the course • Will be able to state the course timings and express their expectations • Will be able to state the guidelines to follow during sessions and understand why

Discussion topic	Training approach	Duration
Introduction		2 minutes
Welcoming the course participants and seating arrangements	Lecture	
Topic		25 minutes
Registration and distribution of training material Notebooks, pen etc will be distributed among the trainees and their names registered in a given form Introduction Trainer through discussion and interaction will complete introductions with the trainees Inauguration of training course One of the trainees will start with recitation from the Quran, there will also be recitation from the Geeta and Bible Establishing Training objectives Trainer will listen and list farmer participants objectives Course contents and period The trainer will distribute the course contents and timing and will explain any questions the trainees have about the course contents Guidelines for the training sessions The trainer will explain the importance of the guidelines and how to write them and then will take the guidelines written on VIP cards from the trainees Main aim and objectives of the training course With reference to the handout of the session, the trainer will explain to the trainees the overall aim and objectives of the training course	Lecture, Discussion, Individual work. VIP card	
Summary		3 minutes
Thanks from the trainees to the trainer	Q&A	

Discussion and link up to the next session

Supporting Training Material Banner, registration form and handout

Training manual on Improved Prawn-Carp Polyculture and Dyke Cropping in Gher System

Training objectives and aims

Aim of the training course:

This training course aims to enhance knowledge and skills of gher farmers in Improved Prawn-Carp Polyculture and Dyke Cropping in Gher System so that they can use improved methods to get optimum results from culture of Golda prawns, carps and vegetables.

Overall objectives

By the end of this course the participants will:

- Be able to describe basic issues of prawn-carp polyculture and dyke crop
- Be skilled to carry out nursery management of Golda prawns
- Be skilled in prawn-carp polyculture management
- Be able to cultivate vegetables on vegetable dykes
- Be able to plan prawn-carp polyculture and keep records of this activity
- Be able to do cost benefit analysis of prawn –carp polyculture

GROUP SESSION PLANNING

Day 01


Time – 10.30

Duration: 75 minutes

- Target group : Golda-carp polyculture farmers
- Title of session : Basic issues about Golda- carp polyculture in gher
- Aim : To educate the Golda farmers on importance of Golda-carp culture and give an overall understanding about the methods and techniques used in this culture so that they can use this information to improve their production of prawns and carps.
- Objective : At the end of this session, the participants -
- Will be able to state the importance of prawn-carp polyculture
 - Will be able to discuss types of Golda-carp polyculture
 - Will be able to articulate the characteristics of water and soil quality necessary for Golda culture
 - Will be skilled to undertake improved Golda culture
 - Will be able to narrate basic requirements of HACCP in prawn culture

Discussion topic	Training approach	Duration
Introduction		5 minutes
<ol style="list-style-type: none"> 1. Welcome/reception: welcoming the participants and asking about participants welfare 2. Discussion about previous session 3. Linking previous session's topic to current session 4. Explanation of aim and objectives of current session 	Q&A and discussion	
Topic		20 minutes
<ul style="list-style-type: none"> • Introducing Golda prawn • The importance of prawn-carp polyculture and types of Golda-carp polyculture and the methods • Characteristics of water and soil quality necessary for Golda culture • Improved Golda culture process • Basic requirements of HACCP in prawn culture • Necessary resources and capital for Golda-carp culture 	Lectures, Q&A Discussion Flipcharts	
Summary		5 minutes
<ol style="list-style-type: none"> 1. Summary discussion of main topic 2. Assessment of session objectives 3. Distribution of handouts 	Q&A	

Discussion and link up to the next session

Supporting Training Material  flipchart, white board and marker and handout

Flip Chart Design

For discussion follow the handout

Basic aspects of Improved Prawn-Carp Polyculture and Dyke Cropping in Gher System	Water criteria: Physical characteristics of water Chemical characteristics of water Biological characteristics of water
Introducing the Golda prawn The importance of prawn-carp polyculture and types of Golda-carp polyculture and the methods Reasons for low production of Golda	Good aquaculture practice for Golda culture
Potential	<ul style="list-style-type: none"> • basic requirements of HACCP in prawn and fish culture
Problems in Golda culture Technologies for profitable Golda production Regular method of Golda culture Comparison of different methods of Golda culture	<ul style="list-style-type: none"> • basic requirements of HACCP in prawn and fish farms
If water and soil quality is not ideal: Water quality: Four main physical properties of soil:	Sequential activities in Golda culture management
Necessary resources and capital for Golda-carp culture	

Introduction to the freshwater prawn: Golda

According to classification and nomenclature by the Food and Agriculture organization (FAO) the freshwater prawn is known as Golda. There are 450 species of prawns worldwide, and in Bangladesh there are about 60 species of prawn (24 freshwater and 36 saline). Prawns of commercial value include:

Local name	English common name	Scientific name
Golda chingri	Freshwater giant prawn	<i>Macrobrachium rosenbergii</i>
Chhatka chingri	Monsoon river prawn	<i>M. malcolmsii</i>
Katalia chingri	Dimla river prawn	<i>M. villosimonus</i>
Chhochhono chingri	Kusho river prawn	<i>M. lamarei</i>
Chhoria chingri	Kria river prawn	<i>M. dayanus</i>
Roda chingri	River prawn	<i>M. rude</i>
Goda chingri	River prawn	<i>M. dolichodactylus</i>

Position in the animal kingdom:

Among the freshwater prawns, the freshwater giant prawn i.e. Golda is the most commercially important prawn. Golda's taxonomical classification in the Animal kingdom is:

Phylum: Arthropoda

Subphylum: Crustacea

Class: Malacostraca

Order: Decapoda

Family: Palaemonidae

Genus: *Macrobrachium*

Species: *M. rosenbergii*

Location:

The Golda is native to the Indo-Pacific region, northern Australia and Southeast Asia especially in countries around the Indian Ocean and these include: Bangladesh, India, Sri Lanka, Myanmar, Thailand, Laos, Indonesia, Kampuchea, Philippines and Vietnam. Golda naturally inhabits the rivers, lakes, floodplains, ox-bow lakes and wetlands. They travel almost 300 km upstream from the coast.

Characteristics:

Golda prawn has a benthic lifestyle, living in the mud at the bottom, feeding on various live and dead flora and fauna. It is omnivorous in feeding habit. It feeds on algae, aquatic plants, mollusks, aquatic insects, worms, and other crustaceans. They seek their food using their long antennae. When there is a shortage of food in water, prawns eat up the weaker prawns, especially those going through metamorphosis. In addition to natural food mentioned the Golda prawn feeds on bran, granular food, oilcake, fruit pieces, fish powder, blood from domestic animals, and mollusk meat. Golda are nocturnal animals i.e. they feed, change shells and lay eggs at night, unlike carp fish, Golda prawns do not consume their food at once, and instead they hold the food between their claw-like legs and eat this slowly.

Growth and metamorphoses: Growth of the Golda is discontinuous. The prawn's growth occurs when it sheds its shell during metamorphosis. Metamorphosis depends on feeding, temperature, water quality, body structure and some hormonal functions. When shedding the shell, the prawn's body becomes weak and soft. From larva to post-larval stage, the shell is shed 11 times. As they grow bigger the rate of shedding shell reduces. If there is green slimy layer on the shell, growth of the prawn slows down. The growth rate of male prawns is more than that of the female prawns.

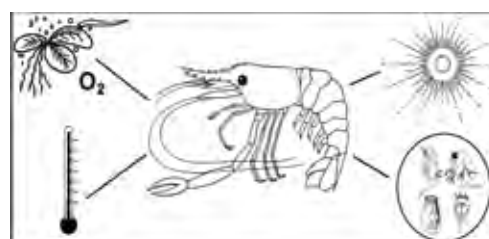
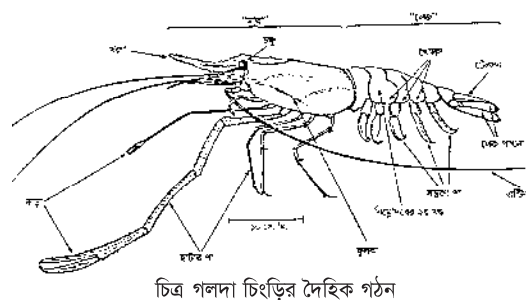


Fig. Factors effecting metamorphosis

Female and male prawns: The size and weight of male prawn is more than the female prawn. The 2nd pair of legs (chelipeds) of the male is longer and thicker than that of the female prawn. Male reproductive organ is located on the 5th pair of walking legs and female reproductive organ is on 3rd pair of walking legs. In mature female prawns the lower part and sides of the head are pinkish/orange in color because of eggs.



External structure: Golda is an invertebrate animal and is covered by a hard layer of chitin known as the exoskeleton which is of two layers. The outer layer is hard, allows gases to pass but not water. The lower layer is soft made of polyglucosamine which can be penetrated by either gas or water. The Golda prawn is made up of 19 sections of which 5 are in the head region, 8 in the thorax and 6 in the abdomen. The appendages on the head are used to look for food. Thorax appendages are used for walking and abdominal appendages used for swimming. The covering of the head and thorax is fused and known as cephalothorax covered by a hard carapace. The appendages attached to the cephalothorax are known as walking legs and those with the abdomen are known as swimmerets. The carapace ends at the front in a long beak or rostrum, which is slender, serrated and curved upwards. The structure of the rostrum can be used to differentiate the different species of prawns. The cephalic appendages include the antennae and antennules which work as sensory receptors. At the base of the antennae is the excretory pore from which excreta is expelled. There are eight pairs of gills located under the carapace. The nervous and reproductive apparatus are also located within the carapace. The abdomen has six segments which are covered with exoskeleton. Each covering over the abdominal parts is known as pleura. The exoskeleton parts are joined by arthrodal membrane of which there are 5 pairs. The last part of the abdominal segments is known as the telson which is narrow and hard on two sides of the telson are uropods.

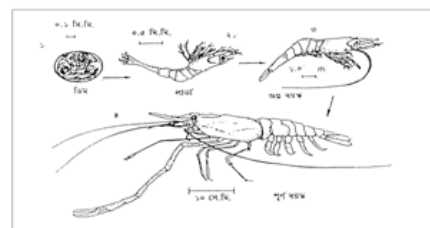


Fig. Life cycle of Golda

LIFE CYCLE:

Stages in the life cycle: Golda life cycle consists of mainly 4 stages namely – egg, larvae, post-larvae and adult.

Time of reproduction: Golda can reproduce throughout the year but most during December to July. During May-June, prawn seed is abundantly available in the coastal/estuarine areas.

Mating and egg production: Golda grow into maturity within 5-6 months if there is a favorable environment and sufficient food. Two to three days before releasing eggs, the carapace of the female prawn takes on an orange hue. One male prawn can successfully mate with four female prawns.

The larva requires semi-saline water and therefore the prawns go to estuarine areas during reproduction. Eggs and larvae do not survive more than 4-5 days if reproduction takes place in freshwater environment.

Before mating, the female prawn sheds her shell which takes about 10-15 minutes and takes six hours for the new shell to harden. The mating period takes place within 3-6 hours i.e. soft-shelled female mates with hard-shelled male prawn. The mating takes place thorax to thorax. The male prawn deposits a gelatinous mass of semen (referred to as a spermatophore) from between its 5th pair of walking legs on the underside of the thorax in area of 3rd pair of walking legs of the female's body. This takes 15-20 minutes.

Within 10-12 hours of mating, the female releases eggs. When the eggs are being extruded they are fertilized by the semen deposited on the female body. The fertilized eggs are held in the brood chamber at the base of the walking legs and kept aerated by vigorous movements of the swimmerets. Eggs stay in the brood chamber for up to three weeks. A 50-100 gm adult prawn can lay 50,000-100,000 eggs. At the initial stages of adulthood of the Golda, eggs laid number 5,000-20,000.

Eggs: The eggs when first released are of orange hue which after 18-21 days becomes grayish. At 28°C, eggs hatch after about 20 days. After hatching female prawn moves its legs to release the larva into the water. It may take two nights for the eggs to release the larvae.

Larva: The larva looks like small insects. These swim actively tail first, ventral side uppermost (i.e. upside down). *M. rosenbergii* larvae require 12-15 ppt saline water for survival and feed on planktonic matter during this stage which lasts 30-45 days.

Post-larva: After metamorphosing into post larva, the habits change. The PL look like miniature adults and become crawling rather than free-swimming animals. At this time they feed on larger planktonic flora and fauna. Post larvae exhibit good tolerance to a wide range of salinities, which is a characteristic of freshwater prawns. After reaching the post larval stage, after 7-15 days (less than one inch length) the PL start swimming towards freshwater i.e. upstream against the current. In about 30 days the post larvae develop into juvenile prawns (1-1.5 inches) which grow for 2-3 months to reach 2-2.5 inch size and after a further 3-4 months become adults.

Basic aspects of Golda-carp polyculture in gher

Gher is modified rice field (usually situated in flood plain) which has canals or trenches on 2-3 sides so as not to allow entry of water from outside. These are used to cultivate paddy in the boro season after which Golda are cultivated. Usually 10-15% of the total rice field consists of these canals.

Of the various freshwater prawns found in Bangladesh, the Golda is commercially the most important one. Also as food it consists of 98% digestible animal protein. There are 27 varieties of freshwater prawns in Bangladesh, among which Golda is the largest. Naturally it grows up to 400-450 gm and in culture conditions up to 200-250 gm. PL, juveniles and adult prawns are found mostly in the southern parts of Bangladesh, but also found in other parts as well. In some parts of Bangladesh Golda is also known as shola ichha or sowa ichha. Prawn seed/PL are found abundantly in estuaries located in southern Bangladesh that have brackish water. The Golda prawn also found naturally in canals, floodplains/flooded rice-fields where they enter from the estuaries and grow naturally. However because of recent environmental disasters, prawn seed are not as abundant as they used to be. Golda culture has been commercially successful through gher cultivation in the south and south west parts of Bangladesh. In these gher, Golda are reared after the boro season (November/December – April/May) of paddy cultivation.

Local and international demand for Golda has made Golda cultivation popular. In lowland areas of Bangladesh where there is water all year round, Golda can also be cultivated all year round. Currently 50 thousand hectares (1 hectare=2.47 acre; 1 decimal=435.6 square feet) are being used for Golda cultivation. Bangladesh earned almost 40 billion taka in from prawn exports in the 2010-2011 fiscal year. Among prawns exported, 25% were freshwater and there is potential to increase this. Because of adverse environmental factors, the production of Golda is 400-500 kg per hectare which is very low compared to Golda production in other countries. The low rate of production of Golda is because:

- Limited availability and high price of prawn seed
- Unavailability of quality seed and quality feed
- Lack of application of proper technical skills in production of prawn seed/PL
- Lack of juvenile production in nurseries and
- Lack of skills in Golda cultivation

If the problems identified in Golda cultivation and production can be solved then the rate of production per hectare would multiply and contribute to export income of the country as well as help in poverty reduction.

Problems in Golda cultivation

We are not very experienced in Golda cultivation, and even though there is opportunity for Golda farming in most parts of Bangladesh, because of the following problems, optimum production has not achieved. The problems are:

Prawn seed:

Availability is low compared to demand. Main source of prawn seed are collection from natural sources which satisfies about 90% of the current demand. Hatcheries in Bangladesh have demonstrated limited success in this area

Feed:

Ready feed for Golda require 25-35% protein. Preparing protein-rich feed at low cost is difficult. Also there is lack of skill in application of the feed.

Capital:

Golda farming requires more capital investment than carp culture and therefore poor farmers cannot afford the appropriate culture management practice

Skilled manpower:

There is lack of skilled manpower and technical advice

Materials:

Not all the materials required for Golda culture are easily available

Marketing:

Product processing and marketing opportunities are still not sufficient because the international market demands a quality level that has not been possible to maintain for various reasons.

Unplanned gher construction:

Constructing ghers in an unplanned manner creates problems such as accumulation of black mud and rotting matter at bottom of gher year after year which cannot be easily removed/ or dewatered for cleaning. In many ghers, the lack of banks, embankments etc hampers necessary activities in Golda culture.

Necessary aspects to consider for successful Golda culture

- Removal of waste matter and rotting earth and maintaining banks of ghers
- Keeping arrangement for changing water
- Stocking ghers with good quality and large size prawn seed
- Using good quality feed, proper method and timely application of feed

Potential of Golda culture in Bangladesh

It can be generally stated that over the last decade, Golda culture has spread to almost all areas in Bangladesh. Golda farms have grown and now cover about 70,000 hectares. At the same time production has increased. Prawn culture is a progressing industry and among the various prawns that are cultured, Golda is of particular importance. The advantages of Golda culture are:

- Farming method is fairly simple
- Almost all sizes are marketable. Most profitable are the prawns of size grade 10-30
- High market price, 450-750 taka/kg in production area
- Short-term investment, within 6-8 months, adult prawns are ready to be marketed
- Can be cultured in shallow ghers i.e. 1-1.5 meter depth
- Can be cultured in seasonal ghers
- Can be cultured along with carp fish
- Can be cultured all year round in coastal areas
- Water logging in coastal areas can be put to use for production of prawns

Standard culture method of fish and Golda

Standard method of culture is based on scientific research ensuring growth of Golda through the use of various resources effectively thus resulting in optimum production of Golda. Basic resources required include: pond/gher, water, environment, prawn seed, capital and labor. Through appropriate use of these resources in a complementary manner, profitable Golda culture can be realized. There are four methods of Golda culture based on the utilization of resources

a. Extensive culture method:

This method requires very little cost or no cost at all. Only prawn PL are released. Supplementary feed and fertilizer are not given. Also other culture activities or technological activities are not carried out. As a result the production is 0.5kg/hectare/year. Instead of following scientific method of fish culture, this method releases PL randomly and harvests them irregularly

b. Improved extensive culture method:

This method is slightly more improved than the previous. The gher is cleared of weeds and predatory fish and stocked with a lower density of Golda PL and carp fish. The other culture activities such as feed and fertilizer application are carried out irregularly. This is the culture method most practiced in Bangladesh and production rate is 1 kg/hectare/year.

c. Semi-intensive method:

In this method, ghers are repaired and prepared by removing predatory and unwanted fish, stocking PL and carp fish at specific density; regular application of fertilizer and supplementary feed; partial harvesting 3-4 months after stocking juveniles, re-stocking and if necessary changing the water and aerating it. This method follows some modern processes in prawn culture. Production is 2-4kg/hectare/year.

d.Intensive method:

In this method, costly infrastructure is used (including electricity, rapid water exchange, artificial aeration of water etc) in preparing the gher after which prawn seed are stocked at high density. This is a highly costly and labor intensive method. While profits are high, risks are too and this culture method has an adverse effect on the environment. This culture method is not widely used in Bangladesh. The box below gives a comparison of feed requirements in the different culture methods.

Feed requirements according to culture methods

Culture management method	Requirement for natural feed (%)	Requirement for supplementary feed (%)
Extensive method	100	0
Improved extensive method	70	30
Semi-intensive method	50	50
Intensive method	0	100

Matrix 1: Comparison of different culture methods

Culture management method	Various activities in fish culture					
	Gher preparation	Stocking density	Fertilizer application	supplementary feed	Water/oxygen supply	Prawn harvest
Extensive method	Unwanted fish and weeds are not cleared	Not specified	No application of fertilizer	No supplementary feed	Not done	Irregular
Improved extensive method	Unwanted fish and weeds are cleared	Semi-specified	Irregular application of fertilizer	Irregular application of supplementary feed	Not done	Fe times in the year
Semi-intensive method	Unwanted fish and weeds are cleared and controlled	Specified	Regular application of fertilizer	regular	Done if required	Partial harvest and irregular re-stocking
Intensive method	Totally cleared of unwanted fish and weeds	Specified and of high density	None	Regular application of supplementary and nutritious feed	All time arrangement	Regular partial harvest and re-stocking

Many farmers have used incorrect, irregular and unwanted processes in type of prawn seed released, feed application, fertilizer, damaging chemicals for quick profits from culture and this has resulted in damaging soil productivity. Unplanned culture results in:

- Loss of nutrients in soil, degrading soil quality and reducing productivity
- Natural environment for survival of fauna is spoiled because of black rotting mud at bottom of pond
- Production of various insects and larvae at bottom of gher is impeded and thus creates shortage of natural feed for Golda. As a result the prawns become prone to diseases and this results in sudden mass mortalities of Golda prawns.

Location of Golda (Prawn) culture and characteristics of the location

Golda can be cultured in two types of locations i.e. ponds and gher. Gher is a piece of lowland around which trenches or canals are dug out and then surrounded by dykes/embankment. In southern Bangladesh it is more common to cultivate paddy and prawns in gher. Gher are of two types depending on availability of water and cultivation method:

1. Paddy and Golda cultivation gher
2. Year-round Golda cultivation

Where there is 1-1.5 meters deep water for at least 6-8 months is suitable for Golda cultivation. Success of Golda production depends a lot on the type of location selected for Golda cultivation. A number of factors have to be taken into consideration in selection of site for Golda cultivation. Some important points in selection of gher are given below:

- Both seasonal and annual gher can be used for Golda cultivation
- Soil quality of gher should be preferably loamy/sandy-loamy/sticky
- Gher should be in flood free and sunny location
- Depth of water should be 1.5-2 meters
- Gher slope should be 1:2
- Rotting mud at bottom of pond should not be more than 4-5 inches thick
- Gher bank should be at least one foot away from main piece of land
- Water supply from external sources should be available
- Good communication for transport and marketing
- PL/juveniles should be collected from nearby sources
- Ready feed or material used for ready feed should be easily affordable
- There should be nearby marketing locations
- Socio-economic opportunities for prawn culture

Gher and environment:

Farmers need to be attentive about the soil and water quality in gher environment, since every fauna has its own specific habitat. Prawns are aquatic animal and they require a healthy aquatic environment. All the prawn life cycle stages take place in water. Therefore appropriate culture of prawns depend on the biological, chemical and physical properties of the water. So that the water parameters are maintained, farmers need to take steps for maintenances and management of the gher water.

If the quality of water and soil in the gher is not of appropriate quality then:

1. Natural food for the prawns will not be produced in sufficient amounts
2. There is wastage of supplementary feed
3. Physical growth of prawn is not as expected
4. There is risk of being affected by diseases resulting in mortality
5. Production of prawns will be low and farmers will incur losses

The water retention capacity of any water body depends on the soil quality. Productivity also depends on the soil quality. For profitable prawn culture, a healthy aquatic environment in essential where the feed required for the prawns can be ensured.

Soil Quality

From wherever plants grow and produce food matter, that part is earth or soil. Simply put if a water body is dug out or is in place where the soil is productive, the water body is also productive. Fertile soil contributes to production of natural feed in water bodies and also helps counter water pollution. Generally there are four types of soil: muddy soil, sandy, red and loamy. Loamy soil is extremely beneficial for prawn culture. Sandy soil has low water retention capacity and red soil makes water turbid. Therefore excavating gher in sandy or red soil is not appropriate for prawn culture. Loamy soil is best for water retention and maintenance of various nutrients. Whether the water environment is appropriate for prawn culture depends on characteristics such as soil pH, phosphorus, nitrogen, organic matter etc.

Material	percentage
Mineral matter	45
Organic matter	5
Air	25
water	25
Total	100

1. Mineral matter: This part of soil consists of sand, sediment and mud particles. These are the soil's main material. Water retention of a gher depends on this matter. Soil with mostly mud particles is muddy soil; that with mostly sediment is known as sedimentary soil and that with mostly sand particles is known as sandy soil. Muddy and sedimentary soil have more water retention capacity than sandy soil.

2. Organic matter: Soil has generally about 1-2% organic matter, however in cold regions this can be up to 5%. The amount of organic matter in the gher soil determines its productivity since it is the bottom soil or earth that releases nutrients into the gher water. The amount of organic matter in the soil depends on the adjacent land and artificially applied organic matter. The amount of nutrients released from the bottom soil of the gher depends on type of soil, temperature, depth, dissolved oxygen, pH, alkalinity and bacterial processes. The bottom soil of a gher is referred to as the gher laboratory. Various types of reactions-interactions in this part of gher changes organic into inorganic and also renews productivity. Organic matter helps to increase water retention of gher.

3. Air: is a necessary material but this is not sufficiently abundant in gher soil. Gases released as a result of organic and inorganic reactions are usually the only gases present in gher soil. In this case the gas produced might have adverse effects on prawns and other aquatic animals.

4. Water: is the medium where organic and inorganic reactions take place in gher soil and water and which enable the release and distribution of nutrients.

Chemical composition of soil:

The amount of pH, phosphorus, nitrogen, organic matter etc are important for prawn and fish culture. The appropriate amounts of these are given in the box below:

Substance	Amount
1. pH	6.5-8.0
2. phosphate	10-15milligram/100gm
3. nitrate	8-10milligram/100gm
4. organic matter	1-2% organic carbon

Below these substances are summarily discussed:

pH: Appropriate soil pH for prawn culture is 6.5-8.0 . When pH is suitable, phosphate availability increases. When pH is below 6, soil is acidic and harmful substances are then present in the water. Also if pH is more than 8 then phosphate production falls.

Phosphorus: When soil has sufficient amounts of organic matter then phosphorus is produced abundantly. For every 100 gm of soil, there should be 10-15 milligrams of phosphate easily available.

Nitrogen: Main source of nitrate in soil is that from the nitrogen in the air. For every 100 gm of soil, there should be 8-10 milligrams of nitrogen easily available.

Organic matter: Organic matter keeps the bottom soil of the gher fresh and productive. Helps to increase water retention and the organic matter is main source of phosphorus and nitrogen. Organic matter takes nitrogen directly from the air. Application of organic matter helps remove floating particles from the water. Excessive amounts of organic matter makes the water acidic i.e. lowering the pH. Usually if the soil of a water body has 1-2% organic matter, water productivity increases.

Gher water in Golda culture

Use of unplanned and unmeasured amounts of material in water results in degradation of water quality and farmer thus does not get optimum production. Also used in prawn culture are externally collected prawn seed and mollusks for feed. Every animal has its own role in nature and if they increase or decrease in number, there may be an imbalance in the environment. Golda can be reared in almost any type of water body (small, big, seasonal, perennial, pond, gher, paddy field). The culture is simple and done in a short period. Methods that do not have adverse effects on the environment include extensive and semi-intensive culture methods. However it can be predicted that in future since prawn culture brings in income and is in demand it can be an important export item.

The prawn life cycle is spent in the water and all its activities and stages are spent in this medium. These include feeding, surviving, growth, reproduction, and other important biological functions for which there are appropriate amounts for a favorable aquatic environment. These are:

Factors	Appropriate amounts
pH	6.9-8.5
Organic carbon	1.5-2.0%
Organic matter	2.5-4.3 (9 milligram/100gm)
Nitrogen	8-10 milligram.100gm
Phosphorus	10-15 milligram.100gm

Physical properties of water:

Color: Light green color of water indicates optimum productivity of the gher. If water is yellowish then it means that nitrate amount is low. If phosphorus is low in quantity then the water takes on blackish hue. If water is grayish then carbon dioxide is low. Below is given amount of feed and suitability of water body for culture based on color of water.

Color of water	Amount of natural feed and type	Suitability for fish culture
Clear	No plant plankton	Not suitable
Greenish	Sufficient plankton flora present	Suitable
Dark green	Excess plankton flora present	Detrimental
Brownish green	Sufficient plankton flora and fauna present	Ideal
Grayish green	Few plankton flora and sediment particles present	Not suitable enough
Reddish	Plant plankton present which are not fish feed	Not suitable

Depth:

In tropical and warm climates, there are three layers in the water depending on depth and these are epilimnion (top layer), thermocline (middle layer) and hypolimnion (bottom layer). Most gher in Bangladesh are 2-3 meters deep and so the hypolimnion layer cannot be seen. The layer has the necessary material for food production. If nursery gher are too deep, then PL cannot tolerate the water pressure. PL are comfortable in shallow water. Nursery gher should be 2.5 – 3 ft deep. For production of natural food i.e. plankton production and photosynthesis, sunlight is necessary however too shallow ponds or gher might heat up and may produce detrimental plant plankton. When gher is very deep then bottom layer is cold and has low levels of oxygen and this produces toxic gases. To avoid this situation bottom feeding fish and other fauna come to the top layer. Gher water depth can be from 3-6 ft deep and 4.5 feet depth is ideal for prawn culture.

Transparency and turbidity:

If water is turbid then production of plankton flora falls. On the other hand if the top layer has excessive plankton flora, the transparency of water reduces and this reduces the amount of dissolved oxygen which affects the fish's survival. If water transparency is up to 10 inches (25 cm) then there is adequate amount of natural food produced. Turbid waters have various floating particles which stick to gills and affects the fish's respiration and appetite.

Sunlight:

If there are large plants or trees by the gher, then the branches should be trimmed to allow sunlight into the water. If waters are turbid, this critically hampers entry of sunlight into the waters – affecting plankton production and limiting it to upper part of the top layer. Aquatic floating weeds also hamper sunlight entry into the water. Sunlight is source of all energy. Photosynthesis depends on availability and intensity of sunlight which give rise to primary feed in the gher and oxygen. Sunlight should be present for at least 6-8 hours in Golda gher.

Temperature:

Since water layers differ according to depth so does the temperature. Ideal temperature For better growth of Golda is 28°C-32°C. For every 10°C rise, the rate of Golda growth doubles. For example it has been found that the growth of prawns at 30°C is double that of growth at 20°C. If prawns are stocked at temperatures lower than 25°C then growth is hampered and so in improved methods of prawn culture, temperature becomes a limiting factor and to address this risk, canals are excavated around gher.

Chemical properties of water

Salinity: Concentration of dissolved sodium chloride (NaCl) and other ions in the water is known as salinity and therefore water quality depends on the concentration of various ions. If salinity increases, the osmotic pressure of water also increases. Golda can tolerate salinity at 0-4 ppt.

Dissolved oxygen: Oxygen is essential for life. Oxygen produced as result of photosynthesis in the production of plankton flora is released into water as dissolved oxygen and all plants and animals in the water body use this oxygen for respiration. Lack of sunlight at night does not produce any oxygen, furthermore oxygen is used in the rotting of organic matter in the bottom layer of ghers. So in the mornings oxygen levels are low and high in afternoon. If there is less than 2.5 milligram/liter of oxygen in the water then prawn cannot have a normal life. Prawns grow well when there is 5-8 milligram/liter of dissolved oxygen in the water. At all times the gher waters should have at least 3.5 milligrams/liter of dissolved oxygen. When there is adequate dissolved oxygen the food conversion ratio increases i.e. with minimum food, optimum production of fish and prawns is achieved. With higher levels of dissolved oxygen, feeding of fish and prawns increases and falls when oxygen levels also falls.

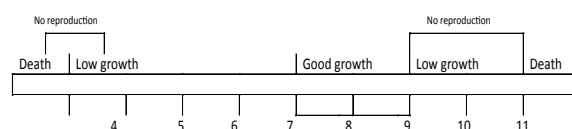
Turbidity: This indicates the amount of sediment, mud and plankton in the water, which hamper the penetration of sunlight in water. Turbidity due to sediment and mud is unwanted in prawn culture, but since plankton is present in the hypolimnion as feed, turbidity due to plankton is necessary. Secchi disc can be used to measure turbidity. For prawn culture 13.5-17.5 inches (35-45 cm) of turbidity is favorable

Alkalinity: Depends on the concentration of calcium carbonate in the water. Alkaline level of 75 milligram/liter in prawn culture is suitable. Alkalinity of water above 120 milligram/water is however preferable. The gher soil is acidic then alkalinity of water is low. Alkaline levels are also low when salinity is low. It is preferred to maintain 80-100 ppm alkalinity and for this lime or dolomite can be used. Since good quality dolomite is not always available, then calcium carbonate should be boiled and applied at rate of 50-100 kg/acre

Alkali and alkalinity: Alkali is the combined combination of concentration of carbonate, bicarbonate and alkalinity is concentration of magnesium and calcium. Slightly alkaline water is good for Golda culture. If the alkalinity and alkalinity is much higher or less than 20 milligram/liter then buffering property of water reduce, primary production falls, effectiveness of fertilizers also falls and the Golda prawns become easily attacked by acidity and other toxic reactions. Alkalinity and alkali levels should be 40 and 200 milligram/liter respectively

pH: indicates the concentration of hydrogen ions which can be measured on a scale 1 to 14. Through pH acidity and alkalinity of water is measured. Neutral pH is 7. More than 7 (7-14) indicates alkalinity and below 7 i.e. (1-7) indicates acidity. pH of water in the gher in the mornings is 7.5-8.5 which suitable for prawn culture. In improved culture method, a lot of algae accumulate in the gher which is why pH varies a lot between morning and evening times and this gives rise to various infections. Ideal pH for prawn culture is 6.9-8.5 which increases gher productivity. Frequently fluctuating levels of pH is not good in fish and prawn culture. If pH of water is low then:

- sodium and chloride is secreted as a result prawn becomes weak and dies
- immunity and appetite of fish and prawns decreases
- productivity of natural food in ghers and ponds decreases
- stops reproduction of fish and prawns



if pH of water increases then fish and prawns are affected in the following ways:

- gills and eyes get damaged
- osmoregulation decreases
- food intake stops, as a result, become diseased and die

Carbon dioxide: is utilized in photosynthesis and so levels of carbon dioxide is low during the day and rises at night. If water has 60 milligrams/liter or more of carbon dioxide, prawns cannot survive. When there is high concentration of carbon dioxide, there is reduction in dissolved oxygen which is why carbon dioxide increases in overcast weather.

Ammonia: is present in water in dissolved state as ammonia ion (NH₄) and un-ionized ammonia (NH₃). It is suitable for prawn culture ponds to have levels of ammonia less than 2 milligram/liter. Though prawns do not die when there are higher levels of ammonia, stress is created.

Nitrate: For prawn culture is suitable for nitrate levels to be less than 2 milligram/liter. Even though it has not been found that high nitrate levels are detrimental for prawn culture, care should be taken since nitrate mixes with blood and hampers oxygen uptake.

Hydrogen sulphide: Any level of hydrogen sulphide in water is detrimental for prawn culture. When pH is low, hydrogen sulphide becomes toxic. Changing water and application of lime can help reduce levels of hydrogen sulphide in water.

Biological properties of water

Floating plants: The roots of these plants are submerged in water while the leaves float on the water. These plants are: water hyacinth, duckweed, Lemna sp, etc. These impede sunlight entering the pond water and reduce utilization of fertilizer and thus productivity of pond falls.

Submerged plants: These live fully under water usually at the bottom and hamper sunlight reaching the bottom and movement of fish. These include Najas sp, jhaji (Utricularia sp) etc.

Plankton: The tiny living flora and fauna in water are known as plankton and these are natural food for fish. Plankton presence in ponds indicates the productivity of the ponds. There are two types of plankton – phytoplankton (flora) and zooplankton (fauna). Abundant phytoplankton is good for fish culture.

Insects: Various types of insects and insect larvae live at the bottom of ponds and are source of food for fish. These include different types of larvae, water beetles etc.

Ways to maintain water quality of a gher: After stocking prawns in a gher, waste from feed, plankton, prawns and other fish are released into the water and the amount of organic and inorganic matter increases and therefore the quality of water is not maintained. In such a situation, water should be changed and its physical and chemical properties improved. During the first 30 days of prawn culture, additional water can be added to maintain water quality. In the following period 10-20% water should be regularly changed every 10-15 days. Where supplementary feed is added, the rate of water being changed should be 30-40%. If tidal waters do not enter the gher then pump can be used to change water. Depth should be maintained when changing water. When changing water, fine mesh net should be used so that unwanted fish or fauna do not enter the gher. The benefits of changing gher water are:

- Production of oxygen in water
- New natural food produced
- Water productivity increases
- Waste matter from water is removed
- Helps in metamorphosis process of the prawns

Prawn culture is comparatively more cost intensive and risky and therefore the management requires extra attention to maintain water quality. This helps to reduce the risk and increase the production. Survival, growth, feeding and metamorphosis etc of prawns depend on the parameters of water quality.

Good Aquaculture Practice and Principles of HACCP

The quality of prawns and food safety is not the single responsibility of farmers, marketers, exporter or international buyers. To ensure quality and food from production safety at farm level to marketing to international buyers, everyone involved in this chain should bear some responsibility. While there should be control in all stages of prawn culture, harvest, processing for marketing, transport, processing for export, processed food for international buyers, there should also be coordination among these various stages. In order to maintain quality and food safety of prawns, there should close communication between the farmers, dealers and processors. The same way food processors need to know how to maintain quality and food safety, farmers should also practice 'ideal fish culture practice' or 'good aquaculture practice' and therefore find out what they need to do to ensure safe harvest and maintain quality for future stages of food processing.

To ensure quality and safety of fisheries and fish processing products in Bangladesh, priority has been given to harvest of the fish/prawns to ensure quality and food safety but actually it is not enough just to carry out harvest safely to ensure quality and food safety of fish and fisheries products. In addition to good harvest management, there is need for correct culture methods as well as monitoring to ensure prawns as a safe food.

Ideal fish culture practice or good aquaculture practice is internationally recognized. In Europe and United States and in other countries, it is put down as aquaculture related laws. Though it is not compulsory in Bangladesh, it can be expected that very quickly this will come into effect as a law.

Ideal practice of fisheries culture and HACCP in fish culture

Even though HACCP is separate subject, nevertheless to understand HACCP, we need to understand Ideal Fisheries Culture Practice which will help explain HACCP. Hazard analysis critical control point is an essential and modern process by which food quality is maintained. HACCP is a scientific, logical, structured, detailed and progressive method. In order to address the faults in the traditional method of quality control of food, HACCP has been established as a recognized international method for maintaining food quality.

In the early 60s, to ensure perfect food standards for the astronauts in their aeronautical ventures into outer space, NASA came up with HACCP method of food quality control. Later this method was adapted internationally as a standard method of ensuring food quality and subsequently came to be applied in fish culture as well

Challenges such as detrimental microbes, antibiotics (residue), and other harmful chemicals are encountered which compromises the quality and food safety of prawn cultured commercially food. To address these problems, neighboring countries have adopted the HACCP method and are now earning high income from their own prawn production and are at an advantageous and advanced stage globally.

HACCP is not just any random method. For establishment of HACCP, the preconditions to qualify for HACCP standards include carrying out activities such as 'Good Manufacturing Practice (GMP)', 'Standard Operating Procedures (SOP)' and 'Sanitation Standard Operating Procedures (SSOP)', etc. In line with these is the 'Ideal Fisheries Culture Practice' which is the pre-condition to establishing HACCP in fish culture. This means for farmers to establish the fact that they practice HACCP, they need to demonstrate they have knowledge of and are following the Ideal Fisheries Culture Practice.

If Ideal Fisheries Culture Practice is not followed then subsequently the drainage, sewerage facilities and other aspects in fish culture will be of low quality, as a result of which risk in unsafe food production also increases. HACCP cannot then be established in the farms. Therefore to establish HACCP, the primary stages of ideal fisheries culture should be practiced to reach an acceptable situation. In order that farmers have an overall understanding about ideal fisheries culture practice, following is discussed:

Ideal Practice in Fisheries Culture (Good Aquaculture Practice)

There are certain activities that farmers are required to follow to ensure good aquaculture practice and establish that the prawns they produce are safe food. All activities from start to end of the culture process contribute to good aquaculture practice (GAP). The associated activities of GAP are discussed below:

1. Location of farm:

When selecting a water body for culture purposes, the farmer has to take into account the surrounding land and environment because the previous use of land defines its physio-chemical properties. If the prawn farm is established near agricultural land then there is high possibility of insecticide and weedicide residue in the soil which are harmful affecting prawn growth and the prawns cultured are in turn harmful for the consumer. In this manner, other aspects to consider in selection of farm location include water supply, waste disposal, drainage and sewerage system, animal and bird movement, air pollution (e.g. chemical pollution) since these affect prawn culture.

The drainage and sewerage system of livestock, poultry farms, industries and factories can adversely affect neighboring prawn farms. If prawn farms are located near agricultural land, livestock and poultry farms, heavily populated areas and slums then location should be closely assessed before finalizing selection. Intensive culture method using insecticides and fertilizers regularly have adverse effects on quality of prawn and compromise it as a safe food. This chemical pollution not only affects prawn production but also the health of the consumer.

2. Water prawn culture:

An essential resource in prawn culture is water supply which determines prawn health, quality and attributes as a safe food. Polluted water can hamper and affect prawn growth and even cause prawn to die. Through polluted water, chemical residues, germs and microbes accumulate in the prawn body which is risky for the consumer's health.

If the source of water supply is polluted, farm water will also be polluted. Therefore in selection of prawn farm, clean water supply has to be ensured. Problems that arise from use of polluted water are heavy metal poisoning, various chemical insecticides and fertilizer residues, chemical waste residue from industries and factories, coliform and Salmonella bacteria. Source of heavy metals include the environment, but most harmful source are the industries and factories (e.g. tanneries, paper factory etc). In agriculture too, some heavy metals are used. Therefore a careful and detailed assessment is required of the area and water supply to ensure that there are no sources of pollution particularly heavy metal pollution.

3. Surrounding environment:

By keeping the environment around prawn farms clean and hygienic, economical risks and losses can be averted. Land erosion or damage directly causes economic losses in prawn culture by bringing about chemical and biological pollution in the water. If any kind of excreta are deposited around or directly in the prawn ghers, then various harmful germs are released in the water such as Salmonella, E. coli, etc and thus affects the prawns. Rodent type animals are source of this kind of pollution. The microbes enter the prawn systems and through harvest, processing and marketing reach the consumers affecting their health.

4. Hygiene practice:

The main healthy and hygienic practice in prawn farms is that human excretion and other harmful activities which release disease-bearing germs are controlled. Excreta and waste of birds and animals are not used as fertilizer. This is because the excreta of warm-blooded animals carry disease-causing germs and microbes which can multiply in the farm environment. If hygiene practice is closely adhered to then deposition of such waste in and around the farm can be avoided.

Also excreta cannot be deposited where it can be washed into the gher by rains. For deposition of excreta, a sanitary latrine should be set up far from the ghers. These should be always kept clean. Since excreta bear harmful germs therefore it is advised not to use organic fertilizers in prawn culture.

5. Care and precaution in application of feed for prawns:

Since prawn is an expensive food item, to ensure optimum growth, supplementary feed is given. However in expectation of very high growth, farmers sometimes give feed indiscriminately without checking feed quality and taking correct steps in feed application. As a result, low quality feed is used, and feeding management is irregular. This is not only harmful for prawn health but that of consumer's health as well. Usually locally available cheap materials such as raw food (mollusks meat, dead fish, dead animal meat, intestines of dead animals, crab meat, etc) are given. These feeds are carriers of various kinds of microbes such as Salmonella, V. cholera, E. coli etc and can easily spread to the prawns through feed. These feeds also pollute the water spoiling the water quality and may even result in high mortality of prawns. However if these raw feeds are boiled well and then used then spread of germs can be prevented.

6. Use of medicine:

Like humans, animals also require medicine for diseases, however if the medicine is misused then there are risks. For example the use of antibiotic helps address some prawn diseases which can be given legally in regulated doses but un-regulated, it is harmful for the culture prawns, farm employees, environment and consumers. After the medicine is utilized, its packet and any leftover medicine should be safely disposed. Medicines that can be safely used has not yet been listed and approved internationally. Each country has its own list of approved medication. Bangladeshi prawns are exported to various countries such as the countries under the European Union, USA, Canada, Japan etc. Therefore in prawn culture requirements of the other countries need to be taken into account.

7. Harvest and pre-assessment of prawns:

All farmers monitor the growth, size and weight of the prawns they culture – this is part of regular monitoring in prawn farms which is necessary for good management. Before harvest, there is therefore the opportunity to check whether quality of prawns has been maintained as well as attributes of safe food. Also before harvesting it has to be assessed whether prawn growth and weight is standard for harvest. This has to be carried out 7-10 days before harvest i.e. pre-harvest assessment of prawns. If the assessment is done after harvest, farmers or processors cannot do anything about correcting any flaws. Steps to address any flaws or problems detected before harvest can be taken and might then result in a successful harvest.

8. Activities to conduct at time of harvest:

Prawn harvest is carried out through a series of steps that ensure the quality and food safety of prawns. These are:

- Reducing/stopping feed
- Keeping all necessary equipment, materials and workers ready before starting the harvest
- Harvest and
- Care and transport

To control germ infestation and maintain quality, the mentioned steps should be completed carefully. To coordinate harvest and sale of prawns, farmers should communicate with potential buyers and fix the sale before the prawns are harvested and then fix a date for harvest of prawns. Even if catching prawns is not so clean, the containers to store, process and transport the prawns should be clean and hygienic. If there is dirt left from previous catch on the container, it should be washed so that any germs or microbes do not spoil the next catch of prawns.

9. Preparation and care of prawns for transport

Before transport, it is essential to ensure that the quality of the prawns are flawless since during the time of travel in the transport vehicles, the quality of prawns may otherwise begin to deteriorate before it reaches the processors. So in preparation for transport farmers should carry out following steps:

- Prawns should be packed in crushed ice made from drinking water. The prawns should be arranged in layers alternately with crushed ice layers in clean, germ-free plastic box.
- Depending on time of transport and surrounding temperature, the ratio of ice to prawn needs to be determined. Usually the ratio is 1:1. Ice amount may be increased according to the temperature and distance
- Prawns should be packed in well-designed plastic boxes so that they are not bruised by pressure of layers of ice and prawns. During transport if the boxes are arranged one on top of the other then consideration should be taken as to whether the prawns in the lower boxes are pressed.
- Insulated truck or vans should be used to transport the prawn boxes and transported as quickly as possible to the depot/storage/service center.
- After transport, the transport van and prawn box should be washed out with soap and detergent and bactericide and dried well

Care and precautions taken during harvest are essential to maintaining quality and food safety of the prawns. Experience shows that quality and food safety of prawns cultured in ghers depend mainly on the prawn farm environment and care taken at harvest time. Since food safety is directly related to culture process, success in prawn culture depends closely on the environment management and control. Regulation of the environment at farm level can ensure that ideal fisheries practice will also be adhered to and thus also establishing HACCP policy should then be easy.

Steps in use of materials	Associated hazards	Preventive measures
Location of prawn farm	Chemical hazards: pollution by insecticide, weedicides and heavy metals (mercury, lead, cadmium, etc)	<ul style="list-style-type: none"> • Healthy and hygienic management of prawn culture • Conduct Water and soil test
	Biological hazards: harmful bacteria, parasite, virus	<ul style="list-style-type: none"> • Healthy and hygienic management of prawn culture • Conduct Water and soil test
Source of water	Chemical hazards: pollution by insecticide, weedicides and heavy metals	<ul style="list-style-type: none"> • Healthy and hygienic management of prawn culture • Conduct Water and soil test
	Biological hazards: harmful bacteria, parasite, virus	<ul style="list-style-type: none"> • Healthy and hygienic management of prawn culture • Conduct Water and soil test
Collection of fish/prawn seed	Does not have any important hazard	
Feed application	Chemical hazards: antibiotic, growth hormone and insecticide	<ul style="list-style-type: none"> • Use of appropriate quality of feed • Hygienic preservation of feed • Carry out feed test
	Biological hazards: harmful bacteria and molds	<ul style="list-style-type: none"> • Use of appropriate quality of feed • Carry out feed test
Use of germicides	Residue of the medicine	<ul style="list-style-type: none"> • Use of medicine in prescribed dose • Harvest of fish after certain period elapses from time of medicine application • Testing fish/prawns
Use of insecticide and weedicides	Residue of insecticide and weedicides	<ul style="list-style-type: none"> • Application of insecticide and weedicides only in prescribed doses • Harvest of fish after certain period • Testing fish/prawns
Harvest of fish/prawn	This does not have any important hazard	
Temporary storage	Hazard due to hard/physical matter: glass and iron pieces, insect parts, body hair of cats, dogs, cows, goats, rats and mongoose, bamboo pieces, fibers from hogla ¹ , jute sacks, dust, sand etc	<ul style="list-style-type: none"> • Fish/prawn to storage in clean room and containers
	Chemical hazards: insecticide, weedicides, detergent, petrol and lubricant	<ul style="list-style-type: none"> • Do not keep insecticide, weedicides, detergent, petrol and other chemicals in storage space
	Biological hazards: harmful bacteria, temperature, and proliferation of germs because of being kept in an unregulated environment	<ul style="list-style-type: none"> • Keeping storage space and all containers clean and hygienic • Keeping abundant supply of clean ice
Transport	Hazard due to hard/physical matter: glass and iron pieces, insect parts, body hair of cats, dogs, cows, goats, rats and mongoose, bamboo pieces, fibers from hogla, jute sacks, dust, sand etc	<ul style="list-style-type: none"> • Transport prawns in clean and hygienic plastic baskets/boxes
	harmful bacteria, temperature, and proliferation of germs because of being kept in an unregulated environment: kerosene, petrol, lubricant	<ul style="list-style-type: none"> • Do not keep hazardous chemicals near prawns during transport
	Biological hazards: harmful bacteria, temperature, and proliferation of germs because of being kept in an unregulated environment	<ul style="list-style-type: none"> • Keeping storage space and all containers clean and hygienic • Keeping abundant supply of clean ice

¹ Hogla is an local leaf used in making mats etc

গলদা কার্প মিশ্র চাষ ব্যবস্থাপনার ধারাবাহিক কাজগুলো -

ঘের বা পুকুরে গলদা চাষ ব্যবস্থাপনায় কতকগুলো কাজ করতে হয়। এই কাজগুলো উপরে আলোচিত চিংড়ি চাষের উত্তম অনুশীলন অনুসরণ করলে গলদা চাষে অধিক লাভবান হওয়া যায়। গলদা চাষ ব্যবস্থাপনার কাজগুলো নিম্নে উল্লেখ করা হলো-

- ঘেরে নার্সারি ব্যবস্থাপনা
- ঘের প্রস্তুতি
- পোনা মজুদ পূর্ব সার ব্যবস্থাপনা
- মজুদ ব্যবস্থাপনা
- পোনা মজুদ পরবর্তী খাদ্য ও সার ব্যবস্থাপনা
- পানির গুণাগুণ ব্যবস্থাপনা
- চিংড়ি ও মাছের রোগ ব্যবস্থাপনা
- চিংড়ি আহরণ ও আহরণ পরবর্তী ব্যবস্থাপনা
- বাজারজাতকরণ

ঘেরের আশপাশের জায়গা বিশেষ করে পাড় ব্যবহার করে যাতে চাষী আর্থিকভাবে অধিক লাভবান হতে পারেন এবং পাশাপাশি ঘেরের পরিবেশ সুসংহত করতে পারেন সে বিষয়টি বিবেচনায় রেখে পাড়ে সবজি চাষ বিষয়টিও বিশেষ গুরুত্বের সাথে উল্লেখ করা হয়েছে।

গলদা চাষের জন্যে প্রয়োজনীয় পুঁজি

সফল মাছ চাষের মূল মন্ত্রই হলো সঠিক সময়ে সঠিক কাজটি সম্পন্ন করা। এর জন্যে প্রয়োজন পুঁজি যা অনেক ক্ষেত্রেই আমাদের চাষীরা নিশ্চিত করতে পারেন না। অনেক চাষীদেরই প্রয়োজনীয় পুঁজি সম্পর্কে সঠিক ধারণা না থাকায় প্রয়োজনীয় পুঁজির সংগ্রহে তৎপর থাকেন না। এ লক্ষ্যেই চাষীদের গলদা চাষে কাজভিত্তিক শতাংশ প্রতি পুঁজির পরিমাণ সম্পর্কে ধারণা দেয়ার লক্ষ্যে নিম্নের ছকে পুঁজির পরিমাণ উল্লেখ করা হলো:

চাষের ধরন	শতাংশ প্রতি পর্যায়ক্রমিক পুঁজির পরিমাণ (টাকা/শতাংশ)					মোট টাকা
	লীজ	মজুদপূর্ব	মজুদকালীন	মজুদ পরবর্তী	আহরণ ও বাজারজাতকরণ	
গলদা নার্সারি	৭০	২০	১২০	১৫	-	২২৫
গলদা কার্প মিশ্র চাষ	-	২০	৫০	২১০	১৫	২৮৫
মোট (সাধারণতঃ ঘেরের ক্যানালো নার্সারি করে, ঘেরে পর্যাপ্ত পানি হলে জুভেনাইলগুলো সারা ঘেরে ছড়িয়ে পরে। তাই শুধু গলদা কার্প মিশ্র চাষের সম্ভাব্য পুঁজির পরিমাণ দেয়া হলো।)						৫২০

বি: দ্র: বাজার দরের তারতম্যের কারণে প্রয়োজনীয় পুঁজির পরিমাণ কমবেশী হতে পারে। উল্লেখিত পুঁজির পরিমাণ শুধুমাত্র চাষীর প্রাথমিক ধারণার জন্য উল্লেখ করা হলো।

GROUP SESSION PLANNING

Day 01

Time – 12.00

Duration: 60 minutes

- Target group : Golda-carp polyculture farmers
 Title of session : Golda nursery management in gher
 Aim : To educate the Golda farmers on importance of stages in Golda nursery management so that they can carry out nursery management in a hygienic manner and be successful in producing high number of Golda juveniles.
 Objective : At the end of this session, the participants -
- Will be able to state the importance of Golda nursery in Golda culture
 - Will be able to state the types of canals, location, size etc in prawn culture
 - Will be able to describe the various stages in preparing and setting up a nursery
 - Will be skilled to carry out Golda PL transport and stocking
 - Will be able to apply fertilizer after stocking PL
 - Will be able to determine the amount of supplementary feed and apply the feed

Discussion topic	Training approach	Duration
Introduction		5 minutes
<ol style="list-style-type: none"> 1. Welcome/reception: welcoming the participants and asking about participants welfare 2. Discussion about previous session 3. Linking previous session's topic to current session 4. Explanation of aim and objectives of current session 	Q&A and discussion	
Topic		45 minutes
<p>At the end of this session, the participants -</p> <ul style="list-style-type: none"> • Importance of Golda nursery in Golda culture • Types of canals and their characteristics • various stages in preparing and setting up a nursery: repair of banks and bottom; controlling aquatic weeds; removing unwanted and predatory fish; application of lime; water irrigation and changing/exchange/replacement; testing water for its suitability; testing for natural feed and setting up shelters • Stocking management in Golda nursery: Identifying good and bad PL, transport and stocking • Post-stocking management: Application of supplementary feed and fertilizer 	Lectures, Q&A Discussion Flipcharts	
Summary		10 minutes
<ol style="list-style-type: none"> 1. Summary discussion of main topic 2. Assessment of session objectives 3. Distribution of handouts 	Q&A	

Discussion and link up to the next session

Supporting Training Material flipchart, white board and marker and handout

Flip chart design

For discussion follow the handout

<p>Golda nursery management in gher Importance of nursery:</p> <ul style="list-style-type: none"> To enable easy acclimatization of Golda to gher environment Easy application of feed for PL PL's survival rate increases PL grow properly and become strong After release to gher, maximum production is obtained 	<p>Stocking density of PL in nursery 800-1000 per acre is ideal Time to release PL Acclimatization and release of PL Post-stocking management of PL in nursery Feeding management Importance of supplementary feed</p> <ul style="list-style-type: none"> To increase growth rate Regulation of PL's cannibalism Culture of fish at maximum stocking density Reduction in mortality of PL PL immunity improves Maximum production can be obtained from a small area 																																															
<p>Characteristics of canals in gher: Width: 5-10 feet (according to land area) Depth : usually: 5-6 feet Slope of Gher bank: 1:1.5</p> <p>Nursery size Nursery type Stocking density of PL Density of PL during transport</p> <p>Transport density/concentration depending of prawn seed size and distance</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th>Size of prawn seed /type</th> <th>Transport concentration per liter</th> <th>Transport time (hours)</th> <th>Type of transport</th> </tr> </thead> <tbody> <tr> <td>Post Larvae : 30-35</td> <td>500-350</td> <td>6</td> <td>Polybag with oxygen</td> </tr> </tbody> </table>	Size of prawn seed /type	Transport concentration per liter	Transport time (hours)	Type of transport	Post Larvae : 30-35	500-350	6	Polybag with oxygen	<p>Criteria in feed selection</p> <ul style="list-style-type: none"> Easily available materials Financial ability of farmers Price of materials Nutritional requirement of PL Favored food and high feed conversation rate <p>Determination of food amount</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th rowspan="2">Name of substance</th> <th colspan="3">Nutrient amount (%)</th> </tr> <tr> <th>Protein</th> <th>Carbohydrate</th> <th>Fat</th> </tr> </thead> <tbody> <tr> <td>Rice bran</td> <td>44.42</td> <td></td> <td>10.45</td> </tr> <tr> <td>Wheat bran</td> <td>14.57</td> <td>66.36</td> <td>4.43</td> </tr> <tr> <td>Mustard oilcake</td> <td>30.33</td> <td>34.38</td> <td>13.44</td> </tr> <tr> <td>Sesame oilcake</td> <td>27.20</td> <td>34.97</td> <td>13.18</td> </tr> <tr> <td>Fishmeal A grade</td> <td>56.61</td> <td>3.74</td> <td>11.12</td> </tr> <tr> <td>Blood meal</td> <td>63.15</td> <td>15.59</td> <td>0.56</td> </tr> <tr> <td>Wheat</td> <td>17.78</td> <td>75.60</td> <td>3.90</td> </tr> <tr> <td>molasses</td> <td>4.45</td> <td>83.62</td> <td></td> </tr> </tbody> </table>	Name of substance	Nutrient amount (%)			Protein	Carbohydrate	Fat	Rice bran	44.42		10.45	Wheat bran	14.57	66.36	4.43	Mustard oilcake	30.33	34.38	13.44	Sesame oilcake	27.20	34.97	13.18	Fishmeal A grade	56.61	3.74	11.12	Blood meal	63.15	15.59	0.56	Wheat	17.78	75.60	3.90	molasses	4.45	83.62	
Size of prawn seed /type	Transport concentration per liter	Transport time (hours)	Type of transport																																													
Post Larvae : 30-35	500-350	6	Polybag with oxygen																																													
Name of substance	Nutrient amount (%)																																															
	Protein	Carbohydrate	Fat																																													
Rice bran	44.42		10.45																																													
Wheat bran	14.57	66.36	4.43																																													
Mustard oilcake	30.33	34.38	13.44																																													
Sesame oilcake	27.20	34.97	13.18																																													
Fishmeal A grade	56.61	3.74	11.12																																													
Blood meal	63.15	15.59	0.56																																													
Wheat	17.78	75.60	3.90																																													
molasses	4.45	83.62																																														
<p>Pre-stocking management of nursery</p> <ul style="list-style-type: none"> Repair of banks and removal of black mud Clearing of aquatic weeds Removal of unwanted and predatory fish Application of lime Application of fertilizer Testing water for suitability Setting up shelter 	<p>Recommended feeding rate 1st week 20 gm/1000 PL 2nd week 40 gm/1000 PL 3rd week 60 gm/1000 PL 4th week 80 gm/1000 PL 5th week 100 gm/1000 PL 6th week 120 gm/1000 PL</p>																																															
<p>Importance of good PL:</p> <ul style="list-style-type: none"> Mortality after stocking Low growthrate Not getting good market price since not marketable on time 	<p>Post-stocking fertilizer application Rate of fertilizer application</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th>Name of fertilizer</th> <th>Rate of application (per acre)</th> </tr> </thead> <tbody> <tr> <td>Compost</td> <td>250-300 gm</td> </tr> <tr> <td>Urea</td> <td>3-4 gm</td> </tr> <tr> <td>TSP</td> <td>1.5-2 gm</td> </tr> </tbody> </table>	Name of fertilizer	Rate of application (per acre)	Compost	250-300 gm	Urea	3-4 gm	TSP	1.5-2 gm																																							
Name of fertilizer	Rate of application (per acre)																																															
Compost	250-300 gm																																															
Urea	3-4 gm																																															
TSP	1.5-2 gm																																															

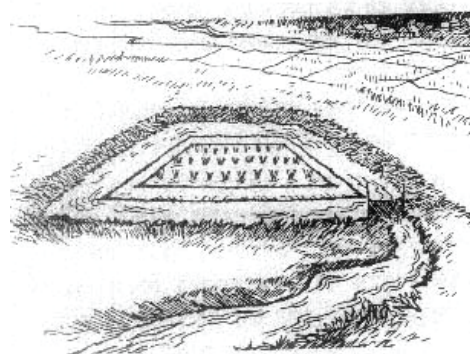
Golda Nursery Management in Ghers

If post larvae (collected either directly from natural sources or hatcheries) are released directly into gher, then mortality is high. The new environment's differences, PL's stress, risks in transport, poor acclimatization etc are reasons for PL death. Therefore, collected PL should be nursed in PL nursery for 30 days or until water levels rise in the ghers. This helps to reduce mortality of PL and increase production. Keeping this in mind, before making arrangements for gher production and management, it is essential to set up nursery. Significance of nursery include:

- Enabling acclimatization with new gher environment
- PL can be properly fed
- PL's survival rate increases
- Juveniles grow well and strong
- Juveniles survival rate in a stocked gher is good and maximum production can be obtained

Characteristics of canals:

Before stocking ghers with juveniles, the prawn seed or PL collected from hatcheries/natural sources are nursed in canals for 1-3 months and this is known as nursery method. In South-West Bangladesh, farmers usually stock these canals with prawn seed at the start of prawn culture season (Baishakh-Ashar i.e. April-June) and nurse them for 1-3 months until of juvenile size before releasing them into the main gher area which is flooded in the rainy season where they are reared for 4-5 months. After 4-5 months they are of marketable size.



চিত্র- চিংড়ি চাষের ঘের

Pre-Stocking Management of Nursery Canals

The activities that are carried out to make gher environment suitable for prawn growth and production is collectively referred to as the preparation. Activities starting from repair of banks and bottom to stocking of PL is known as pre-stocking management. In the three stages of prawn culture, this is a very crucial stage. The foundation for prawn culture is laid in the pre-stocking management activities.

Repair of gher banks and bottom and control of aquatic weeds

Control of aquatic weeds: There are various types of aquatic plants in water which directly or indirectly hamper fish/prawn production and these are known as aquatic weeds. Ponds and gher usually have the following aquatic weeds:

a) Floating:

These float and are of two types:

- Free-floating : roots take nutrients from the water egg hatchure pana water hyacinth, khuti pana - duckweed (*Wolffia* sp), topa pana (*Lemna* sp)
- Root fixed in soil from where they take their nutrients: shushni shak (*Marsilea* sp), arail, shapla-water lily (*Nymphaea* sp)



চিত্র- বিভিন্ন ধরনের জলজ আগাছা

b) Creepers:

These plants have roots in the slope of pond/gher just under water level and branches and leaves spread out on the water – e.g. malancha, helencha (*Enhydra* sp), water spinach *Ipomea aquatica* (nutritious leafy vegetation)

c) Submerged:

These are plants in the bottom of water body. Roots are fixed in soil and branches and stems never cross water level e.g. Jhaji (*Utricularia* sp)

d) Emergent:

These plants are partly under water and partly outside water e.g. Bishkatali, arail, *Najas* sp

e) Algae:

kapure algae, bhotka algae (*Spirogyra* sp) – different types of submerged and floating algae

Harmful effects of aquatic weeds:

Aquatic weed directly or indirectly adversely affect fish/prawn culture. The harm caused by excess aquatic vegetation include following:

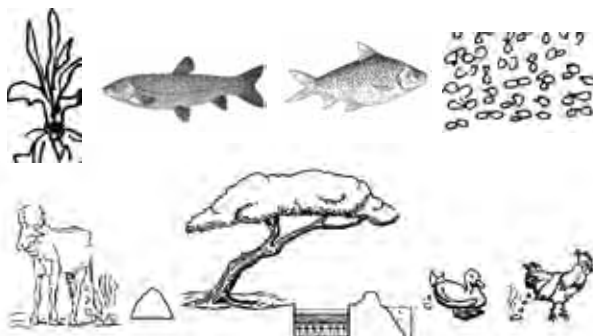
1. Aquatic vegetation takes up the nutrients in the pond soil and water and thus reduces primary productivity of the water body
2. Prevents sunlight from penetrating water impeding photosynthesis process which prevents the production of natural feed
3. Fish movement is hampered
4. Excess vegetation makes it easy for predatory animals to hide
5. It is difficult to harrow the water body as required
6. It is difficult to net at time of harvest
7. Excessive weed causes oxygen depletion resulting in mortality of prawns



চিত্র- আগাছাপূর্ণ পুকুর

Benefits of aquatic weeds

While aquatic weeds are generally considered harmful, some benefits from these plants can be derived. Khuti pana/khudipana - duckweed (*Wolffia* sp) and soft grass are feed for grass carps and shorputi. Prawns feed on *Spirogyra* algae. Water hyacinth and other weeds can be used in compost preparation. If gher is not deep the water heats up and then fish and prawns can take shelter under helencha and *Wolffia* sp. However aquatic weeds should not cover more than 10% of water body.



চিত্র- কম্পোস্ট তৈরী

Method of controlling aquatic weeds

1. Physical labor: All vegetation around gher canal needs to be removed physically either by cutting them down. Pulling out the plants with roots if possible is advised. Floating vegetation can be drawn by tying them with rope and dumping them outside the pond.
2. Natural/biological control: Fish such as grass carp eat vegetation. Also mirror carp and *Carpio* pull submerged plants by roots when feeding and these can then be removed by hand.
3. Fertilizer application method: if the pond/gher has plenty of submerged plants then inorganic fertilizer can be applied in excess. Where there are excessive amounts of *Najas* sp, 500 gm urea per decimal should be applied and then 2-3 days later a green layer forms on the pond surface, preventing the entry of sunlight, and resulting in the death of *Najas* sp in just a few days
4. Chemical method: The chemicals used in aquatic weed control are:
 - a. 2-4 D, 138-180gm/decimal to kill floating and creeper type plants
 - b. Cimazin 3milligram/liter – to kill small herb-type plants
 - c. Endothal 1-3 milligram/ liter – to kill submerged plants



চিত্র- জলজ আগাছা পরিস্কার ও পাড় মেরামত

The best way to control aquatic weeds is by physical labor and biological methods. The chemical method is least desirable

Repair of banks and removal of black mud

Sometimes in gher preparation it is necessary to repair gher banks and remove the rotting black at the bottom. If gher banks break down and black mud is not removed then there are various problems:

If pond banks are not repaired:

- Unwanted and predatory fish might enter the gher
- In excessive rains or floods, fish and prawns might get washed out
- Polluted water might enter

If black mud is not removed:

- Gher waters become polluted
- Fish and prawns suffer from oxygen depletion
- Toxic gases accumulate at the bottom
- Color of prawns become black and do not get a good price at the market
- Prawns are easily attacked by different diseases
- It becomes difficult to harvest the prawns.

Controlling predatory and unwanted fish

Usually after harvest of boro paddy, there is no water left and removal of predatory and unwanted fish is not required. If however there is water and farmer thinks that there are predatory and unwanted fish in the water, then there is need to take steps to remove these fish. For profitable prawn production it is necessary to remove predatory/unwanted fish. These fish hamper growth and movement of culture fish and prawn, hampering optimum production, thus the necessity to remove these fish.

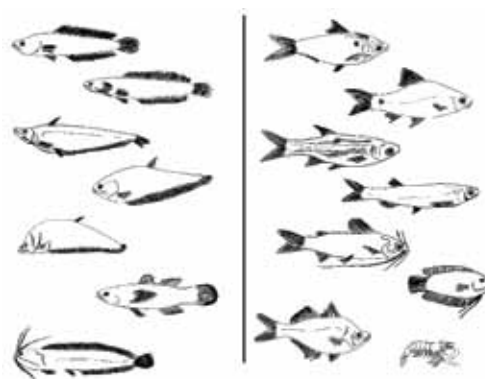
Predatory fish: Fish that eat other fish and animals are predatory. These eat up culture fish and prawns and hamper production. These are : shoal (*Channa striata*), Chitala chitala, Kakila(*Xenentodon cancila*), baila (*Glossogobius giuris*), *Channa striatus*, *Clarius batrachus* etc.

Unwanted fish: Fish that do not eat other fish but compete with culture fish for food, space and oxygen are unwanted fish. The presence of these fish cause wastage of feed and reduce production. These include mola(*Amblypharyngodon mola*), dhela(*Osteobrama cotio*), chapila (*Gudusia chapra*), *Puntius puntius*, *Chanda* (*Chanda nama*), small prawns etc

Harmful effects of predatory and unwanted fish:

Unwanted and predatory fish have to be removed before fish/prawn culture because:

- Predatory fish eat fish and prawn seed. For growth of 1 kg, predatory fish consumes 10-12 kg of other fish.
- Unwanted fish spoil prawn feed e.g. 1 kg unwanted fish consume up to 10-12 kg of fish feed
- Both types of fish spread diseases
- Create competition for food and space with culture fish



চিত্র- বিভিন্ন ধরনের রাস্ফুসে ও অবাঞ্ছিতমাছ

Removal process of predatory and competitive fish

The three methods that can be used to remove predatory and competitive fish:

1. Drying the canal
2. Application of chemicals
3. Repeated netting

1. Drying the canal: This is the most preferable method of removing unwanted fish. By de-watering the canal using a shallow pump, fish can be killed easily. After de-watering, the canal should be dried in the sun such that the bottom hardens and footprints are not left when walking. This is possible during February –March and requires little time and money.

2. Use of rotenone: When fish cannot be removed by de-watering or netting, then application of rotenone is a preferred method to remove predatory and unwanted fish. If canal is not wide then it is preferable not to use rotenone

Application of rotenone: Rate of application of rotenone depends on its strength and temperature. Below is given recommended application rate of rotenone based on its strength.



Strength	Rate of Application gm/ft depth
9.1%	18-24 gm
7%	24-30 M

Application method of rotenone:

Required amount of rotenone should be taken in a bucket and slowly mixed with water and made into dough. The dough should be equally divided into three parts of which one part should be made into small balls and remaining two parts dissolved in water to make a solution. The rotenone balls should be scattered over the canal equally and the solution also similarly distributed over the canal. 20-25 minutes later, fish should be netted and removed. Afterwards the water should be moved around to create currents and make rotenone more effective. This should be done on a sunny day.



Precautions in use of chemicals:

- Chemical containers should be opened only before its use
- Should be out of reach of children
- When mixing rotenone and applying in pond water, hands should be covered in polythene and mouth and nose should be covered using a towel or cloth
- It should be scattered or sprinkled with the wind current

For proper determination of rate of application, depth of water should be ascertained correctly. For this an average depth should be calculated from the deep and shallow parts of the canal. Canal depth should be measured in at least 5 places.

Repeated netting of fish: If the canal cannot be dewatered or poisoned using rotenone then it is preferable to repeatedly net to catch and remove all fish. This can be carried out in small and shallow ghers.



Best way to remove unwanted and predatory fish is by dewatering the canal

Application of lime:

Lime is an inorganic calcium compound which makes acidic medium either alkaline or neutral and enables in structural growth of animals.

Reason for lime application: are usually two which are:

Primarily:

- To maintain soil and water pH at a suitable level for fish culture
- To maintain alkaline content of water above 20 milligram/liter



Secondly:

- In gher preparation, burnt lime is used to remove parasites and germs
- Hasten the rotting process of organic matter at bottom of gher and help release and make available nutritious material.

Effect of acidic water:

- If pH of water is below 5 then fish loses sodium and chloride through osmosis, causing the fish to become weak and die. This happens when calcium levels are low.
- Fish body releases large amounts of mucus which cover the gills
- Prawn's immunity system weakens, loses appetite and gets easily bruised
- PL are more swiftly attacked than larger prawns

Effect of alkaline water: If pH is above 11, fish dies quickly. If pH increases:

- Gills get damaged
- Eye lens and cornea are damaged
- Natural productivity of gher falls
- Osmoregulation ability of fish becomes less and fish become weak and die
- Immunity system weakens and loses appetite
- Reproductive ability becomes weak/deteriorates

Benefits of lime application

Application of lime is necessary to maintain balance of hydrogen and hydroxyl ion and maintain pH at a neutral level and enable plankton production. Calcium and silica are necessary for structural development in animals and in photosynthesis, helps in the production of carbon dioxide. Also:

- Releases phosphorus which is necessary in plankton production
- Hastens rotting process of organic matter and release of nutritious substances, and increases natural productivity
- Kills parasites and germs
- Increases effectiveness of fertilizers
- Hardens prawn exoskeleton
- Removes parasites and germs during gher preparation

Types of Lime

Name of Lime	Chemical composition
Pathure Lime / Calcium carbonate	CaCO_3
Koli Lime / slaked lime	Ca(OH)_2
Pora lime/ quicklime / burnt lime	CaO
Dolomite	$\text{CaMg(CO}_3)_2$
Gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

How to determine amount of lime to be applied

Before lime is applied, it is necessary to know the pH and level of alkalinity of water. Gher productivity depends largely on water acidity/alkalinity level.

Determination of water acidity and alkalinity

- a. Hacc kit
- b. Chemical process (titration)
- c. pH paper
- d. Using soap: If alkalinity is more than 40 milligram/liter then water is said to be alkaline. Soap does not form soap suds in alkaline water. Water with less than 40 milligram/liter of alkali, the water is considered sweet which gives rise to a lot of soap suds.
- e. Using betel leaf spit: If betel leaf spit is applied to water and the color of the spit does not change then water pH is more than five and if it changes to a blackish color then the pH is less than five. This is a suitable method to use in old or unused ponds.
- f. Water color: acidic water is sometimes blackish or copper colored

Methods a and b are not applicable in all cases. It is usually not possible to use these methods. However when a new farm is being established, the soil and water of the location should be assessed correctly for pH. When a and b are not possible then following method should be used to determine the amount of lime to be applied.

1. Gher history: e.g. age of gher, natural productivity and prawn culture-based information
2. Status of surrounding environment: To see whether neighboring farmers have had problems concerning acidic water such as whether after fertilizer application, natural food production is not enhanced. Need to check from farmers whether area has bad soil, red soil or acidic soil.
3. Soap test and betel leaf spit test

In 1993, the Directorate of Fisheries and Grameen Bank in BAFRU directed a survey, which found that apart from northwest of Bangladesh, the rest of the country water bodies have alkalinity more than 20 milligram/liter. Furthermore it was mostly 70 milligram/liter and average pH is 7-7.5. Though this survey was not carried in farmers' ponds, the data from the mentioned survey can give a general picture and taking this into consideration recommended steps for lime application may be followed as given below:

1. Even if the area does not have acidity problems, minimum amount of lime should be applied and lime application should be continued until algae is formed in the water.
2. If the soil has quality issues, then best advice should be sought to assess soil pH and if this is not possible, then recommended maximum amounts stated should be applied. Cost should be taken into consideration.
3. Blackish soil or acid sulfate soil should be treated with 2-3 times the normal recommended amount. In such a case calcium carbonate and dolomite are recommended.

Taking understanding and knowledge from previous experience

An experienced farmer can easily state what is required for the land when he visits it. This is a result of experience. In the same way, to know about the rate of application of lime in a specific area, first the history of gher needs to be considered and after applying lime, should be monitored to check for natural production. Based on assessment, lime application should thus be determined. In some areas soil can be tested to determine lime application rate. Within 5 km of a location, lime application rates are usually the same.

Rate of lime application

Lime application rate should be assessed based on soil pH and type of lime to be applied. When considering only pH then quicklime is applied twice the amount of calcium carbonate and 1.5 times the strength of slaked lime. Below is given amount of lime required per decimal

pH	Quicklime	Slaked lime	Calcium carbonate	Dolomite
5-6 (muddy soil)	4 kg	6 kg	8 kg	8-9 kg
6-7 (loamy soil)	1-2 kg	3 kg	4 kg	3-4 kg

Based on soil type, recommended dosage of application is

Soil type	New pond/gher	Old pond/gher
Loamy	1 kg	2 kg
Muddy	4 kg	6 kg

In both dry and wet soil, powdered lime should be scattered all over the gher area including the banks. In water-filled pond, required amount of lime should be mixed in water either in bucket or earthen pot and evenly sprinkled over the gher.

Application time of Lime: 1-2 days after dry gher has been ploughed or 1-2 days after soil has been irrigated or 6-7 days after fertilizer application in a water-filled gher.

Precautions of applying lime:

- When dissolving and sprinkling lime, cover nose and mouth with cloth or towel
- Do not dissolve lime in plastic bucket
- Before pouring water into bucket which has lime, the bucket should be covered with sack or cloth
- First take water in the bowl or bucket and then apply lime
- Sprinkle the lime along with the wind current
- If lime gets into the eyes, wash it repeatedly with clean water



চিত্র: পানি ভর্তি ঘেরে চুন প্রয়োগ



চিত্র: শুকনা ঘেরে চুন প্রয়োগ

Water supply and treatment

After lime application in nursery, water should be supplied. The water should be supplied through a sieve or strainer.

3-4 days after water is aerated, it needs to be treated. Materials and process for water treatment is given below:

Materials	Amount/decimal	process
Bleaching powder	2.5-3 kg for 3 ft of water	Required amount of bleaching powder should be dissolved in twice the amount of water which should be sprinkled over then pond in evening /late evening
Dipterex/sumithion	60 gm Dipterex/ 9 ml sumithion for 3 ft water	Required amount of Dipterex/sumithion should be dissolved in twice the amount of water which should be sprinkled over then pond in evening /late evening
Rotenone	For 3 feet water - 60-70 gm of 9.1% rotenone - 70-80 gm of 7% rotenone	Required amount of rotenone should be taken in a bucket and slowly mixed with water and made into dough. The dough should be equally divided into three parts of which one part should be made into small balls and remaining two parts dissolved in water to make a solution. The rotenone balls should be scattered over the canal equally and the solution also similarly distributed over the canal. 20-25 minutes later, fish should be netted and removed. Afterwards the water should be moved around to create currents and make rotenone more effective. This should be done on a sunny day.

Application of fertilizer during gher preparation

The existing flora and fauna in the aquatic environment are directly or indirectly dependant on each other for food and there is a constantly moving cycle of food which is known as the food chain. Since one stage of the chain is the rotting of dead animals or organic matter to release inorganic nutrient, it is also referred to as saprophytic food cycle.

The main products in the existing food cycle of ponds/ghers are phytoplankton, bacteria, aquatic plants, zooplankton, small insects and larvae at bottom and fish etc. these are all produce and consume and therefore are known as producers and consumers. There are 3 layers in the food cycle according to producers and consumers. These are:

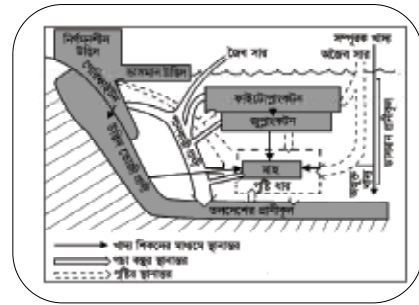
1st layer: primary producers (phytoplankton, bacteria)

2nd layer: primary consumers (zooplankton, herbivorous fish)

3rd layer: secondary consumers (zooplankton-eating fish, prawns and carnivorous animals)

The food cycle starts with primary producers, phytoplankton which take up organic and inorganic nutrients and reproduce. Next in the food cycle are zooplankton as primary consumers which feed on the primary producers i.e. phytoplankton and bacteria. In the same way, the 3rd layer in the food cycle are secondary consumers – fish which feed on phytoplankton and zooplankton and who are in turn consumed by carnivorous fish.

On the other hand the waste released by the pond fauna and dead flora/fauna accumulate at the pond bottom. Specific types of bacteria and fungus aid the rotting process of these matter and release inorganic nutrients which regenerates phytoplankton production. These interactions in the food cycle help to maintain balance in the pond/gher environment. However when planned fish/prawn culture is carried out in a water body then there are large numbers of 3rd layer consumers that feed on the primary producers and consumers and there is a depletion of the lower layer of plants and animals. In order to maintain the balance of the food cycle especially at the lower layers there is need to supply nutrients in the canal after it is stocked fish/prawn.



চিত্র- পুকুরের প্রতিবেশে বিভিন্ন জৈব রাসায়নিক উপাদানের সম্পর্ক

Objective of fertilizer application: There are different types of plankton in the water which are source of food for the prawn. Both phytoplankton and zooplankton are important as primary source of food for fish and prawns. Almost all fish and prawns that are cultured are dependent on plankton. At the same time zooplankton feed on phytoplankton and bacteria and multiply. Conclusively it is necessary to increase production of natural food for prawns for which fertilizer application is required.

Types of fertilizer: Both organic and inorganic fertilizers are applied to gher because: Organic fertilizers – is directly taken up by zooplankton and bacteria as food. Also releases inorganic nutrients in the water and helps in production of phytoplankton. Cow manure, poultry excreta and compost are used as organic fertilizers.



চিত্র: বিভিন্ন ধরনের অজৈব সার



চিত্র- বিভিন্ন ধরনের জৈব সার

Inorganic fertilizers – aid in the primary production of phytoplankton which in turn increases production of zooplankton. Urea and TSP are used as inorganic fertilizers. [different types of inorganic and organic fertilizers]

The table below gives the nitrogen and phosphorus amounts in the different types of fertilizers which are directly or indirectly utilized for production of phytoplankton and zooplankton

Nutrient	Manure (%)	Chicken excreta (%)	Duck excreta (%)	Urea (%)	TSP (%)
Nitrogen	0.60	1.6	1.0	43-46	
Phosphorus	0.16	1.5-2.0	1.4	-	40-45

Advantages and disadvantages of using organic and inorganic fertilizer

Advantages of organic fertilizer

- Directly used as food by plankton and bacteria
- Helps water retention in sandy and loamy soil water bodies
- Increases productivity of soil
- Locally and cheaply available
- Side effects are few
- Has almost all nutrients for plankton production
- Is a shelter for bacteria

Disadvantages of organic fertilizer

- Carrier of parasites and germs
- Results are slow since it is a compound material
- Releases toxic gases at bottom
- Needed in large quantities and application process is difficult
- In some cases, there are cultural taboos in the use of organic fertilizer

Even though there are advantages in using organic fertilizers, currently with consideration for food safety, use of manure and poultry excreta is discouraged. Instead compost is internationally recommended.

Advantages of inorganic fertilizer

- Quick acting
- Easily available in market
- Produces nutrients at a specific measured rate
- Application method is easy

Disadvantages of organic fertilizer

- Effectiveness is short term
- Soil hardens
- Effectiveness of soil microbes becomes less
- If used long-term then pond productivity becomes less
- Unmeasured amounts give rise to diseases

Rate of fertilizer application

The main objective of fertilizer application is to boost the primary production of phytoplankton in adequate amounts. The rate of fertilizer application depends on a number of factors such as :

1. Soil status
2. Requirement of nutrients for middle layer of algae
3. Environment condition (temperature, turbidity, rains etc)
4. Fertilizer quality
5. Availability of fertilizer
6. Financial ability of farmer

Also, farmer's experience in determining rate of application of fertilizer is also important. Recommended rates at time of canal preparation are

Name of fertilizer	Amount per decimal
Cow manure	5-7 kg
Compost	8-10 kg
Urea	100-150 gm
TSP	50-75 gm

Note: during gher preparation, any one of organic fertilizers mentioned in the table should be used.

Application method of fertilizer

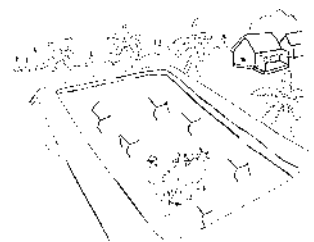
Dry gher: Required amount of organic fertilizer should be equally distributed to cover bottom of gher and then mixed evenly with the soil. Before soil is ploughed and after the fertilizer dries, a hole should be dug to see if there is red discharge from the soil. If there is reddish discharge then it is recommended not to plough the soil. If necessary along with organic fertilizer a layer of mustard oilcake (0.5kg/decimal) should be added and mixed with the organic fertilizer.



চিত্র- পানি ভর্তি ঘেরে সার প্রয়োগ

After filling the gher with water, TSP should be soaked for 12-24 hours and just before application mixed with urea which then sprinkled evenly over the canal.

Water-filled gher: TSP and manure should be mixed in a bucket or drum with water which is three times the amount of this fertilizer combination and soaked for 12-24 hours. Before application, urea should be added and then sprinkled over the gher. If the gher size is big then application of manure in solution is difficult. It is then better to scatter evenly the dry manure carefully over the gher.



চিত্র- শুকনা ঘেরে সার প্রয়োগ

Time of fertilizer application: Fertilizer should be applied 5-6 days after lime application and 5-6 days before stocking PL. While fertilizer can be applied at any time of the day, it should be done ideally on a sunny day and best with morning to afternoon.

Precautions in fertilizer application

- Fertilizer effectiveness is poor in acidic soil. In very high or low pH, sediment of phosphorus forms at the bottom
- Fertilizer effectiveness is poor in turbid waters
- In presence of aquatic plants fertilizer effectiveness is not good since the plants take up the nutrients more than the phytoplankton
- If water is not retained in gher for more than 3 weeks, the effectiveness of fertilizer is poor.
- In deep gher, if phosphorus is stuck to bottom mud then, the effectiveness of fertilizer is poor.
- Before using combination of fertilizers, these should be dissolved properly in water before application to ensure effectiveness

Fertilizer application in cloudy weather reduces its effectiveness

If urea is kept in open container then its effectiveness is reduced

Location of compost preparation:

- In shady place where sunlight does not reach e.g. below a tree or next to gher under a shade
- Damp place
- Where humidity is good and maintained
- Rain waters do not accumulate

Materials and amount

Material	rate of mixture
Green rotting soft plants, water hyacinth, duckweed, branches and stems of plants, banana leaves, green waste etc	48%
Manure	48%
Lime	2%
Urea	2%

Preparation process: Green plants should be cut up in small pieces and made into 3-4 portions. A 3 by 4 feet hole should be dug. In this hole, green plant matter, manure, lime and urea should be laid down in layers and then covered with earth.

Humidity test: 2/3 days later, compost location needs to be checked for dampness. If it is not damp then water should be sprinkled over the area to dampen it. Four holes should be made for compost preparation. 7 days after first hole is filled, the material of the 1st hole should be transferred to 2nd hole. The 1st hole should then be refilled. In this way the compost should be moved from hole to hole every 7 days. Within 28 days compost is fully prepared.

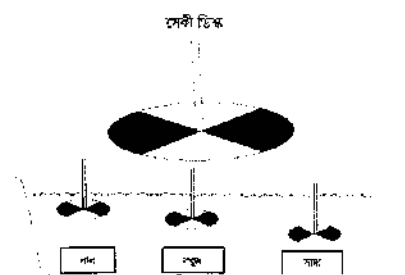
Assessment of natural food:

Before stocking PL, natural food of the gher should be assessed. Color of the pond water can indicate type and amount of food - light green, brownish/reddish green or light brown colors indicate gher water is suitable for release of PL. the colors indicate the presence of phytoplankton and zooplankton which are natural food for prawns. Dark green, copper red or clear water is not suitable for fish or prawn culture. Therefore whether water has required amount of food, should be assessed by first observing the color of the gher with naked eyes and then using the following methods to more specifically define the natural feed present in the pond water:

1. Secci disc test:

The Secci disc is a disc (circumference of 8 inches) which is painted black and white alternately in four parts. It is made of cast iron or any other metal from the centre of which rises a lead. The lead is tri-colored according to depth. From the centre of the disc the lead is colored red and is 10 inches, after which 4 inches are colored green and last 5-7 feet are colored white.

Method of use: If the red part of the lead is above water then this indicates that there is excess feed in the pond and to give additional fertilizer and feed is not advisable. However this might also be seen thus if waters are turbid. It is not advisable to release prawn/fish seed in such waters.



চিত্র- সেকিডিস্কের সাহায্যে প্রাকৃতিক খাদ্য পরিমাপ

If the white of the disc can be seen at depth of white of the lead then this indicates additional feed or fertilizer is required for the pond. If the green part of the lead is above the water then this indicates that the amount of feed in the pond is just right and the fish seed can be released.

[Insert drawing of Secci disc]

Time to use the disc: Secci disc test should be carried out 5-7 days after fertilizer application around 10-11 in the morning and standing against sunlight.



চিত্র- গামছা-গ্লাস পদ্ধতিতে প্রাকৃতিক খাদ্য পরিমাপ

2. Glass and gamchha test:

5-7 days after application of fertilizer, water should be collected using a clean gamchha (traditional towel) and put into a clean glass and then held up in sunlight to see color of the water. It should ideally contain green phytoplankton and 5-10 zooplankton. A clean and clear glass should be used, not one that is decorated, colored or dirty.

Hand test: Dip hand in the water with the palm facing upward. If the palm of the hand cannot be seen even before being dipped elbow-depth then it indicates that there is feed in the water. And if the palms can be seen after being dipped elbow deep then this indicates there is not enough feed.

Test for suitability of water

Before release of PL, water should be tested for suitability. For this a hapa has to set up on the gher and care should be taken so that hapa bottom does not touch mud. Then release 10-15 PL in the hapa. These PL are monitored for 24-48 hours. If there is no problem with the water then all PL will survive. Even if mortality is 10-20% - it can be considered safe. If there are any problems in the water then steps should be taken to fix this. If the water is repeatedly harrowed and then left for a few days, the water problems might be resolved before testing again for suitability.

Setting up shelter for prawns: When prawns metamorphose they are very vulnerable and require a shelter. This is because not all prawns metamorphose at the same time and so the prawns that are not metamorphosing eat the ones that are weak. There are submerged aquatic plants such as Hydrilla and Najas which provide shelter for the prawns. In addition to this dried palm or coconut leaves, bamboo sticks, broken plastic pipes, broken branches (especially of hijal tree) can be used as shelter for the prawns.

Importance of shelter for prawns

- Save prawns from theft
- Save prawns from high temperatures
- Save the metamorphosing prawns from other prawns
- Help production of periphyton which is a primary food on substratum

How to set up shelter: Palm/coconut leaves should be fixed in soil so that leafy part is slightly above soil. Bamboo sticks or plastic pipes should set on the bottom of the gher.

Number of shelters: For every 2 decimals 1-2 palm/coconut leaves should be placed. Other items for shelter should be placed proportionately.

Time to set up shelter : 2-3 days before stocking



চিত্র- চিংড়ি চাষের পুকুরে আশ্রয়স্থল স্থাপন

The practice of setting up shelters at field level is hardly done. Bamboo sticks are used to deter theft of fish but these sticks tied in bundled and immersed in gher can provide shelter as well as prevent theft.

Precautions in setting up shelters: Care should be taken not to use green leaves and branches and every few months, branches or bamboos being used should be taken out of water, cleaned and dried before replacing them.

Stocking Management in Nursery

Identification of good and bad quality PL: It is not enough just to stock canal with prawn PL. The PL have to be of good quality and healthy to get optimum production. The quality of PL depends on its source and handling. Whatever the reason for bad quality, if these PL are stocked farmers will face huge losses. If good quality PL are not stocked :

- After stocking there will be high mortality
- Rate of growth will be low
- Will not be marketable on time and thus not get good price

Characteristics of good and bad prawns are given in the box below

Characteristic	Good PL	Bad PL
Body color	Bluish brown/ash	Reddish orange
Exoskeleton	Clean	Dirty
Behavior (tested by creating current in a round bowl)	Swims against current	Gather in the center of the bowl
Marks on exoskeleton	Every segment has clear lateral markings	Unclear marking
Food	Stomach is filled with food	Stomach empty
Muscle	Good and clean muscles in tail segment	Tail muscles are ash in color

Transport of Prawn Seed: In Bangladesh only hatchery PL are transported in oxygen-filled polythene bags and PL collected from natural sources are transported in drums or aluminum pots. However if there is opportunity, it is safe to transport using modern method. Transporting PL using traditional method causes injury to the PL as they get knocked around the drum or pot and large numbers of PL die. Transporting PL in oxygen filled polythene bags does not cause oxygen shortage and physical injury is very little. Transporting PL using traditional method requires more precaution and preparation.



চিত্র- চিংড়ির পোনা প্যাকিং ব্যবস্থা

Density of prawn seed during transport: Stocking density mainly depends on PL size, weight and transport distance. Usually PL are transported in polythene bags measuring 36" x 20".

Size and type of prawn seed	Transport density/liter	Transport time (hour)	Transport process
Post larva (PL) 30-35	500-350	6	Oxygen-filled polybag

Transport density of prawns based on size and distance of transport

PL stocking density/decimal: It is ideal to stock 800-1000 PL per decimal but culture method and experience of the farmer this may vary.

Time to release PL: PL should be released at a cool time of the day into the canal. Evening and late evening are best time to release the PL. PL should not be released under the afternoon sun, on cloudy days or in hot and humid weather (especially in depressions).

Release and Acclimatization of PL: Because of temperature and fluctuating oxygen levels, there may be high mortality of PL when being released into the canal. In order to avoid this, before releasing into canal, the PL should be acclimatized with the new environment. This means making the temperature of the

transport container the same as that of the canal. To carry this out following activities should be followed sequentially:

- Transport container should be floated in canal water for 15-20 minutes
- After opening the container or bag, the canal water and container water should be slowly and gently mixed to bring the two to the same temperature
- The temperature difference should be measured by hand and care taken so that difference in temperature is not more than 1-2 0C.

After it is ensured that the temperature of the two waters are similar, the transport container can slowly be tipped and the healthy and strong fish/prawn seed will swim out against the water current that is created gently by hand. Care should be taken to release prawn seed at the edge of gher in shallow waters and not the middle of the gher.

Post-stocking management of nursery

Feeding management: Prawn PL feed on mainly two types of food, these are natural food and supplementary feed. Natural food can be ensured in the canal by fertilizer application but natural food does not ensure complete nutrition for prawns and require supplementary feed.

Supplementary feed: For quick and good growth of prawn PL, in addition to natural food, supplementary feed should also be given. Prawn like other animals require a complete diet that includes protein, carbohydrate, fat, vitamin and minerals. If any of these food substances are not adequately available in the prawn diet, the prawn's growth will slow down. In modern culture methods where prawns are reared at high stocking density, the natural food present in the gher does not meet requirements of the prawns and therefore various types of feed need to be supplied to the canal regularly. Farmers in our country usually give two types of supplementary feed based on the source. These are:



চিত্র- বিভিন্ন ধরনের সহজলভ্য সম্পূরক খাদ্য

Plant-type: polished rice bran, wheat bran, broken rice, wheat, molasses, mustard oilcake, sesame oilcake etc

Animal-type: fish meal, ground prawn heads, crab powder, livestock blood etc.

Farmers give feed according to their financial ability and availability of food substances made in the homestead and the local market. In homemade feed, it is not always possible to meet nutritional requirements of the prawns, but this can be found in the commercial feed which is prepared with consideration for prawns. It is therefore ideal to use commercial feed even though it might be a little expensive.

Importance of supplementary feed: To maintain ideal growth of prawns and control cannibalism. Prawns can be reared at high stocking density and thus-

- Reduce PL mortality
- Enhance prawn immunity
- Maximum production can be obtained from minimum space

Criteria for selection of supplementary feed: Oilcake and bran are most popular supplementary feed items. All over the country farmers use certain food item which are not actually beneficial for prawn growth and have detrimental effects on gher environment. Application of supplementary food is intended to enhance

Recommended rate of application of supplementary feed:

1st week 20 gm/1000 PL
2nd week 40 gm/1000 PL
3rd week 60 gm/1000 PL
4th week 80 gm/1000 PL
5th week 100 gm/1000 PL
6th week 120 gm/1000 PL

Preparation of supplementary feed: Farmers can easily prepare supplementary feed using various types of food material. If possible a food processor may be used. Below are steps in preparation of fish feed.

- Required amount of oilcake should soaked for at least 12 hours and the oil layer on top of the water should be thrown away
- Rice husk, wheat bran and fishmeal should be sieved well
- If rice bran is used then it should be boiled
- All the different materials should be taken in own bowl
- Wheat should be boiled in enough water to produce a gluey substance
- The gluey wheat should be used to mix the other materials into a dough and then made into small balls

Distribution of supplemental feed: Prawns are nocturnal animals and prefer to move and feed at night. Daily feed required should divided into two portions and given at two times i.e. 6 in the morning and 6 in the evening.

Commercial feed: Many different feed companies are seen in the markets nowadays. These companies sell feeds prepared according to age of fish/prawn. Each company gives the dealers guideline on how to use and apply the feed. Farmers choose feed of their choice and take the guideline on how to apply the feed from the dealer/seller.

Precaution in feed application:

- Feed should be given at the same time and place everyday
- If water is excessively green then amount feed should be reduced or temporarily stopped

Post-stocking fertilizer application

The suitable color of water is light green, reddish green or brownish green. These colors indicate that there are floating phytoplankton and zooplankton in the canal water. Depending on the concentration of the plankton, the water changes color. Natural feed present in the canal should be tested before supplementary feed is given. Canal water should be observed from its banks on a sunny day. Color should be checked with naked eyes. If color is light green, reddish green or brownish green, then at least twice a week, a Secci disc should be used to test status of natural feed in the water. The test should be carried out on a sunny day at 10-12 in the morning. If the white of the Secci disc can be seen at 14 inches i.e. green part of the cord, then fertilizer needs to be given.

Rate of fertilizer application

For phytoplankton production nitrogen and phosphorus are important elements which are easily obtained from organic and chemical fertilizers and so it is recommended to regularly apply manure, urea and TSP to the canal waters. Fertilizer should be ideally applied on a daily basis. But it is not possible to apply daily and therefore should be given at least weekly. Whatever the rate of application, the fertilizer amount might be more or less according need. The table below gives rate of fertilizer application per decimal:

Fertilizer name	Application rate per decimal
Compost	250-300 gm
Urea	3-4 gm
TSP	1.5-2 gm

If fertilizer cannot be applied daily then the daily rate given should be given seven times more in weekly application. According to international standards it is recommended not to use manure or poultry excreta and instead compost should be used.

Method of fertilizer application

Compost and TSP should be taken in a bucket with three times the amount of water and soaked for 12-14 hours. The TSP should be dissolved properly in the water. To this mixture urea should be added before applying to water body. Time of application is 10-11 in the morning on a sunny day.

Precautions of fertilizer application:

- If the color of water is excessively green, then fertilizer application should be temporarily stopped
- Should not be applied on cloudy day or if weather is overcast
- If urea is kept open then its effectiveness is reduced
- The effectiveness of fertilizer is reduced if applied in turbid or acidic water
- When using mixed fertilizer, it has to be well mixed and dissolved in water

In order to avoid any adverse effects because of excessive amounts of phytoplankton in the water in every decimal two five-inch sized silver carp can be released.

GROUP SESSION PLANNING

Day 01

Time – 13.00

Duration: 60 minutes

- Target group : Golda-carp polyculture farmers
- Title of session : Golda gher management (pre-stocking and post-stocking)
- Aim : To educate the Golda farmers on preparation/repair of Golda gher banks and bottom , removal of aquatic weeds, lime application, pre-stocking fertilization, natural food test, shelter construction, transport of Golda prawn seed, acclimatization, and release etc so that they can carry out these activities successfully and obtain optimum production of fish and prawn.
- Objective : At the end of this session, the participants -
- Will be able to prepare/repair pond banks/bottom
 - Will be able to remove aquatic weeds and predatory fish
 - Will be skilled in pre-stocking lime and fertilizer application
 - Will be able to carry out test for natural food.
 - Will be able to construct shelters
 - Will be skilled in transporting, acclimatization, and release of Golda prawn seed

Discussion topic	Training approach	Duration
Introduction		5 minutes
<ol style="list-style-type: none"> 1. Welcome/reception: welcoming the participants and asking about participants welfare 2. Discussion about previous session 3. Linking previous session's topic to current session 4. Explanation of aim and objectives of current session 	Q&A and discussion	
Topic		45 minutes
<p>At the end of this session, the participants -</p> <ul style="list-style-type: none"> • repair of banks and bottom; • removing aquatic weeds and unwanted and predatory fish; • application of lime; • pre-stocking fertilizer application and testing for natural feed • constructing shelter • transporting, acclimatization, and release of Golda prawn seed • stocking PL 	Lectures, Q&A Discussion Flipcharts	
Summary		10 minutes
<ol style="list-style-type: none"> 1. Summary discussion of main topic 2. Assessment of session objectives 3. Distribution of handouts 	Q&A	

Discussion and link up to the next session

Supporting Training Material flipchart, white board and marker and handout

Flip chart design

For discussion follow the handout

<p>Golda gher production/stocking management (pre stocking and post-stocking)</p>	<p>Fertilizer application</p> <p>Rate of fertilizer application</p> <table border="1"> <thead> <tr> <th>Type of fertilizer</th> <th>Material</th> <th>Before release of Prawn seed</th> </tr> </thead> <tbody> <tr> <td rowspan="4">Organic fertilizer</td> <td>Mustard oilcake</td> <td>4-6</td> </tr> <tr> <td>Molasses</td> <td>5</td> </tr> <tr> <td>Auto-polish, bran</td> <td>2</td> </tr> <tr> <td>yeast</td> <td>2-4 teaspoons</td> </tr> </tbody> </table> <p>Application method</p> <p>Precautions in fertilizer application</p> <ul style="list-style-type: none"> • Should be applied on sunny day • 5-7 days after lime application or 8-10 days before release of juveniles • Water should not become excessively green otherwise prawn juveniles might die 	Type of fertilizer	Material	Before release of Prawn seed	Organic fertilizer	Mustard oilcake	4-6	Molasses	5	Auto-polish, bran	2	yeast	2-4 teaspoons									
Type of fertilizer	Material	Before release of Prawn seed																				
Organic fertilizer	Mustard oilcake	4-6																				
	Molasses	5																				
	Auto-polish, bran	2																				
	yeast	2-4 teaspoons																				
<ul style="list-style-type: none"> • Appropriate location and environment for Golda culture • Pre-stocking management (similar to Golda nursery management) • Stocking density <p>Primary activities</p> <ol style="list-style-type: none"> 1. Criteria for selection of gher location 2. Importance and process of controlling aquatic weeds 	<p>Test for natural food</p> <ul style="list-style-type: none"> • Hand test • Secci disc test • Glass and gamchha test <p>Construction of shelters for prawns</p> <p>Materials: bamboo sticks, coconut leaves, date leaves, etc</p> <p>5-7 shelters per decimal</p>																					
<p>Preparation of gher</p> <p>Removal of predatory and unwanted fish</p> <p>Importance</p> <p>Method</p> <p>Application rate of rotenone or tea seedling oilcake</p> <table border="1"> <thead> <tr> <th>Name</th> <th>Strength</th> <th>Rate (per decimal per foot depth)</th> </tr> </thead> <tbody> <tr> <td>rotenone</td> <td></td> <td>20-25 gm</td> </tr> <tr> <td>Tea seedling oilcake</td> <td></td> <td>150 gm</td> </tr> </tbody> </table>	Name	Strength	Rate (per decimal per foot depth)	rotenone		20-25 gm	Tea seedling oilcake		150 gm	<p>Stocking density</p> <table border="1"> <thead> <tr> <th colspan="4">Stocking density</th> </tr> <tr> <th>Per sq. meter</th> <th>Per decimal</th> <th>Per bigha</th> <th>Yearly stocking events (number)</th> </tr> </thead> <tbody> <tr> <td>1-1.5</td> <td>40-60</td> <td>1320-1500</td> <td>4-5</td> </tr> </tbody> </table> <p>To abide by in stocking prawn seed</p> <ul style="list-style-type: none"> • Prawn seed should be released 8-10 days after bleaching powder application/ 15 days after dipterex application/56 days after rotenone application • Gher water should be tested for suitability by taking water in a bucket from the gher, releasing prawn seed and observing this for 12 hours • Prawn seed should not be released in the afternoon or when temperature is hot • The number of prawn seed to be stocked should be calculated in advance for the total gher and nursery 	Stocking density				Per sq. meter	Per decimal	Per bigha	Yearly stocking events (number)	1-1.5	40-60	1320-1500	4-5
Name	Strength	Rate (per decimal per foot depth)																				
rotenone		20-25 gm																				
Tea seedling oilcake		150 gm																				
Stocking density																						
Per sq. meter	Per decimal	Per bigha	Yearly stocking events (number)																			
1-1.5	40-60	1320-1500	4-5																			
<p>Lime application</p> <p>Advantages of lime application</p> <ul style="list-style-type: none"> • Maintain water pH at suitable level for culture • Clears water of turbidity • Increases effectiveness of fertilizers • Maintains environment for plankton production • Releases calcium • Increases carbon dioxide release in photosynthesis • Hastens rotting process of organic matter and release of nutritious substances, and increases natural productivity • Kills parasites and germs 	<p>Transport of prawn seed:</p> <p>Transport density of prawns based on size and distance of transport</p> <table border="1"> <thead> <tr> <th>Size and type of prawn seed</th> <th>Transport density/liter</th> <th>Transport time (hour)</th> <th>Transport process</th> </tr> </thead> <tbody> <tr> <td>Post larva (PL) 20</td> <td>500-350</td> <td>12-16</td> <td>Oxygenfilled polybag</td> </tr> <tr> <td>Post larva 30-35</td> <td>500-350</td> <td>6</td> <td>Oxygenfilled polybag</td> </tr> <tr> <td>Juvenile 2-3 inches</td> <td>20-10</td> <td>6-3</td> <td>Oxygenfilled polybag</td> </tr> </tbody> </table>	Size and type of prawn seed	Transport density/liter	Transport time (hour)	Transport process	Post larva (PL) 20	500-350	12-16	Oxygenfilled polybag	Post larva 30-35	500-350	6	Oxygenfilled polybag	Juvenile 2-3 inches	20-10	6-3	Oxygenfilled polybag					
Size and type of prawn seed	Transport density/liter	Transport time (hour)	Transport process																			
Post larva (PL) 20	500-350	12-16	Oxygenfilled polybag																			
Post larva 30-35	500-350	6	Oxygenfilled polybag																			
Juvenile 2-3 inches	20-10	6-3	Oxygenfilled polybag																			
<p>Rate of lime application</p> <table border="1"> <thead> <tr> <th>Type of lime</th> <th>Application rate (kg/decimal)</th> </tr> </thead> <tbody> <tr> <td>Calcium carbonate</td> <td>3-4</td> </tr> <tr> <td>Slaked lime</td> <td>2</td> </tr> <tr> <td>Quicklime</td> <td>1-2</td> </tr> <tr> <td>dolomite</td> <td>3-4</td> </tr> </tbody> </table>	Type of lime	Application rate (kg/decimal)	Calcium carbonate	3-4	Slaked lime	2	Quicklime	1-2	dolomite	3-4	<p>Precautions during transport</p>											
Type of lime	Application rate (kg/decimal)																					
Calcium carbonate	3-4																					
Slaked lime	2																					
Quicklime	1-2																					
dolomite	3-4																					

Golda gher production/stocking management (pre-stocking and during stocking)

Appropriate location and environment for Golda culture

Suitable environment for prawn culture means an environment where the infrastructural arrangements, water management, water depth, availability of different materials are in place to ensure quality and export of prawns produced. Prawns of commercial value are cultured in floodplains, rivers, streams, canals, ponds, ditches, paddy fields- i.e. almost all types of water bodies. The extent of prawn culture area is increasing every year.

Selection of prawn gher location:

Even though different methods of prawn culture require different types of farms, there are some common aspects to all locations. Advantages of selecting suitable locations are given below:

- Little cost in location selection
- Farm management is easier and management cost is less
- No problems are created in water management and suitable water technology can be used easily.
- Other aspects that need to be considered in farm selection

1. Pollution-free area: In city and industrial areas, where the waste is released into the surrounding rivers and canals, is risky for prawn culture. Also where insecticides have been used in farming, setting up prawn farms in these areas is risky and therefore these areas should be avoided.

2. Area not washed away by floods and rains: Where there are floods and risks of rain-water caused flooding, the water quality fluctuates. Building dams is expensive and flood water has a lot of organic matter which is harmful and therefore flood-prone areas should be avoided.

3. Water source (and availability): Prawn farms should be constructed in such areas where the water source is pollution-free and easily accessible for water supply and change of farm waters.

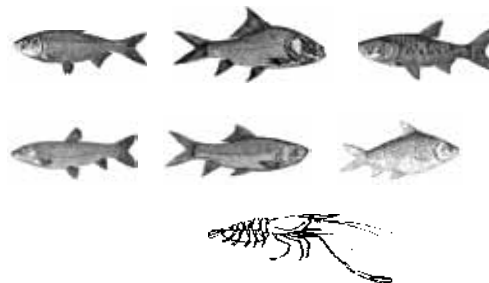
Pre-stocking management of ghers

Usually after boro paddy is harvested there is no water in the fields, at this time the paddy roots should be removed.

The pre-stocking management in prawn culture includes preparatory work such as preparation/repair of Golda gher banks and bottom, removal of aquatic weeds, lime application, pre-stocking fertilizer application, natural food test, test of water suitability and shelter construction. These have already been discussed in nursery management – it is recommended to revise these discussions. Usually after boro paddy harvest there is no water and therefore no need to remove predatory or unwanted fish. If for any reason there is water and the farmer thinks there are predatory and unwanted fish then arrangements should be taken to remove these fish.

Species selection and determination of stocking density

The basis of culturing fish and prawns together is the availability of natural food in the gher. Natural food is produced in three layers of gher water – top, middle and bottom. The fish and prawns cultured together live and feed in the different layers. Fish such catla, silver carp and bighead carp live in the top layer, ruhi (*Labeo rohita*), in the middle layer and mrigel (*Cirrhinus mrigala*), carpio (*Carpio carpio*), mirror carp and prawns live at the bottom. Only shorputi (*P. gonionotus*) and grass carp roam around all the layers of water. Therefore if fish and prawns that feed in one layer are only released then there is competition for food and space in that layer while other layers remain unutilized. This can be compared to land crops. For example if all the seedlings required for one bigha land were planted in only 10% of the land and the rest of the land is left empty, good production cannot be obtained.



চিত্র- কার্প-গলদা মিশ্রচাষের উপযোগী প্রজাতি

In the same way, if optimum use is not made of all the water layers, despite stocking with adequate number of prawn seed/juveniles, good production cannot be obtained. When stocking the gher, care should be taken to utilize all layers of the gher. If stocked at high concentration, the prawn juvenile and fish fingerlings may have high competition for food, space and oxygen. As a result the growth is hampered, environment balance is not maintained and diseases break out and so expected production and profit is not obtained. On the other hand if juveniles and fingerlings are stocked at very low density then also total production is low. Therefore according to overall gher management and culture method, stocking density should be determined. Aspects to consider in determination of appropriate stocking density:

Productivity of gher: Based on quality and characteristics of water and soil, number of fingerlings/juveniles for stocking may vary e.g. sandy or muddy soil is less productive than loamy soil. Therefore loamy soil ghers can be stocked at high density compared to other soil types.

Expected production size: If fish and prawns are to grow to a specific size within a given time (5-6 fish at 500 gm-1kg and prawns less than 80 gm) then fish and prawn should be stocked at low density. When density is high, growth slows down and average weight is low.

Size of fish fingerling and prawn juveniles: If large sized fish fingerling (4 inches) and prawn juveniles (2-3 inches) are stocked then higher production can be achieved in a short period. Sometimes large sized fingerlings and juveniles are not available for stocking, then higher number of smaller fingerlings and juveniles can be released. When large sized fingerlings and juveniles are stocked, recommended stocking density reduces by 25%.





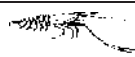
Type of culture: Stocking density in monoculture and polyculture varies.

Management approach: This may include only fertilizer application with low stocking density or both fertilizer application and supplementary feed supply with higher stocking density. Also gher management may include partial water change and aeration where stocking density can be higher. In some ghers the stocking density and rate depends on its physio-chemical properties and management. Based on the aspects discussed, below is given examples of mono and poly culture stocking densities:

Stocking density

Monoculture: Golda prawns: 50-70 pieces/decimal. Depending on rearing and feeding management this can be from 1.5 to 2 times more.

Carp-prawn polyculture: Prawn juveniles are stocked in different ways and so variations can be seen in stocking densities of juveniles. Below is given two examples of stocking juveniles with different carps:

species	Size: (inches)	Example 1	Example 2
 Catla (Catla catla)	4-6	6-8	2-3
 Silver carp	4-6	6-8	4-5
 Rui (Labeo rohita)	4-6	4-6	1-2
 Grass carp	4-6	0-1	0-1
 Golda	2-3	50-60	30-40
total		65-80	37-51

Currently many parts of Bangladesh has drought issues where culture period is only for 4-6 months. To cope with this situation, example 2 i.e. 37 per decimal is recommended for good results. However if water is present for more than 5 months, 51 pieces per decimal can be released. Getting a good price depends on the size of the fish and prawn i.e. large fish /prawn of species gets a higher price than the smaller sized fish/prawn of the same species. Therefore stocking at the appropriate density can ensure good sized fish and prawns.

Identifying good and bad juveniles and fingerlings

It is not enough to just stock fish and prawn for good production, the fingerlings and juveniles being stocked have to be of good quality, strong and healthy to ensure good production. The quality of fingerlings/juveniles depends on their source and handling. Whatever the reason for being of poor quality, the farmer will incur high losses since large numbers of fingerlings/juveniles will die on being released into the gher. If good quality fingerlings/juveniles are not stocked:

- There is high mortality after stocking
- Rate of growth is slow
- Does not grow to marketable size on time and therefore does not good market price

Therefore before stocking, the quality of fingerlings/juveniles should be assessed. Characteristics for identifying good and bad fingerlings/juveniles are given below:

Prawn juveniles

- Good juvenile has bluish white/ash body color; bad juvenile is reddish/blackish
- Antenna and walking legs are not broken in good juveniles
- Exoskeleton of good juveniles are clean and that of bad juveniles, blackish with algae
- Stomach of good juvenile is full, which is empty or partially full in bad juveniles



Fish fingerlings

- Healthy and strong fingerlings are active and strongly, but the weak ones are slow and lethargic
- Scales of good quality fingerlings are shiny while that of the bad fingerlings, dull
- Body of good fingerling is slippery while that of bad fingerling rough
- Good quality fingerlings have no marks, and in the bad fingerlings, reddish marks are seen on the fins and tail.



Transport of juvenile: Since juveniles are produced in the same gher, there is no need to make special arrangements for it transport

Transport Density of fish fingerling: Transport density mainly depends on size, weight of fingerling and distance to be travelled. Usually fish fingerlings are transported in pots or drums. Fingerling dealers supply fingerlings according local requirements. Since large-sized fingerlings are stocked and transporting this size is risky and costly, it better to procure from local fingerling dealers. Below is given transport density of carp fingerlings and prawn juveniles:

Transport density of carp fingerlings

Transport method	Size (inches)	Density/liter water	Transport distance (hours)
 Modern method	1.5-2	33-35	10-12
	2-2.5	20	10-12
	2.5-3	13	10-12
	3-3.5	5	10-12
	3.5-4	4	10-12
 Traditional method	1.5-2	15	3-4
	3-4	5-6	3-4

Transport density of prawn juveniles

Transport method	Size (inches)	Density/liter water	Transport distance (hours)
 Modern method	PL	125-150	12-16
	PL	300-350	6
	Juvenile	100	6
 Traditional method	PL	250-500	1-1.5
	juvenile	15-20	4-6

Acclimatization and release of juveniles: Since the juvenile have already been reared in the gher canal, there is no reason to acclimatize the juveniles. If however the juveniles are collected from another canal then they should be acclimatized the same way fish fingerlings are acclimatized as described below.

Acclimatization and release of fish fingerlings: Because of the fluctuating temperature and oxygen levels in the environment, fish fingerlings die after stocking. Before releasing the fingerlings, they should be acclimatized with the gher waters to minimize mortality. The following steps should be followed to acclimatize fingerlings/juveniles:

- Transport container should be floated in canal water for 15-20 minutes
- After opening the container or bag, the canal water and container water should be slowly and gently mixed to bring the two to the same temperature
- The temperature difference should be measured by hand and care taken so that difference in temperature is not more than 1-2 0C.

After it is ensured that the temperature of the two waters are similar, the transport container can slowly be tipped and the healthy and strong fish/prawn seed will swim out against the water current that is created gently by hand. Care should be taken to release prawn seed at the edge of gher in shallow waters and not the middle of the gher.

Time to release fingerlings/juveniles: Fingerlings/juveniles should be released at a cool time of the day into the canal. Evening and late evening are best time to release the fingerlings/juveniles. Fingerlings/juveniles should not be released under the afternoon sun, on cloudy days or in hot and humid weather (especially in depressions).

GROUP SESSION PLANNING

Day 02

Time – 10.00

Duration: 30 minutes

- Target group : Golda-carp polyculture farmers
 Title of session : Discussion of previous days sessions
 Aim : Participants will narrate and discuss previous day's sessions, express their opinions so that previous day's discussions are recalled and any gaps in understanding resolved.
 Objective : At the end of this session, the participants -
- Will be able to come to a common understanding on previous day's sessions through discussion

Discussion topic	Training approach	Duration
Introduction		5 minutes
<ol style="list-style-type: none"> 1. Welcome/reception: welcoming the participants and asking about participants welfare 2. Discussion about previous session 3. Linking previous session's topic to current session 4. Explanation of aim and objectives of current session 	Q&A and discussion	
Topic		25 minutes
At the end of this session, the participants - <ul style="list-style-type: none"> • One participant will review previous day's session through discussion • Everyone's opinion taken on previous day's session 	Lectures, Q&A Discussion Flipcharts	
Summary		3 minutes
<ol style="list-style-type: none"> 1. Summary discussion of main topic 2. Assessment of session objectives 3. Distribution of handouts 	Q&A	

Discussion and link up to the next session

Supporting Training Material flipchart, white board and marker and handout

GROUP SESSION PLANNING

Day 02

Time – 10.30

Duration: 60 minutes

- Target group : Golda-carp polyculture farmers
 Title of session : Golda gher management (post-stocking)
 Aim : To educate the Golda farmers on feeding management, post-stocking fertilizer application, common problems in Golda culture, prawn diseases and health management etc so that they can carry out these activities successfully and obtain optimum production of fish and prawn.
 Objective : At the end of this session, the participants -
- Will be able to determine amount of feed required in the gher and the application of feed
 - Will be skilled in post-stocking fertilizer application
 - Will be able to state common problems in fish prawn culture and how to manage these.
 - Will be able to discuss about fish and prawn health and disease management

Discussion topic	Training approach	Duration
Introduction		5 minutes
<ol style="list-style-type: none"> 1. Welcome/reception: welcoming the participants and asking about participants welfare 2. Discussion about previous session 3. Linking previous session's topic to current session 4. Explanation of aim and objectives of current session 	Q&A and discussion	
Topic		45minutes
<ul style="list-style-type: none"> • Determination of amount of feed required in the gher and the application of feed • Post-stocking fertilizer application • Common problems in fish prawn culture and how to manage these. • Fish and prawn health and disease management 	Lectures, Q&A Discussion Flipcharts	
Summary		10 minutes
<ol style="list-style-type: none"> 1. Summary discussion of main topic 2. Assessment of session objectives 3. Distribution of handouts 	Q&A	

Discussion and link up to the next session

Supporting Training Material flipchart, white board and marker and handout

Flip chart design

For discussion follow the handout

<p style="text-align: center;">Post-stocking management</p>	<p>Amount of supplementary feed</p> <table border="1"> <thead> <tr> <th colspan="2">Amount of feed for 15-51 days (per 1000 juveniles)</th> <th colspan="3">Amount of feed for 52-120 days</th> </tr> <tr> <th>Source (day)</th> <th>Amount (gm)</th> <th>Average weight of prawn (gm)</th> <th>Rate (% body mass)</th> <th>Type of feed</th> </tr> </thead> <tbody> <tr> <td>16-21</td> <td>60-70</td> <td>6-8</td> <td>5.5-5.0</td> <td rowspan="7">Home-prepared feed/ commercial feed</td> </tr> <tr> <td>21-26</td> <td>70-80</td> <td>9-11</td> <td>5.0-4.5</td> </tr> <tr> <td>26-31</td> <td>80-90</td> <td>12-14</td> <td>4.5-4.0</td> </tr> <tr> <td>31-36</td> <td>90-100</td> <td>15-17</td> <td>4.0-3.5</td> </tr> <tr> <td>36-41</td> <td>100-110</td> <td>18-20</td> <td>3.5-3.0</td> </tr> <tr> <td>41-46</td> <td>110-120</td> <td>21-24</td> <td>3.0-2.5</td> </tr> <tr> <td>46-51</td> <td>120-130</td> <td>25-30</td> <td>2.5-2.0</td> </tr> </tbody> </table>	Amount of feed for 15-51 days (per 1000 juveniles)		Amount of feed for 52-120 days			Source (day)	Amount (gm)	Average weight of prawn (gm)	Rate (% body mass)	Type of feed	16-21	60-70	6-8	5.5-5.0	Home-prepared 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																													
Amount of feed for 15-51 days (per 1000 juveniles)		Amount of feed for 52-120 days																																																																			
Source (day)	Amount (gm)	Average weight of prawn (gm)	Rate (% body mass)	Type of feed																																																																	
16-21	60-70	6-8	5.5-5.0	Home-prepared 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																																																																		
<p>Food and feeding habit</p> <p>Necessary nutrition for prawns:</p> <ol style="list-style-type: none"> Protein (essential amino acids) Lipid (taken from plant animal as fatty acids and cholesterol) Energy (carbohydrates) Vitamin Minerals <p>Appropriate environment for utilization of feed</p> <ul style="list-style-type: none"> - Need to maintain water quality - Pond bottom should be kept pollution free and clean - Soils microbes have to kept in control - Other aquatic animal populations need to be regulated - If required in bagda culture, feed should be given - Cost benefit analysis should be carried out in use of feed - Diseased prawns do not eat - Food requirement for different size and age of prawns is different 	<p>Amount of supplementary feed</p> <p>For every 1000 juveniles – approx amount of daily feed (16120 days)</p> <table border="1"> <thead> <tr> <th>week</th> <th>Prawn age (days)</th> <th>Daily feed amount</th> <th>Weekly feed amount (kg)</th> </tr> </thead> <tbody> <tr><td>3</td><td>16-22</td><td>70</td><td>0.490</td></tr> <tr><td>4</td><td>23-29</td><td>85</td><td>0.595</td></tr> <tr><td>5</td><td>30-36</td><td>100</td><td>0.700</td></tr> <tr><td>6</td><td>37-43</td><td>115</td><td>0.805</td></tr> <tr><td>7</td><td>44-50</td><td>130</td><td>0.910</td></tr> <tr><td>8</td><td>51-57</td><td>170</td><td>1.190</td></tr> <tr><td>9</td><td>58-64</td><td>250</td><td>1.750</td></tr> <tr><td>10</td><td>65-71</td><td>300</td><td>2.100</td></tr> <tr><td>11</td><td>72-78</td><td>350</td><td>2.450</td></tr> <tr><td>12</td><td>79-85</td><td>450</td><td>3.150</td></tr> <tr><td>13</td><td>86-92</td><td>600</td><td>4.200</td></tr> <tr><td>14</td><td>93-98</td><td>700</td><td>4.900</td></tr> <tr><td>15</td><td>99-105</td><td>800</td><td>5.600</td></tr> <tr><td>16</td><td>106-112</td><td>900</td><td>6.300</td></tr> <tr><td>17</td><td>113-120</td><td>1000</td><td>7.000</td></tr> <tr><td>Total</td><td></td><td></td><td>42.140 kg</td></tr> </tbody> </table>	week	Prawn age (days)	Daily feed amount	Weekly feed amount (kg)	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	93-98	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
week	Prawn age (days)	Daily feed amount	Weekly feed amount (kg)																																																																		
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	93-98	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																																																																		
<p>Type of supplementary feed</p> <ol style="list-style-type: none"> Fresh food Farm-prepared mixed feed Factory-prepared/commercial feed <p>Rate of use of different materials in feed preparation</p> <table border="1"> <thead> <tr> <th rowspan="2">Name of material</th> <th colspan="2">Example 1</th> <th colspan="2">Example 2</th> </tr> <tr> <th>Use rate (%)</th> <th>gm/kg feed</th> <th>Use rate (%)</th> <th>gm/kg feed</th> </tr> </thead> <tbody> <tr> <td>Fish meal</td> <td>30</td> <td>300</td> <td>30</td> <td>300</td> </tr> <tr> <td>Mustard oilcake</td> <td>40</td> <td>400</td> <td>30</td> <td>300</td> </tr> <tr> <td>Mollusk shell powder</td> <td>-</td> <td>-</td> <td>5</td> <td>50</td> </tr> <tr> <td>Polished bran, wheat bran</td> <td>20</td> <td>200</td> <td>20</td> <td>200</td> </tr> <tr> <td>wheat</td> <td>9</td> <td>90</td> <td>10</td> <td>100</td> </tr> <tr> <td>Molasses</td> <td>1</td> <td>10</td> <td>5</td> <td>50</td> </tr> <tr> <td>Mineral salts</td> <td>-</td> <td>1 spoon</td> <td>-</td> <td>1 spoon</td> </tr> <tr> <td>Total</td> <td>100</td> <td>1000</td> <td>100</td> <td>1000</td> </tr> </tbody> </table>	Name of material	Example 1		Example 2		Use rate (%)	gm/kg feed	Use rate (%)	gm/kg feed	Fish meal	30	300	30	300	Mustard oilcake	40	400	30	300	Mollusk shell powder	-	-	5	50	Polished bran, wheat bran	20	200	20	200	wheat	9	90	10	100	Molasses	1	10	5	50	Mineral salts	-	1 spoon	-	1 spoon	Total	100	1000	100	1000	<p>Precautions in feed application</p> <ul style="list-style-type: none"> - Food quality should be suitable and so it should be tested - Rotten food or food with fungus should not - Feeding behavior should be observed in feeding tray - Food should be given at a specific location at specified times - Growth hormones or any antibiotics should not be used with food <p>Post-stocking fertilizer application</p> <p>After releasing fingerlings/juveniles in the gher, fertilizer should applied every lunar cycle</p> <p>Water exchange</p> <ul style="list-style-type: none"> - Oxygen increases in gher water - New natural food and nutrition is produced - Water productivity is enhanced - Polluted matter gets removed - Helps in metamorphosis of prawns 																			
Name of material		Example 1		Example 2																																																																	
	Use rate (%)	gm/kg feed	Use rate (%)	gm/kg feed																																																																	
Fish meal	30	300	30	300																																																																	
Mustard oilcake	40	400	30	300																																																																	
Mollusk shell powder	-	-	5	50																																																																	
Polished bran, wheat bran	20	200	20	200																																																																	
wheat	9	90	10	100																																																																	
Molasses	1	10	5	50																																																																	
Mineral salts	-	1 spoon	-	1 spoon																																																																	
Total	100	1000	100	1000																																																																	
<p>Time for feed application</p> <p>Daily required feed should be split in two parts and then given at 6 in the morning and then 67 in the evening</p> <p>Amount of supplementary feed</p> <p>In first 4-5 weeks (prawn weight =5gm) feed amount should be 5% of prawn body and in following weeks 3% of body mass.</p>	<p>Disease and health management of prawns</p> <p>Reasons for diseases</p> <ol style="list-style-type: none"> Environment Germs Prawn <p>Common problems in prawn culture and solutions</p>																																																																				

Post-stocking management

Water and food management

Water management: means keeping the bad elements in the water at acceptable level so that it does not harm the fish and prawns. The physio-chemical components that affect quality of water are discussed summarily below:

A) Physical properties

a. Depth of water: Water quality varies with depth of water. If depth is low i.e. less than 1 meter, sunlight reaches the bottom of the gher and heats up the water. In excessive rains, pH, temperature, dissolved oxygen falls and turbidity of water increases. This results in a decline in feeding habit of the prawn, it becomes weak and dies. If water depth increases more than a meter, the excess water should be drained off.

b. Temperature: For prawns to stay healthy, water temperature should be 25-30°C. If temperature falls below 20°C then prawn stops feeding, weakens and dies. When it is above 30°C, the muscles become thin and as temperature increases, the prawn dies.

c. Transparency: depends on soil sediment, plankton concentration and pollution. When plankton increases in gher waters, water has to be changed, and if it is low then fertilizer should be applied.

B) Chemical properties

a. pH: Alkalinity and acidity of water measured on the pH scale gives an indication of the productivity of water. Gher water should have pH between 7.5 and 8.5. If pH is less than 7.5 then the prawns are stressed and mortality rate increases. Because of low pH, the prawn's exoskeleton becomes soft and cannot metamorphose. If pH is higher or lower than the ideal range, then prawn's feeding also reduces. When pH is low, prawn body color becomes black and there may be degeneration of body. At low pH, production of natural food i.e. plankton decreases. Usually application of quicklime helps regulate the pH. Frequently fluctuating levels of pH is not good in fish and prawn culture. If pH of water is low then:

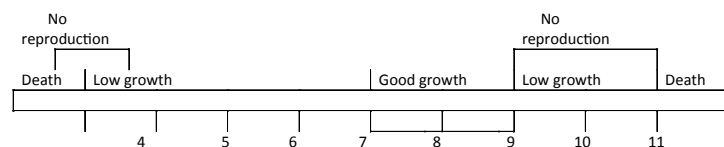


Fig: the effect of pH in fish and prawn culture

Because of low pH, the prawn's exoskeleton becomes soft and cannot metamorphose. If pH is higher or lower than the ideal range, then prawn's feeding also reduces. When pH is low, prawn body color becomes black and there may be degeneration of body. At low pH, production of natural food i.e. plankton decreases. Usually application of quicklime helps regulate the pH. Frequently fluctuating levels of pH is not good in fish and prawn culture. If pH of water is low then:

- Sodium and chloride is secreted as a result prawn becomes weak and dies
- Immunity and appetite of fish and prawns decreases
- Productivity of natural food in ghers and ponds decreases
- Stops reproduction of fish and prawns

if pH of water increases then fish and prawns are affected in the following ways:

- Gills and eyes get damaged
- Osmoregulation decreases
- Food intake stops, as a result, become diseased and die

b. Alkali and alkalinity: Alkali is the combined concentration of carbonate, bicarbonate and alkalinity is concentration of magnesium and calcium. Slightly alkaline water is good for Golda culture. Alkalinity and alkali levels should be 80 and 200 milligram/liter respectively.

c. Dissolved oxygen: For prawn culture, 4-8 milligram/liter of dissolved oxygen is preferred and at least 3 milligram/liter. During the day, plants and phytoplankton produce plenty of oxygen. At night the plants, phytoplankton and rotting matter utilize oxygen creating a shortage of dissolved oxygen and therefore to regulate the oxygen levels, the rotting mud at the bottom should be removed

d. Ammonia: Presence of ammonia pollutes the water. When pH is high, excessive ammonia becomes toxic. Ammonia increases as a result of the rotting process of organic matter and plants, and excreta deposited by aquatic animals. Levels of free ammonia ion should be less than 0.1 milligram/liter. If levels are higher than this, it affects the prawn's health and lead to death. Lime application and water exchange can help regulate level of ammonia in the water

e. Hydrogen sulphide: The smell of rotten eggs at the bottom of gher indicates the soil has hydrogen sulphide gas which is extremely harmful. Any level of hydrogen sulphide in water is detrimental for prawn culture. When pH is low, hydrogen sulphide becomes toxic. Hydrogen sulphide levels should be less than 0.03 milligram/liter. Removal of black mud during gher preparation, and regular water exchange can help minimize levels of hydrogen sulphide in water

Ways to maintain quality of water

After stocking prawns in a gher, waste from feed, plankton, prawns and other fish are released into the water and the amount of organic and inorganic matter increases and therefore the quality of water is not maintained. In such a situation, water can be changed and its physical and chemical properties improved. During the first 30 days of prawn culture, additional water can be added to maintain water quality. In the following period 10-20% water should be regularly changed every 10-15 days. Where supplementary feed is added, the rate of water being changed should be 30-40%. If tidal waters do not enter the gher then pump can be used to change water. Depth should be maintained when changing water. When changing water, fine mesh net should be used so that unwanted fish or fauna do not enter the gher. The benefits of changing gher water are:

- Production of oxygen in water
- New natural food produced
- Water productivity increases
- Waster matter form water is removed
- Helps in metamorphosis process of the prawns

Feed management

For quick and good growth of prawn PL, in addition to natural food, supplementary feed should also be given. Prawns like other animals require a complete diet that includes protein, carbohydrate, fat, vitamin and mineral. If any of these food substances are not adequately available in the prawn diet, the prawn's growth will slow down. In modern culture methods where prawns are reared at high stocking density, the natural food present in the gher does not meet requirements of the prawns and therefore various types of feed need to be supplied to the gher regularly.

Importance of supplementary feed

For body growth and survival, fish and prawn consume zooplankton, phytoplankton, bottom-dwelling insects, larvae, bottom-dwelling worms, dead matter etc as food, however this is not enough when fish and prawns are cultured at high stocking density according to modern methods, they require supplementary feed. Unless supplementary feed is given the fish and prawns become weak and growth slows down affecting overall productivity. Supplementary feed is therefore very important for good growth and production.

Also, supplementary feed helps control cannibalistic behavior of prawns. When there is a shortage of food in the gher, prawns become cannibalistic - the stronger ones eat the weaker prawns and this leads to high mortalities. Through application of appropriate amount of supplementary food, the prawn's harmful behavior can be controlled. Currently in Bangladesh, the annual production of prawns is 6kg/decimal in ponds and 2-2.5 kg/decimal in coastal gher. According to experts, application of supplementary feed can easily increase the rate of production by five times.

Given below are some points on the importance of supplementary feed:

- Fish and prawns can be cultured at high densities
- Fish and prawns become marketable within a short period.
- Fish and prawn mortality is reduced.
- Immunity of Fish and prawns improves
- Cannibalistic behavior of prawns is controlled
- Maximum production can be obtained from minimum space

Farmers in our country usually give two types of supplementary feed based on the source. These are:

Plant-type: Polished rice bran, wheat bran, broken rice, wheat, molasses, mustard oilcake, sesame oilcake, duckweed, leafy vegetation, banana leaves, papaya leaves, drumstick leaves, napier grass etc

Animal-type: Fish meal, ground prawn heads, crab powder, livestock blood, silk worms, intestines of poultry, cow stomach and intestines etc.

Criteria for selection of feed: feed: Oilcake and bran are most popular supplementary feed items. All over the country farmers use certain food item which are not actually beneficial for prawn growth and actually have detrimental effects on gher environment. Application of supplementary food is intended to enhance growth of prawns and keeping this in mind certain criteria need to be considered in selection of supplementary feed for successful prawn/juvenile growth:

- Availability of feed material
- Financial ability of farmer
- Cost of the feed material
- Nutritional requirement of fish and prawn
- Favored by fish and prawn
- High food conversion ratio

খাদ্য নির্বাচনের কৌশলের উপর মাছচাষের সফলতা নির্ভরশীল। বিগত বছরের অভিজ্ঞতার আলোকে দেখা গেছে যেসব চাষী চাষকৃত মাছ ও তাদের মুখের আকার বিবেচনা করে খাদ্য নির্বাচন ও প্রয়োগ করেছেন, সেক্ষেত্রে খাদ্যের অপচয় কম হয়েছে এবং মাছের উৎপাদন ভালো হয়েছে। এছাড়া চিংড়ি মাছ রাতে খাবার খায় সুতরাং চিংড়ির জন্য রাতের বেলা খাবার দিতে হবে যাতে তারা সময় নিয়ে খাবার খেতে পারে।

Nutritional requirement of fish and prawn:

For good survival and growth, nutritious food for fish and prawn includes in mostly protein. When discussing fish nutrition it is usually about protein. The substances used to prepare fish feed include all food components e.g. carbohydrate, mineral salts, fat etc. When protein requirements are fulfilled so are the requirements for the other nutritional components. It has been found that the protein requirement of fish and prawns in ghers is 30-40% and 40-45% respectively, therefore food intake of fish and prawns should include appropriate amount of protein. However fish and prawns get only 5-15% protein from natural food. Considering this supplementary feed is prepared to include 25-30% protein.

Assessment of nutrition in feed

In Bangladesh, it has been found that supplementary feed used in fish or prawn culture have been found to be of high quality nutrition-wise. Nutritional quality of feed materials is given below. This is based on research findings.

Table: Amount of nutrition in different food substances p 54

Name of food substance	Nutritional value (%)		
	Protein	Carbohydrate	Fat
Broken rice/rice bran	11.88	44.42	10.45
Wheat bran	14.57	66.36	4.43
Mustard oilcake	30.33	34.38	13.44
Sesame oilcake	27.20	34.97	13.18
Fishmeal grade A	56.61	3.74	11.12
Blood meal	63.15	15.59	0.56
Wheat	17.78	75.60	3.90
Molasses	4.45	83.62	-
Duckweed	14.02	60.88	1.92
Lemna sp	19.27	50.19	3.49

In assessing nutritional value of fish and prawns only the protein amount is assessed. Common method of preparation of feed requires mixing various food substances which can be easily assessed. Below is given an example of how protein amount is assessed. For example fish meal, mustard oilcake, wheat bran and wheat is used to make 1 kg food and percentage of each food substance is 25% fish meal, 25% mustard oilcake, 40% wheat bran and 10% wheat. Then the protein amount in the food is:

Substance	Present protein amount (%)	Utilization rate (%)	Required amount (gm)	supplied protein (%)
Fishmeal	56.61	25	250	14.15
Mustard oilcake	30.33	25	250	8.33
Wheat bran	14.17	40	400	5.82
Wheat	17.78	10	100	1.77
Mineral salts			1 teaspoon	-
Total		100	1000	30.7

Proportion of food substances used in feed preparation: In preparation of fish feed, food substances that are low cost but at the same time have required nutritional value should be selected so that investment cost for feed is minimal. Common food items used in Bangladesh include oilcake, bran, wheat bran, fishmeal, and molasses etc which are used to meet nutritional requirements of fish and prawns and prepare supplementary feed. Based on farmer's financial ability and nutritional requirements of fish and prawns, below is given two examples of supplementary food preparation:

substance	Example 1		Example 2	
	Utilization rate (%)	gm/kg food	Utilization rate (%)	gm/kg food
Fishmeal	30	300	30	300
Mustard oilcake	40	400	30	300
Broken/powder mollusks	-	-	5	50
Polish rice bran/wheat bran	20	200	20	200
	9	90	10	100
Molasses	1	10	5	50
Mineral salts	-	1 teaspoon	-	1 teaspoon
Vitamin pre-mix	-	1 teaspoon	-	1 teaspoon
Total	100	1000	100	1000

In addition to mixed food, grass carp and shorputi eat duckweed, soft grass, banana leaves, papaya leaves, potato leaves, drumstick leaves, napier grass, winter vegetables etc. on daily basis grass carp eats green stuff about 40-45% of its body mass.

Determination of feed amount to be given:

This depends on the gher's primary productivity, culture management, food status, nutritional value etc. smaller fish/prawn have higher food requirements than when they grow big. However, even if the rate of feeding for larger fish and prawns decrease, the total amount of food increases. In improved extensive culture method, an example of amount daily feed required is 10% of total body mass of fish and prawn together, which reduces by 2% every 15 days and when it comes down to 4%, should be completed at 4% of total body mass.



চিত্র- খাদ্য তৈরি

Preparation of supplementary feed

Fish feed can be prepared quite easily which the farmer can make by herself. If possible a food processor may be used. Below are steps in preparation of fish feed.

- Required amount of oilcake should soaked at least 20-24 hours and the oil layer the water on top should be thrown away
- Rice husk, wheat bran and fishmeal should be sieved well
- If rice bran is used then it should be boiled
- All the different materials should be taken in own bowl
- Wheat should be boiled in enough water to produce a gluey substance
- The gluey wheat should be used to mix the other materials into a dough and then made into small balls

Application of supplementary feed:

Fish are diurnal i.e. eat during the day while prawns are nocturnal – eat and move about during the night. Therefore to satisfy feeding requirements of both fish and prawns, the daily feed given for carp-Golda culture has to be divided in 3 equal portions, of which one portion is to be given at 6 in the

Good commercial feed are available in the market. User guideline can be collected from the feed dealers about how to give supplementary feed. It is best to follow the leaflets however the food conversion ratio of feed being sold should not be more than 1.5

morning and two portions at 6 in the evening. The portion given in the morning should be in a deep location of the gher in the morning and the evening feed should be applied in shallow part of the gher. The spots where feed is given should marked using sticks.

Providing green food:

Feed for grass carp or shorputi should be given in bamboo frame which might be round or square (feeding ring) and the green vegetation that they feed on should be given in this ring. The frame should be placed 1-2 feet from the ponds edge. The frame is usually 1m² or 10 feet² in a 30 decimal pond. If banana leaves are given, these should cut into small pieces. When the green feed finishes, it should be given again.

Prawns are characteristically nocturnal and prefer to feed at night. Prawn collect food and hold it with their walking legs from where they eat it slowly. Prawn feed is thus best given in pellet form which maintains its shape for at least an hour after sinking in water

Precautions in giving fish feed

- Feed should be given in the same place every day
- If the water is excessively green, supplemental feed should be lessened or temporarily stopped
- On cloudy day, feeding should be reduced or stopped
- Feed for prawns should be given at night.

Conservation of natural food and post-stocking fertilizer application

Fish and prawns consume various types of natural food from the water. The availability of the natural food is ensured by regular application of fertilizer. If there is not enough available food after juveniles/fingerlings are released in pond/gher then production will be poor thus the necessity for regular fertilizer application.

[insert (4) drawings of phytoplankton, rotifers, copepods, cladocera]

Fertilizer application is not only necessary for natural food production but also to maintain balance



and diversity of the aquatic environment. The natural food produced as a result of fertilizer application is appropriate food for fish and prawns to consume, which they can easily digest. Also the nutritional value and food conversion ratio of natural food is high ensuring high production of fish and prawns.

Natural food produced as a result of fertilizer application inhabits different layers of the water stratum and these are easily available for fish and prawns to consume. Availability of sufficient natural food in the gher prevents competition among fishes/prawns. Also fish species which are not interested in consuming supplementary feed can be ensured of sufficient natural food through fertilizer application.

Various nutrients and food substances such as carbohydrate, protein, fat, vitamin and mineral salts, amino acids and fatty acids are present in sufficient quantities in natural food. Therefore consumption of natural food helps in the quick growth of fish and prawns. Immunity is better and problems from malnutrition are little. For these reasons, the importance of fertilizer application is great in ensuring successful and profitable production with minimum investment.

Importance of post-stocking fertilizer application: In a culture gher, the suitable color of water is light green, reddish green, or brownish green. All these colors indicate presence of floating phytoplankton and zooplankton. The water color varies because of the concentration of the plankton and gher water has different colors at different times because of the varying concentration of plankton.

The presence of plankton or natural food can be primarily assessed by observing the gher water with naked eyes on a sunny day. If color is light green, reddish green or brownish green, then at least twice a week, a Secchi disc should be used to test status of natural feed in the water. The test should be carried out on a sunny day at 10-12 in the morning. If the white of the Secchi disc can be seen at 12 inches i.e. green part of the cord, then fertilizer needs to be given.



চিত্র- পুকুরের প্রাকৃতিক খাদ্য পরীক্ষা

Rate of fertilizer application

For phytoplankton production nitrogen and phosphorus are important elements which are easily obtained from organic and chemical fertilizers and so it is recommended to regularly apply manure, urea and TSP to the canal waters. Fertilizer should be ideally applied on a daily basis. But it is not possible to apply daily and therefore should be given at least weekly. Whatever the rate of application, the fertilizer amount may be more or less according need. The table below gives rate of fertilizer application per decimal:

Fertilizer name	Application rate per decimal
Compost	300-400 gm
Urea	4-5 gm
TSP	3 gm

Method of fertilizer application

Compost and TSP should be taken in a bucket with three times the amount of water and soaked for 12-14 hours. The TSP should be dissolved properly in the water. To this mixture urea should be added before applying to water body. Time of application is 10-11 in the morning on a sunny day.

Precautions of fertilizer application:

- If the color of water is excessively green, then fertilizer application should be temporarily stopped
- Should not be applied on cloudy day or if weather is overcast
- If urea is kept open then its effectiveness is reduced
- The effectiveness of fertilizer is reduced if it applied in turbid or acidic water
- When using mixed fertilizer, it has to be well mixed and dissolved in water



চিত্র- মজুদ পরবর্তী সার প্রয়োগ

Common problems in fish prawn culture and solutions to manage the problems

Optimum and profitable production depends on good management. Even after good management, technical problems are faced in fish and prawn culture that are potentially risky and can impede production. Below are some common technical problems farmers may encounter in fish and prawn culture.

1. Predatory and unwanted fish entering the gher:

Even after de-watering gher and applying poison, predatory and unwanted fish still remain or enter the gher. Also they can come in over-flowing rain waters such as shoal (*C. striata*), taki (*C. punctatus*), koi (*Anabus testudineus*), singh (*Heteropneustes fossilis*), magur (*Clarias batrachus*), tilapia etc. this reduces production of fish and prawns.

Remedy: Predatory and unwanted fish get in through birds, netting, rains and so precautions should be taken about these sources. Following management steps may be taken:

- Do not allow water to enter gher from outside
- Careful in use of nets
- Keep an eye on children
- If necessary, set up a 12-15 inch high wall made of mosquito net or fish net.

2. Thick green layer on water

Remedy: immediate steps should be to supply cool water using shallow water pump and at the same time reduce or stop application of fertilizer and supplementary feed. Silver carp fingerlings can be released to control the phytoplankton bloom by eating it.

3. Red layer on water

Excessive production of red algae gives rise to the red layer which prevents sunlight from entering the water body causing a shortage in food and oxygen

Remedy: Bundle of paddy straw or banana leaves tied with a rope can be used to remove the red layer on top of the water

4. Ammonia accumulation

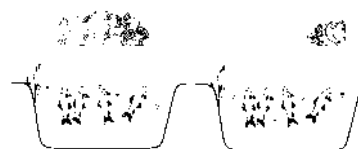
Ammonia is produced for various reasons in the bottom layer. High pH and ammonia together are very toxic. When phytoplankton increases, pH also increases very rapidly as a result of which there is high mortality of fish and prawns. Black marks on prawn's gills indicate increase in nitrogen waste and other chemicals in the water. When ammonia increases, the blood system is rapidly attacked.

Remedy: Stocking density should be reduced, and fertilizer and feed application stopped. If possible change 40-50 % of the water and stabilise pH. In primary stage 3.25 kg/decimal for every 12 inch depth, salt should be applied.

5. Gulping:

During August-September and April-May, the problem of fish/prawns gulping for air is common. Usually at dawn fish and prawn are seen to float near the water surface and gulp for air. This is because of shortage of dissolved oxygen in the water. If oxygen shortage is for a long period then fish become weak and die.

Remedy: Initially fertilizer and food application should be stopped and water aerated by beating a bamboo pole on water surface. Aeration can also be done by swimming in the gher water. In extreme cases, clean water should be supplied or water should be sprayed using shallow water pump. However if oxygen depletion is a long term problem, the large fish should be harvested and sold.



চিত্র- মাছ খাবি খাওয়া



চিত্র- গুই সাপ



উদ



সাপ



ব্যাঙ

6. Nuisance of predatory animals:

Snakes, frogs, crabs and otters are a nuisance since they eat fish and prawns and hamper production.

Remedy: Predatory animals are best controlled physically. As soon as they are spotted they should be killed. Otters can be controlled by placing lime-filled egg shells around gher perimeter. Bamboo spears can be used to kill crabs. Areas where frogs lay eggs i.e. around the edge of the gher and on the banks, need to be cleared of grass and vegetation. Wherever there is excess vegetation around ghers, predatory animals also are more.

7. Excessive feed application:

This is a common problem in southern Bangladesh. Almost all farmers give more feed than is necessary as a result of which the excess amount deposits at the bottom and pollutes the water. This causes fish and prawns to be easily attacked by disease and die.

Remedy: Before feed is given, it should properly determined and then applied. Mud in feeding location should be cleared time to time.

8. Turbidity:

Rains make gher water turbid preventing sunlight from entering the gher waters and limiting natural food production. Also fish gills get damaged in turbid water.

Remedy: To prevent entry of rain water coming in from over the gher/pond banks, the banks should be made higher. To address the turbidity, 1-2 kg of quick lime or gypsum should be applied to the water.

9. Black mud at bottom of gher

As a result of excess food and fertilizer application, there is accumulation at bottom of pond and these rot to become black putrid mud. This problem is more common after culturing for a long period. Toxic gases are emitted and this results in death of prawns. Also the prawn body color becomes black.

Remedy: Before releasing prawns, bottom mud should be removed. If prawn mortality is observed during culture, water should be changed swiftly, stocking density reduced, fertilizer and feed application stopped.

10. Cannibalism:

This is a major problem in prawn culture. Prawns are inherently cannibalistic animals and when there is shortage of food, they eat the smaller and weaker prawns.

Remedy: When stocking PL or juveniles they should be of same size and also fertilizer and feed should be applied regularly to ensure sufficient food for the prawns.

11. Fish and prawns floating near water surface after rains

Often after rains, fish and prawns are seen to float to the water surface and gulp for air. This is because water pH is low. When pH is low toxic reaction of hydrogen sulphide increases.

Remedy: Water pH should be measured after rains and after heavy rains, 75-80 gm/decimal of quicklime or dolomite should be applied.

12. Prawns leaving water during new moon/full moon

During new moon or full moon, prawns tend to leave waters and walk around the banks at which time they are risk of being eaten by fox and other nocturnal predatory animals.

Remedy: Additional precaution should be taken at time of new moon/full moon, however this might be necessary if the gher environment is clean.

Prawn disease and health management

In any animal, disease is its abnormal state and these are manifested by some symptoms. Like other animals, prawns are also prone to certain diseases. Due to lack of awareness of disease and health management of prawns, every year many farmers suffer huge losses in prawn mortality and the country also loses hundred thousands of taka in export income.

Reasons of diseases:

As a result of stress on water environment and presence of germs which affect the fish's immune system, diseases are triggered. There are various factors that contribute to fish diseases. The main reasons contributing to fish diseases that have been identified so far include:

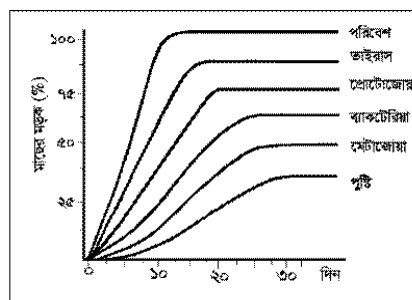
- Degradation of water's physical and chemical composition: temperature, waste matter, pH, dissolved oxygen, ammonia, hydrogen sulphide etc
- Application of excessive feed and fertilizer
- Pollution by gases and water from outside the pond
- High stocking density
- Insufficient nutrition
- Faulty handling and transport
- Infestation by parasites and germs

There is a close relation between the causes of prawn diseases and prawn mortality. It has been observed that when water is polluted, the rate at which fish die is comparatively less when compared causes such as germs, and insufficient nutrition

Common indicators of diseases in fish:

Depending on the type of disease, and disease-causing agent or parasitic infection, fish manifest various types of symptoms. The most common indications of a diseased prawn are:

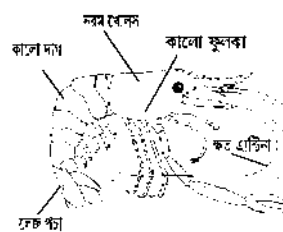
- Feeding is reduced or even stopped
- Moves lethargically
- Swims at surface of water in a haphazard manner
- Float near water edge and gulp for air
- Exoskeleton becomes soft
- Gills become black
- There is blue color/algae on body of prawn
- Walking legs and swimmerets degenerate, become bent or fall off



চিত্র- চিংড়ি মৃত্যুর সম্ভাব্য কারণ ও ফলাফল

Common diseases of Prawns:

The treatment of prawn diseases is a complex and costly matter because identification of disease and treating each prawn separately is not possible. Nevertheless if the prawn becomes ill, it becomes imperative to treat them. Following are some common diseases and their remedial management:



চিত্র- রোগের সাধারণ লক্ষণীয় অঞ্চল

1. Degeneration of antenna and swimmerets

Cause: Bacterial infestation

Symptom 3-4 months after stocking antenna and swimmerets degenerate and fall off

Remedy

- Temporarily stop feed application
- Change water
- Test pH and apply 250-300 gm/ decimal of dolomite

2. Shell becomes hard

Cause: Environmental: increase in pH. Salinity or temperature results in hardening of shell instead of metamorphosis

Symptom Shell harder than normal and prawn body is smaller than what it should be with respect to age

Remedy

- Improvement of water environment
- Quick change in water e.g. depth or fertilizer application

3. Stone formation in carapace and upper part of the body

Cause: Fluctuation in any of the water parameter, especially increase in salinity

Symptom In serrated parts and carapace of prawn tiny grayish stones form

Remedy

- Water change
- Supply of freshwater
- Increase in water depth

4. Exoskeleton becomes spongy

This is observed mid-way through culture period

Cause: Decrease of calcium in water

Increase in ammonia and temperature

Insufficient nutritious food

Water not changed for a long period

Symptoms Shell becomes soft

Legs become long and tail short

Body becomes swollen and spongy

Remedy

- Every 2-3 months apply 0.5 kg /decimal lime
- Increase amount of calcium in feed

5. Death after metamorphosis

Cause: Insufficient amounts of vitamin B complex, fatty acid, protein and minerals salts in food

Symptom Body becomes soft and bluish

If dead prawns are cooked, they become orange and if healthy prawns are cooked they become red

Remedy

- Add 50 milligram of vitamin B premix per kg of food (Embavit-G)

6. Algae deposition on body

Cause Not changing shell, and reducing movement

Symptom After harvest, green algae is seen on body

Remedy

- Increase supply of water and application of chemical fertilizer

Prevention of prawn diseases

Taking into consideration the socio economic status of poor and marginalized farmers in Bangladesh, it is difficult for them to take remedial measures when prawn become diseased since these are quite expensive and therefore they need to take preventive measures seriously. Disease prevention should be a part of the prawn culture management from the beginning. If the steps given below are taken, then treatment of diseases may not be required:

- Ensure sufficient sunlight in the gher environment
- Dewater the gher and apply lime periodically
- Do not over-stock pond
- Be careful to prevent entry of unwanted fauna and flora from outside
- Not to have excessive mud at bottom of pond
- Apply fertilizer and feed in prescribed amounts
- Not to frequently net fish from the pond and to prevent sedimentation

GROUP SESSION PLANNING

Day 02

Time – 11.45

Duration: 30 minutes

Target group : Golda-carp polyculture farmers
 Title of session : Sampling, harvesting, re-stocking and marketing
 Aim : To educate the Golda farmers on Sampling, harvesting, re-stocking and marketing so that they can carry out these activities successfully and obtain optimum production of fish and prawn and market these well.

Objective : At the end of this session, the participants -

- Will be able to carry out sampling of fish
- Will be skilled in harvesting marketable fish and re-stock gher.
- Will be able to successfully market fish and prawns

Discussion topic	Training approach	Duration
Introduction		5 minutes
<ol style="list-style-type: none"> 1. Welcome/reception: welcoming the participants and asking about participants welfare 2. Discussion about previous session 3. Linking previous session's topic to current session 4. Explanation of aim and objectives of current session 	Q&A and discussion	
Topic		45 minutes
<ul style="list-style-type: none"> • Sampling of fish • Harvesting and re-stocking • Marketing of prawns 	Lectures, Q&A Discussion Flipcharts	
Summary		10 minutes
<ol style="list-style-type: none"> 1. Summary discussion of main topic 2. Assessment of session objectives 3. Distribution of handouts 	Q&A	

Discussion and link up to the next session

Supporting Training Material flipchart, white board and marker and handout

Sampling, Harvesting and Marketing of Prawns

Sampling of fish and prawns

Usually sampling is the method used to assess the growth, weight and health of fish and prawns being cultured by netting fish from the pond time to time. One to two months after stocking fish, sampling of fish should be carried about and every month following this. To get correct results, 5-10% of the total prawn population should be sampled and if 5-10% cannot be sampled then at least 30-40 pieces of prawns sampled. The monitoring indicators and steps for sampling of prawns are given below:

Monitoring indicator	To do
1. Whether there is food in stomach	If there is no food, cause should be identified and if necessary feed should given
2. Whether there are white marks on shell	Test whether prawn has been attacked by virus and then take steps for harvest
3. Are gills black	If most of the prawns have gills that are black, then the gher water has to harrowed and 100 gm/ decimal lime applied
4. Is the tail swollen with water	If diseased prawns are high in number, then 1.5 kg/bigha doctor's potash should dissolved and sprinkled
5. Prawn is weak or alert	If most of the prawns are weak, cause should be identified and if necessary partial harvest carried out
6. Whether shell is soft or hard	If most of the prawns have soft shell, cause should be identified and 100gm/decimal lime applied to gher water
7. Is there a gap between flesh and shell	Feed nutrition and application should be properly assessed and then applied if required
8. Is growth according to age appropriate	Cause should be identified and if necessary feed should given

Note: Steps should be taken from sampling results according to the monitoring indicators and for this it is advised to communicate with local fisheries directorate

Harvest, post-harvest care, grading and marketing: The capture of fish for either consumption or sale is known as harvesting. For profitable prawn and fish culture, harvest using proper method is essential. Harvesting can be done in two ways: 1) partial harvest and 2) complete harvest.



Each gher has its own holding capacity and when this is fulfilled, the prawn/fish production slows down or stops even though fertilizer and feed continue to be supplied. This is not profitable for the farmer. If some large prawns/ fishes can be harvested before the pond's holding capacity is fulfilled then other prawns/fishes can continue to grow. This is partial harvesting is recommended. Also partial harvest reduces the risk of loss from theft and disasters and if these are sold timely, good market price can be availed. Whether prawns/fishes are partially or completely harvested, following points are taken into consideration:

- a) Prawn/fish size and weight
- b) Total prawn/fish population
- c) Market price
- d) Risks
- e) Availability of larger-sized fish fingerling for re-stocking

Size and weight: Inherently fish and prawns move in schools and not all grow equally. To get a better profit, it is advisable to harvest large prawns/fishes and let the smaller prawn/fish grow. Following are appropriate harvest weight of different fish species:

- Catla: more than 500 gm
- Ruhi: more than 250 gm
- Silver carp: more than 750 gm
- Bighead carp: more than 750 gm
- Shorputi: more than 100 gm
- Grass carp: more than 750 gm
- Golda : more than 80 gm

Biomass: This is the total weight of all fish prawn stocked in the gher. In extensive culture method, total biomass should not be more than 7.5 kg per decimal. If it is more, the balance in the environment may be disturbed and possible risk of disease arises. As soon as biomass is more than 7.5kg/decimal, the large fish and prawns should be harvested

Seasonal risks in fish and prawn culture: There are a number of seasonal risks in fish and prawn culture. If steps are not taken to manage the risks, then there is high possibility of loss in production, even total culture management might break down.

- 1. Risks in rainy season:** There is risk of flooding and breakage of banks, and therefore large fish and prawns should be harvested and sold
- 2. Risks in the dry season:** In the dry season water dries up and water depth in the gher reduces, and therefore the gher water heats up quickly resulting in oxygen depletion and shortage. There is thus the risk of all fish and prawns dying. Before this situation arises, marketable fish and prawn should be harvested.
- 3. Risks in winter:** In Bangladesh the Epizootic Ulcerative syndrome is prevalent. EUS is seen mostly during November –February. If biomass is high in the gher, the possibility of this disease is higher and therefore, large prawn and fish should be harvested to reduce biomass.

Theft: This is a common social problem especially when there are large prawns/fishes in the gher. This risk can be reduced by harvesting the fish as soon as they are big enough to be marketed or eaten.

Market price: Since fish culture is carried out also for economic benefit and therefore the market price is very relevant for the prawn and fish being harvested. This varies from place to place and also season to season. Fish and prawn should be harvested keeping in mind maximum profit.

Furthermore, there are other aspects that need to be taken into consideration in harvest of prawn. For example if at time of sampling, the claws of the large pair of walking legs become bluish or black, then this prawn will not grow any bigger. These prawns should be harvested. Normally male prawn is larger than the female prawn which is why farmers prefer to stock male prawns. In this case, at time of sampling or partial harvest, mature female prawns can be harvested and gher restocked with male prawns. When prawns are 30-40 gm, their sex can be differentiated.

Farmer's preparation and precautions for harvest:

- Appropriate transport along with buyer should be fixed before harvest
- Prawns should be caught in the early morning
- Keep supply of clean water to quickly clean the harvested prawns
- Not to catch prawns during and two days after new/full moon since during this time prawns metamorphose
- To take care not to injure prawns at time of harvest
- Make shade near gher so that prawns can be caught and immediately kept in shade
- Prawns should not be kept on earth, bamboo, bamboo basket/mat, hogla mat, sack etc and instead on plastic sheets.

Method of fish harvest: This depends on the size of the pond and number of fish to be harvested. There are various methods of harvesting fish:

1. Ber jal / seine net
2. Jhaki jal/cast net
3. Dewatering

1. Seine net method: When the gher is large and number of prawn/fish to be caught is high then seine net or ber jal is used. The net spacing should be 1:1.5 inches. The net length should be twice as deep as the gher and 1.5 times wider than the gher. In one gher, the netting should not be done more than twice so as to minimize the stress on the smaller fish and prawns. After drawing the net, large fish/prawns should be collected and smaller fish/prawns quickly released back into the water.

2. Cast net method: This method is used to catch smaller numbers of fish and prawn. 20- 25 minutes before catching the fish and prawns, feed should be distributed at the feeding locations to make it easy to catch the fish/prawns

3. De-watering: This best way to collect prawns i.e. by dewatering the whole pond and harvesting all the prawns and fishes

Time of harvest: Fishes and prawns should be caught in cool and clear weather especially in the early morning as well as taking into consideration of local market time

Grading of Golda prawn:

With head		Without head	
grade	Pieces per kg	grade	Pieces per kg
5	Up to 5	5	Up to 5
10	6-10	8	6-8
20	11-20	12	9-12
30	21-30	20	13-20
50	31-500	30	21-30

Marketing of fish and prawn:

Main consideration in marketing of fish and prawn is to maintain flawless quality. This includes carrying out specific careful activities from harvest to sale i.e. keeping the harvest in ice, clean and sanitary collection trays, and then transport.

Process of marketing prawns:

Prawns should be sorted according to size and quality and arranged in rows in ice-filled trays. Prawns should be kept in shade in the time between harvest and marketing. In the box or tray used to transport the prawns, the bottom should be lined with ice on top of which the prawns should be arranged and thus layered alternately and then finally packed with covering of wet sack or hogla mats. When harvesting prawns, the small ones should be released and the packing box of ice and prawns should not be more than 2 feet high because pressure of upper layers may bruise the body of the lower layers of prawns. In Bangladesh to date, no ideal method of transport has been developed and between the farmers and buyers there are middlemen involved in the transport of prawns. These middlemen who have little or no technical knowledge of how to transport prawns properly end up causing damage to the prawns affecting its quality. Therefore the middlemen involved in transport should be given proper technical training regarding transport of prawns and at the same time ice-factories and landing centre should be set up in prawn-producing areas.

Steps to keep prawns fresh after harvest:

- After harvest prawns should not be kept in the sun – should be kept indoors or under a shade
- The prawns should be kept on smooth clean surface such as plastic sheets so that there is no bruising and no external matter (egg dirt, grass etc)sticks to it
- Prawns should be cleaned in cool and clean water
- Clean prawns should be dipped in ice water tanks so that the body becomes as cool as ice

Considerations for transport of prawns:

- Whole prawns cooled in ice water should be packed with crushed ice in a plastic box and insulated truck or van
- Prawns should not be transported open during the day under the sun in open boat, rickshaw van, rickshaw or cycle
- The packing box of prawns should always be kept in shade
- To pack prawns proportionately with ice according to the distance of transport. Usually ratio of ice to prawn is 1:1. Also need to consider the day temperature
- Need to take care that prawns are not subject to any heat.
- Prawns should be transported to prawn processing factory as soon as possible.
- After transport, the transport van and prawn box should be washed out with soap, detergent and bactericide and dried well

Re-stocking: To get high productivity from ghers, the cycle of prawn/fish culture management should be continued throughout the year. To continue the production cycle, every time fish/prawn are harvested, for each species the same amount plus 10-15% of this amount should be the number of prawn/fish seed for re-stocking. If large prawn/fish are stocked then 10% might die which is why the additional number of prawn/fish seed are considered during re-stocking. For example if a 100 prawn/fish are harvested, then 110-115 juveniles/fingerlings should be released. To ensure restocking, availability of juveniles/fingerlings should be ensured before harvesting.

Temporary preservation of gher/farmer:

- A. Physical infrastructure
 1. Arrangement of clean water supply for washing after harvest
 2. Shelter/shade for harvested prawns which should be such that flies, insects, birds, cats etc cannot enter
 3. Clean, smooth plastic sheet on even ground to keep the harvested prawns
 4. Arrangements for supply and preservation of clean and hygienic ice
 5. Arrangement to keep ice-cold water in a plastic tank
 6. Plastic microbe-free plastic box to transport prawns
 7. Arrangement for hygienic handling of prawns
 8. Arrangements for cleaning of plastic basket, box and other items with detergent and bactericide (bleaching powder).

B. Activities to carry out after harvest

- After harvest, prawns should not be kept in sun, should be kept under shade
- After harvest prawns should be kept on clean, hygienic, microbe-free plastic sheets in the shade
- Prawns should be washed in clean cool water
- Prawns should be preserved in crushed ice made from clean water and arranged in alternate layers of crushed ice and prawns in plastic box.
- Prawns should not be de-headed on the farm – this is not allowed by HACCP rules
- Prawns should be transported as soon as possible to the prawn depot/storage/service center
- Whole prawns packed in crushed ice in a plastic box should be transported in an insulated van
- To pack prawns proportionately with ice according to the distance of transport. Usually ratio of ice to prawn is 1:1. Also need to consider the day temperature
- Need to take care that prawns are not subject to any pressure and therefore should be packed in a well-designed plastic box so that even if arranged in layers, lower layer prawns are not bruised because of pressure
- Prawns should not be transported in bamboo basket/mat, hogla mat, sack, banana leaves
- Prawns should be transported to its destination as soon as possible

After transport, the transport van and prawn box should be washed out with soap and detergent and bactericide and dried well

Note: Receiving headless prawns, removing head in depot, injecting water, sago, barley, wheat, cement to increase weight to insert bits of iron, glass, coconut pieces so that soft prawns look hard are all grievous and punishable offences . because of these illegal actions, Bangladeshi prawn export is under threat to close down and therefore these should be avoided

GROUP SESSION PLANNING

Day 02

Time – 12.15

Duration: 60 minutes

Target group : Golda-carp polyculture farmers
 Title of session : Vegetable cultivation on gher banks
 Aim : To give an overall understanding about importance of vegetable cultivation, main aspects of cultivating vegetables on gher dykes/banks so that they can cultivate vegetables on their gher dykes and meet requirements of family nutrition and also economically benefit.

Objective : At the end of this session, the participants -

- Will be state the importance of vegetable cultivation
- Will be to discuss selection criteria of vegetables that can be cultivated on gher banks
- Will know about the main aspects of vegetables cultivation
- Will know about diseases of vegetables, the prevention and remedies

Discussion topic	Training approach	Duration
Introduction		4 minutes
<ol style="list-style-type: none"> 1. Welcome/reception: welcoming the participants and asking about participants welfare 2. Discussion about previous session 3. Linking previous session's topic to current session 4. Explanation of aim and objectives of current session 	Q&A and discussion	
Topic		50 minutes
<ul style="list-style-type: none"> • Importance, advantages and justification of vegetable cultivation on gher banks • Selection of vegetables based on specific criteria for cultivation on gher banks • Main aspects of vegetable cultivation on gher banks • Management practices of vegetable cultivation on gher banks 	Lectures, Q&A Discussion Flipcharts	
Summary		6 minutes
<ol style="list-style-type: none"> 1. Summary discussion of main topic 2. Assessment of session objectives 3. Distribution of handouts 	Q&A	

Discussion and link up to the next session

Supporting Training Material flipchart, white board and marker and handout

Importance of Vegetable Cultivation on Gher Banks

According to nutritionists, an adult on average requires 200-250 gm but based on the amount of vegetables produced in Bangladesh, on average an adult person gets only 80-100 gm of vegetables in his daily diet. As a result of not eating enough vegetables, many people suffer from malnutrition. The lack of many nutrients in the daily diet results in diseases such as night blindness, anemia, sores in the mouth, scurvy, beriberi, thyroiditis etc. To solve this, vegetable production needs to increase and change people's behavior to want to consume more vegetables. Notable is that in South Korea, per head vegetable consumption is 549 gm and in Japan this is 348 gm. Vegetables are filled with



vitamins and minerals. Almost all leafy greens have carotene which converts into vitamin A after being consumed. Colored vegetables such as carrots, pumpkin are carotene-rich. Many vegetable have minerals such as calcium, iron, zinc, phosphorus etc. broad beans, long beans, pearl gourd, bitter gourd, drumsticks, teasle gourd are sources of protein that are good for health. In Bangladesh, due to lack of vitamin A, about 500,000 children are afflicted by night blindness every year. For the same reason, a hundred children on average every day and 30,000 children annually become blind. Dark green leafy

vegetables and colored vegetables are full of carotene and these are there important as preventive medicine for night blindness. To save children from being afflicted by night blindness, they should be fed daily dark green and colored vegetables. Vegetables also have anti-cancer elements. Daily consumption of green vegetables can prevent skin diseases, scurvy, mouth sores, rickets and anemia. Vegetables are so important for people that doctors advice to consume vegetables as medicine for many diseases like diabetes, heart conditions, skin diseases etc. Fiber in vegetables helps ease constipation. Vegetable consumption does not have any side effects and according to nutritionists vegetarians have long life spans. Therefore intensive vegetable cultivation on pond banks can help meet family requirements for nutrition and prevent malnutrition.

Vegetable cultivation on pond/gher banks is part of integrated cultivation which ensures maximum utilization of land and at the same time help maintains environmental balance as well as be economically profitable since multiple crops are produced from a single piece of land. For example, paddy-fish/prawn and poultry, paddy-fish and vegetables, fish and livestock etc. Integrated agricultural management may be new to Bangladesh but in many countries it has been historically practiced for many years. It is important to make integrated agricultural management popular in rural Bangladesh.

Vegetable cultivation on pond/gher banks

Simply stated, vegetable cultivation on pond/gher banks depends on the type of pond/gher bank, market demand and production season according to which management and planning of various vegetables can be determined.

Importance of vegetable cultivation with fish culture

Vegetable cultivation with fish culture is an improved agricultural practice. This ensures maximum use of small cultivable plots. By cultivating vegetables on pond/gher banks:

- Household requirements for vegetables can be met and malnutrition prevented
- Extra income can be earned
- Vegetables and fish can be cared and monitored at the same time
- Change in diet can be effected with increased vegetable cultivation
- Saves environment from degradation
- Multiple use of resources can be ensured
- More vegetables are available in the market
- Various crops are obtained at low cost and short period

The taste of fresh vegetables is extremely good. Fresh vegetables have high nutritional value and get high price. To eat insecticide/pesticide free vegetables, grow these on pond bank and earn extra income and ensure nutritional requirements are met.

Criteria for selection of vegetables to cultivate on pond banks

Status of pond bank, presence of sunlight, market price, soil type and quality, farmer's financial ability, availability of seed, consumer's demand, and damage to pond bank needs to be considered in selection of vegetable. Also vegetables of the same family should not be multi-cropped since this will create competition as well as being attacked by the same pests and diseases. The main criteria in selection of vegetables are

- Type of bank
- Sunlight
- Soil quality
- Market price
- Farmer's economic ability
- cultivation of vegetables from the same flora family

Further aspects that should be considered in vegetable cultivation on gher banks:

- source of seed
- time of planting seedlings
- special arrangements for seedling production
- crop growth
- maintaining appropriate spacing between plants
- additional fertilizer application
- care during culture (very important)
- soil status
- use of plant-based insecticides instead of chemical insecticides
- highly productive, disease-resistant, short-term species and
- optimum utilization of banks and slope

Preparation of pond/gher banks

Base on the type of bank, vegetables should be selected. Not just any vegetable can be cultivated on pond/gher banks. The bank has to be prepared suitably for vegetable cultivation. Based on land type, the different types of banks are:

- High banks
- Medium high bank
- Low bank
- Medium low bank
- Broad/wide bank
- Narrow bank, etc

The preparation to make pond/gher banks suitable for vegetable culture include following steps:

- To cultivate creepers on low banks, mud from bottom of gher and placed on the bank at an elevation on which pit is made to plant the creeper vegetable.
- To use narrow banks for vegetable cultivation, it has to be made broad (17-18 inches) and use required amount of earth to make the bank higher
- If the pond bank is suitable for vegetable cultivation then the bank should be ploughed to loosen the soil and remove weeds.
- If bank is to be utilized to plant various layers of vegetables, then the slope should be ploughed well with a hoe to remove weeds and loosen the soil
- If the pond bank is a path for people to cross then additional earth has to be piled on land adjacent to the bank
- Without changing gher/pond bank, vegetables can be planted in pits spaced appropriately on the bank
- When preparing land for vegetable cultivation, the banks have to be prepared at the same time using required amount of organic and inorganic fertilizer. depending on the bank preparation, one or two lines of crops can be planted.

Preparation of pit on banks

One or more pits can be prepared in which broad beans or pumpkin-type crops can be planted such as bitter gourd, ash gourd, bottle gourd. A trellis can be made or a bamboo pole simply erected next to the pit.

Size of pit:

Bottle gourd, pumpkin: 1 hand x 1 hand x 1 hand

Ridge gourd, snake gourd, cucumber, bitter gourd, teasle gourd: 15 inches x 15 inches x 15 inches

Broad beans: 1.5 foot x 1.5 foot x 1.5 foot

Pit to pit spacing:

Bottle gourd, pumpkin: 4.5 hands

Ridge gourd, snake gourd, cucumber, bitter gourd, teasle gourd: 3.5 hands

Broad beans: 5 feet

Amount of fertilizer for pits on banks

Fertilizer	Amount per pit				
	7-10 days before planting seedling	10-15 days after planting seedling	30-35 days after planting seedling	50-55 days after planting seedling	70-75 days after planting seedling
Organic	10 kg	-	-	-	-
TSP	100 gm	-	-	-	-
Urea	-	25 gm	25 gm	25 gm	25 gm
MOP	40 gm	20 gm			
Gypsum	15 gm	-	-	-	-
Zinc	10 gm	-	-	-	-
Borax	10 gm	-	-	-	-

Vegetable production model on pond/gher banks and slope

Suitable location	Rabi	Kharif
Bank and slope	Broad beans, German turnip, tomato	Bitter gourd, cucumber, ash gourd, lady's fingers, bottle gourd, pumpkin

** in addition to the mentioned vegetables, other vegetables can be selected according suitability for cultivation on banks*

Management practices of vegetable cultivation on gher banks

The modern management practice in vegetable cultivation starts from planting the seeds/seedlings to harvest of the crops.

The steps in crop management are:

1. Mulching
2. Arranging shade
3. Irrigation
4. Weeding
5. Loosening the soil
6. Thinning the number of seedlings
7. Application of additional fertilizers
8. Filling up the empty spaces
9. Placing earth around base of plant
10. Placing sticks for support
11. Building pit
12. Trimming and thinning number of fruits
13. Fertilization
14. Pest management
15. Disease management

The steps above are discussed in short below:

Mulching: Covering the crop bed or base of a plant with rotting hyacinth, dry grass and other vegetation is known as mulching. Amount of mulch is about 1-2 inches. Mulching helps the soil to improve its water-retention, can absorb water better and enable aeration of the soil, reduces soil erosion, produces organic fertilizer, increases budding of the plant and its ability to absorb nutrients from the soil also improves. Sometime ants and termites make nests in mulch so this needs to be turned over time to time.

Shade for plants: Just after planting seedling, sunlight or rain might kill the seedling and therefore it needs some protection in form of shade which can be made from banana leaf twisted into a cone.

Irrigation: Water is extremely important for vegetable cultivation and so just after planting seedling or seeds, water has to be given daily. The soil needs to be kept moist, not water logged and so the water can be given using a small bucket. After giving additional fertilizer, watering is a must. In most cases plants are irrigated 5-7 times.

Weed control: Weeds are plants biggest enemies. To get good production from vegetable cultivation, the crop beds should always be weed free. From time of planting for about 40-50 days, the crop beds should be weeded regularly. Good time to weed is in the early morning and then the weeds dry up.

Loosening the soil: The earth around vegetable crops should be kept loose and soft. After rains or watering, the soil usually clumps and becomes hard, this should be loosened using tools such as hoes, sickle etc

Thinning seedlings: It is not always possible to maintain prescribed spacing between plants especially when they grow from seeds. 8-10 after seeds have been planted, the seedlings that grown need to be sorted to keep the healthy ones and throw away the weak ones and also ensure there is enough spacing between the plants.

Application of additional fertilizer: The recommended application of fertilizer during vegetable cultivation should be given and after application of fertilizer, the soil should be irrigated.

Pit/frame/pole for support: For vine-like plants, support is required for the plants to grow quickly and various types of frames or sticks can be fixed beside the plant. These can be made from bamboo slats, jute straw, etc.

[insert photograph]

Pruning: Fruiting plants sometimes do not give enough fruit. To ensure that sufficient fruit is produced, excessive branches should be pruned. Also branches and parts of plant that have been attacked by pests or disease should be cut to avoid spread.

If the upper parts of ridge gourd and sponge gourd are pruned then more branching and more fruit can be produced. Excessive branches of tomatoes should be pruned so that the tomatoes produced are big. Old plants of lady's fingers and eggplant should be pruned so that another crop can be grown again.



Cross-fertilization: It has been observed that on pumpkin plants, shortly after the female flower blooms it dies. When there are no bees or other insects to help with the fertilization, the female flower withers away. The cross fertilization therefore has to be carried out artificially. In the evening or morning, a freshly bloomed male flower should be taken and petals removed keeping the stamens

intact which should then be touched with the female flower 2-3 times to ensure that fertilization will be successful. One male flower can be used to fertilize 8-10 female flowers.

[insert photograph]



Pest and disease management:

Diseases and pest are serious enemies of plants. If plants are not kept disease and pest-free then productivity will be poor. To manage this, instead of using chemical pesticides it is better to prevent using physical control e.g. proper cultivation methods used, keeping the land clean, mechanical control e.g. pruning off parts of plant that are diseased, biological control e.g. using beneficial insects to control pests.

Various methods of vegetable cultivation in rural households

Name of vegetable	variety	Planting time for seed and seedling	Seed/seedling gaps (ft/inch)	Seed rate per decimal or 40 sq meters	Crop growth duration/period (days)	Produce kg/decimal
1. Bottle gourd	BARI 1 – winter BARI – 2 – winter and summer High quality variety	August– October and March - April	Row to row: 10 ft Pit size: 21x21x18 inches	20-25 gm	140-185	140
2. Pumpkin	High quality variety	all-year round in all seasons but best July October	Pit to pit: 10 ft Pit size: 16x16x16	5 gm	100-120	150-170
3. Wax gourd	BARI wax gourd-1, High quality variety	February- May	Row to row: 8 foot Pit to pit 8 ft	15-20 gm	120-130	80-100
4. Cucumber	High quality hybrid variety	Mid February – Mid April and July-August	Row to row: 5 ft Pit to pit 5 ft Pit size: 17.5x17.5x17.5 inches	20 gm	75-125 days	100-120
5. Bitter gourd	BARI corolla 1	February – May	Row to row: 3.2 ft Plant to plant: 3.2 ft Pit size: 17.5x17.5x17.5 inches	25 gm 4-5 seeds / pit	After sowing seeds 110-120 days	20-25
6. Broad beans	BARI broad beans – 1, BARI broad beans-2, 12 monthly IPSA-1 Purple IPSA -2, High quality variety	Middle of January	Row to row: 6.5ft Plant to plant: 6.5 ft	40-50 gm	Advance: 130-150 days and nabi 150-200 days	85
7. Tomato	Local and Hybrid quality variety	September- October	Row to row: 2 ft Plant to plant: 15 inches	1.5 gm/90-100 seedlings	After planting seedlings 70-90 days, After sowing seeds 100-120 days	70-100
8. Lady's fingers	BARI -1 and Hybrid quality variety	All year round but best during February-May	Row to row: 2ft Plant to plant: 1.6 ft	25-30 gm	80-100	80-120
9. German turnip	Hybrid quality variety	August–September to October- November	Row to row: 1 ft Plant to plant: 9 inches	3.3 gm	40-60 days	100-120

Major diseases and pests of vegetables and integrated pest management

Common pests of vegetables cultivated on gher banks and their control management

Name of vegetable	Name of pest	Symptoms	Control management
1. Broad beans, bottle gourd, cabbage, pumpkin, cucumber	Jab Poka	Feeds on flower and fruit juice. Fruit and flower fall to the ground	Organic pesticides such as neem oil and tobacco. - Make a paste of 20 ml neem oil + 60 gm soap powder and dissolve this with 10 liters of water. This mixture should be sprayed using a spray machine. - Tobacco powder should be soaked in water overnight and then sieved the water should be used to spray the affected plants - Dissolve 10 ml of Malathion-57 EC or Admire-200 in every 10 liters of water and spray
2. Broad beans, tomato	Fruit-boring insect	insect nymph bore the fruit and centre is eaten causing the fruit to fall off tree	By pruning affected fruits and burying them in soil helps control the disease somewhat. And when the attack is severe, 10 ml of lebacid50 EC or sevin-85 should dissolved in 10 liters of water and sprayed
3. Bottle gourd, pumpkin, wax gourd, and other gourds	Fruit fly	Fruit rot while still in green/unripe and fall off tree	Poison trap: 100 gm of pumpkin diced or mashed and mixed with 0.25 gm mypsin or sevin 85 + 100 ml water should all be mixed together and placed in a clay pot. The clay pot should be placed 1.5 feet above the ground near the affected plants and renewed 34 days later. Sex pheromone: either poison traps or sex pheromones should be placed among crops at 13 yard gaps to help pest control
4. Bottle gourd. Pumpkin, cucumber, bitter gourd, ridge gourd, teasle gourd	Red pumpkin beetle	Bores thru matured or old roots from beneath the ground through to the stem. Plant thus bends over, dries up and dies	Up until the seedlings are 20-25 days old, they should be protected by mosquito netting. The rate of attack is high then after planting the seedlings, the earth around the pit should be mixed with 25 gm of carbofuran and watered to ensure the chemical is well-mixed

Common diseases of vegetables cultivated on gher banks and their control management

Name of vegetable	Name of disease	Symptoms	Control management
1. Broad beans, tomato, papaya	Virus	Papaya leaves take on a green-yellow mosaic look. Broad beans and tomato leaves stop growing and curl up	White fly is a virus carrier and so that this fly does not come near crops every 7-10 days from the time seedlings are planted use organic pesticides. Remove infested plant far from the crops. Also every 15 days 1 ml of dimecron mixed per liter water should be sprayed. Neem oil can also be used.
2. Lady's fingers, pumpkin, ridge gourd	Root and stem rot	Lower stem of seedling rots and seeding dies	Irrigation should be reduced. 10 gm of Diethon M-50/Rovral-50 WP/ Entral-70 WP should be dissolved with 10 liters of waters and sprayed every 7-10 days 2-3 times around the lower part of the stem.
3. Chili, broad beans	Anthrnose	Whichever part of the plant is attacks, the part bursts and fruits fall off	Diseased and dead plants should cleared from the crop cultivation area. 20 gm of Diethon M-45/redomil gold/ mencozeb group of fungicide Entral 70 WP should be dissolved with 10 liters of waters and sprayed every 7-10 days 2-3 times on the diseased plants
4. Broad beans, string beans and Malabar spinach	Leaf spot disease	Leaves have round and watery-looking marks, which come together and make big round marks	20 gm of Diethon M-45/redomil gold/ mencozeb group of fungicide Entral 70 WP should be dissolved with 10 liters of waters and sprayed every 7-10 days 2-3 times on the diseased plants

Production, processing, and preservation of vegetable seeds

Production and preservation of quality seeds are the first condition of good production. However good the crop variety might be, unless the seeds used are not fresh and strong, production will not be as good as expected and therefore good quality seeds are essential in vegetable cultivation. The different activities associated with seed production are discussed below:

1. **Selection of vegetable and vegetable variety:** Locally available vegetables and their variety should be selected.
2. **Collection of foundation seed:** Foundation seed should be collected from a reliable source. If any other type of seed is used apart from foundation seed, the seed quality cannot be maintained.
3. **Selection of land:** Land selection for vegetable cultivation should consider following cultivation:
 - i. Sufficient light and air
 - ii. Loamy soils rich with organic matter
 - iii. Good irrigation and drainage
4. **Determination of cultivation season:** Season for cultivating seed should be determined so that favorable weather prevails.
5. **Preparation of land:** Land should be ploughed well and all weeds removed. The soil should be loose and aerated with which the recommended basal dose of fertilizer should be applied.
6. **Fertilizer application:** For good seed structure, nutrition and fruit production, various types of nutrients are required and therefore additional fertilizer application is necessary and for seed production phosphorus and nitrogen are especially important
7. **Cultivation method:** Seed crops should be spaced properly and cultivated in lines.
8. **Control of weeds:** Weeds compete with cultivated plants for nutrients, air and light, and is also habitat for pests and diseases. Weeds therefore should be controlled timely. When there are weeds, cross fertilization compromises seed quality.
9. **Irrigation –drainage arrangements:** Proper irrigation and drainage for seed production is very important. If the soil does not have enough water, then this hampers normal growth and nutrition of the plant. The stamens of the flower dry up, seeds also become dry maturing at an early stage resulting in low production. If there is water logging in the soil, plant's respiration is hampered, plants die, seed endosperm decays (known as chita in Bengali) and are attacked by viral and bacterial diseases and therefore timely drainage should also be carried out.
10. **Attack by disease and pests:** Attack by disease and pests results in transmittable diseases of seeds. Therefore preventive and remedial measures should be taken.
11. **Rogging :** The removal of weak vegetable crops growing in the same land as the seed crop is known as rogging. The weak plants spoil the purity of the seed crops and these have to be removed before time of fertilization
12. **Isolation spacing:** To maintain purity of the seed variety, the plants should be spaced so that they are in isolation of each other and minimize the risk of fertilization, as well as attack by pests and diseases affecting other plants. Isolation spacing can be done either by physical distance or time of planting. When physically isolating a plant, need to consider whether these are cross-fertilized or self-fertilized. If the plant reproduces through cross fertilization then physically isolating seed crops is necessary.
13. **Pruning:** Plants sometimes grow unnecessary branch. To ensure that sufficient and quality seed is produced, excessive branches should be pruned. Also branches and parts of plant that have been attacked by pests or disease should be cut to avoid further spread. 3-4 main branches of vegetables such as cucumber, pumpkin, bottle gourd should be kept and others pruned to ensure good fruit and seed production

14. Thinning fruits: Fruits borne at the base and tip of plant are usually weak, prone to disease and attack and so if these are removed the fruits borne in the middle grow and flourish well

15. Seed crop cutting and collection: To ensure seed quality, properly ripe and matured fruits/vegetables should be cut and collected. Unripe or immature fruits/vegetables do not produce good quality seed. Fruits or vegetables of a plant do not mature at the same time. Care should be taken to collect properly mature and ripe fruits/vegetables

Seed processing and preservation

Seed processing means sorting the good seeds from external matter (such as sand, dried grass etc) and poor quality seeds, ensuring correct moisture, and the preserving the seeds for future use.

First the seeds should be aired lightly and shaken using a kula (U-shaped tray) to remove excess dust, soil particles and dry extraneous matter. It should then be sorted by hand to select the good quality seeds from the smaller weaker/marked seeds and other extraneous matter. The sorted seeds should then be dried in sunlight. the moisture should be dried to about 6-8%. If moisture remains then quality of seed spoils and is prone to attack by disease and pests.

The seed should not be dried under direct sun. the seeds should laid on a mat or polythene and laid flat on even floor/ground. The seeds should be stirred time to time to ensure they are dried equally. Test to see whether the seed has dried properly is to bite one with teeth and listen for a crackling sound. After drying the seeds should be cooled, and then preserved in airtight drum, tin container or glass jars that have been cleaned and dried. some neem/bishkatali leaves can be added to ward off pests. If the preserved seeds are aired and sunned time to time, they can be used in the next planting season.

GROUP SESSION PLANNING

Day 02

Time – 13.15

Duration: 45 minutes

- Target group : Golda-carp polyculture farmers
- Title of session : Cost-benefit analysis of prawn-carp polyculture and vegetable cultivation on gher banks and data preservation
- Aim : Participants will know about cost benefit analysis of prawn-carp poly culture and will be able to carry out record keeping and data preservation
- Objective : At the end of this session, the participants -
- Will be able to calculate cost benefit analysis of carp-prawn polyculture
 - Will be able to fill record book

Discussion topic	Training approach	Duration
Introduction		2 minutes
<ol style="list-style-type: none"> 1. Welcome/reception: welcoming the participants and asking about participants welfare 2. Discussion about previous session 3. Linking previous session's topic to current session 4. Explanation of aim and objectives of current session 	Q&A and discussion	
Topic		40 minutes
<ul style="list-style-type: none"> • Cost benefit analysis of prawn-carp polyculture • Record keeping and monitoring 	Lectures, Q&A Discussion Flipcharts	
Summary		3 minutes
<ol style="list-style-type: none"> 1. Summary discussion of main topic 2. Assessment of session objectives 3. Distribution of handouts 	Q&A	

Discussion and link up to the next session

Supporting Training Material flipchart, white board and marker and handout

Annual cost benefit analysis of Golda-Carp polyculture in a one acre water body

Prawn culture is a highly profitable venture. Compared to other agricultural-based interventions, prawn culture can bring profits in a short time and over the long term require low investment. Financial risks are also comparatively low, however the profit-loss calculation depends on a number of factors:

- Farmer's experience
- Management approach
- Price of materials
- Harvest method and time
- Weather and environmental status
- Culture method
- Availability of materials
- Culture period
- Opportunities for marketing

Materials for prawn culture are primarily: lime, poison, fertilizer, feed, prawn seed, labor, pond preparation where cost is involved. According time and location, the price of these materials may vary and therefore the cost-benefit analysis might also change. Below is given cost benefit analysis of Golda prawn-carp polyculture in a one-acre water body.

Estimated cost

#	Description	Amount (number/kg)	Unit cost (taka)	Total cost (tk)	
1	Lease price	8 months	200	15,000	
2	Bank preparation (including nursery bank and cleaning mud from bottom)	-	-	10,000	
3	Water exchange	-	-	2000	
4	Poison application (rotenone)	3	200	600	
5		150	20	3000	
6	Fertilizer application	Urea	70	22	1540
		TSP	42	25	1050
7	juveniles	4000	6	24000	
8	Carp seed/fingerlings	1000	5	5000	
9	Supplementary feed	700	45	31500	
10	Harvesting and marketing			2000	
11	Miscellaneous			2000	
	Total			97,690	

Estimated income

#	Description	Amount (number/kg)	Unit cost (taka)	Total cost (tk)
1	Prawns	300	600	180,000
2	Fish	400	100	40,000
	Total			

Annual profit: Income – cost: 220,000- 97,690 = 122,310 taka

Because of the fluctuating price of materials in the local markets, the cost benefit analysis also varies

Cost benefit analysis of vegetable cultivation on gher banks

Calculation of vegetable cultivation

We already know that crops are selected based on the type of bank and that different crops have different cost-benefit calculations. Some crops such as red spinach or water spinach have very low investment cost while crops such as tomato and bitter gourd require a lot more investment. Below is given an estimate of cost-benefit analysis of different crops:

1. Cost benefit analysis (per decimal) of Bottle gourd/pumpkin/ash gourd/bitter gourd/cucumber cultivation

#	Cost item	Amount	Price Taka	comments
	Plastic thread (for trellis) /Bamboo	1 kg and 1 piece	250	
	Land preparation	0.5 persons	100	With 0.5 workers, family labor is also included
	Seed/seedling	5-20 gms	60-130	
	Fertilizer	Urea: 2 kg; TSP: 1.8 kg; MOP : 1kg; borax : 50 gms	100	
	Pest control and other management		100	Poison trap/sex pheromone, and other pest control
	Irrigation	3 times	60	
	Total cost		670-740	
	Income sources			
1	Fruit	100-170 kg	2000-2550	15-20 taka/kg
2	Leave and stems	30 kg	300	In case of bottle gourd
	Total		2000-2850	
	Total profits			

**cost of land, organic fertilizer, and family labor have not been considered.*

2. Cost benefit analysis (per decimal) of Broad beans cultivation

#	Cost item	Amount	Price Taka	comments
	Bamboo for creeping	2 pieces	200	
	Seed/seedling	50 gms	50	
	Land preparation	0.5 persons	100	With 0.5 workers, family labor is also included
	Fertilizer	Urea: 350 gm; TSP: 100 gm; MOP : 300 gms borax : 40 gms	30	
	Pest control and other management		50	If required
	Irrigation	3 times	60	
	Miscellaneous		10	
	Total cost		500	
	Income sources			
1	Fruit	90 kg	1530 -1800	17-20 taka/kg
	Total		1030-1300	
	Total profits			

**cost of land, organic fertilizer, and family labor have not been considered.*

3. Cost benefit analysis (per decimal) of German turnip cultivation

#	Cost item	Amount	Price Taka	comments
	Land preparation	0.5 persons	100	
	Seed/seedling	250 seedling	150	1000 taka/kg
	Fertilizer	Urea: 0.8-1 kg; TSP: 400 gm; Gypsums: 0.75 gm; zinc: 20 gm;	55	
	Pest control and other management		35	If required
	Irrigation	3 times	60	
	Total cost		400	
	Income sources			
1	Fruit	150 kg	1500 -1800	10-12 taka/kg
	Total		1100-1400	
	Total profit			

**cost of land, organic fertilizer, and family labor have not been considered.*

4. Cost benefit analysis (per decimal) of lady's finger cultivation

#	Cost item	Amount	Price Taka	comments
	Land preparation	0.5 persons	100	
	Seed/seedling	25 gms	40	
	Fertilizer	Urea: 600 gm; TSP: 400 gm; MOP :6300 gms; gypsum: 280 gm; boron: 80 gm; zinc :240 gms	60	Manure/compost from own land – cost has not been included
	Pest control and other management		40	If required
	Irrigation	3 times	60	
	Total cost		300	
	Income sources			
1	Fruit	55 kg	825-1100	15-20 taka/kg
	Total		525-800	
	Total profits			

**cost of land, organic fertilizer, and family labor have not been considered.*

5. Cost benefit analysis (per decimal) of tomato cultivation

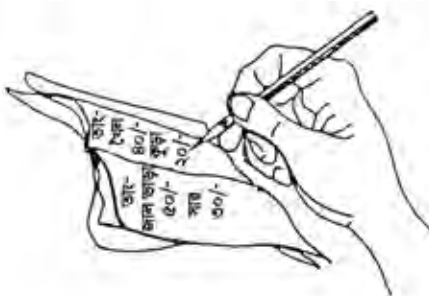
#	Cost item	Amount	Price Taka	comments
	Land preparation	0.5 persons	100	
	Seed/seedling	150	200	
	Bamboo for support	3 pieces	300	
	Fertilizer	Urea: 800 gm; TSP: 1.8 kg; MOP : 1 kg; borax : 50 gms	80	
	Pest control and other management		100	If required
	Irrigation	3 times	60	
	Total cost		840	
	Income sources			
1	Fruit	90 kg	1680-2100	8-10 taka/kg
	Total		840-1260	
	Total profits			

**cost of land, organic fertilizer, and family labor have not been considered.*

Data Preservation

For any productive activity, it is important to maintain record in order to assess the success or failure of the activity. By maintaining records of the prawn-carp cultivation process, cost and income, helps to determine future decision-making in culture management and planning. Therefore from start to finish of productive activity, the following should be recorded:

- Physical characteristics of the gher (turbidity, transparency)
- Depth of water
- Description and cost of pond preparation
- Prawn/Fish seed collection/ transport/ stocking cost
- Stocking density
- Fertilizer application data – type/weight/cost
- Feed application data - type/weight/cost
- Sampling data
- Amount of fish/prawns harvested/ income etc



There is no particular form for data collection. It is more important to be careful in correctly recording the data whatever the format may be. The farmer can record data according to his own convenient format. CSISA-BD uses a specific format for record-keeping which may be adopted or recording the items listed above can also be used by the fish farmer to keep an easy record of income and costs.

Some commonly used measurements in fish culture

12 inches	One foot
435.6 square feet	One decimal
10.76 square feet	1 square meter
40.46 square meters	One decimal
1 meter	3.281 ft
100 decimals	1 acre
247 decimals	1 hectare
10,000 square meters	1 hectare
1 inch	2.54 cm
35.31 ft ³	1 meter ³
1 ft ³	28.317 liters
1 meter ³	1000 liter
1 kg	2.205 pounds =1.07 sher
1 metric ton	26.7924 maund
1 gm	1000milligm
1 liter	1000 ml
1 ppm	1 milligram/liter =1 gm/m ³
ft ³	Gm/ milliliter
35.31 x ppm	

References:

1. Technical Guideline, Golda Prawn-Carp polyculture, BAFRU, 1996
2. Gold culture training manual, FTEP, DOF, Dhaka 2003
3. Carp and Golda polyculture, poverty reduction through integrated fisheries (part 2), DOF, Dhaka 2003
4. Course manual: training course of Golda Prawn-Carp polyculture, freshwater prawn culture extension project, DOF, Dhaka August 2006
5. Annual Fisheries and Livestock Souvenir, Strengthening Fisheries and Livestock Rearing project, Ministry of Fisheries and Livestock, 2010
6. Experiences of farmers in the south-western region
7. Dorver erosion project, Practical Action Bangladesh