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Training manual
on
IMPROVED RICE-FISH CULTURE
and
DYKE CROPPING

SEPTEMBER 2011

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



IRRI
INTERNATIONAL RICE RESEARCH INSTITUTE



TRAINING MANUAL ON IMPROVED RICE-FISH CULTURE and DYKE CROPPING

CEREAL SYSTEMS INITIATIVE FOR SOUTH ASIA IN BANGALDESH (CSISA-BANGLADESH) Project
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Training Manual on Improved Rice-Fish Culture and Dyke Cropping

A Course Manual for Rice-fish Farmers



PREFACE

Due to lack of sufficient technical knowledge and training on improved rice-fish culture which is expanding every day, many farmers are not getting optimum results in production. World Fish Center, from the start of the CSISA-BD project took the initiative to develop guideline for improved system for rice-fish culture. It was felt that there is a lack of efficient and skilled trainers and appropriate training materials. Presently there are a number of training manuals published on rice-fish culture by different Government and non-government organization including Department of Fisheries, Bangladesh Fisheries Research Institute, World Fish Center. Based on field experience and with the help of current manuals World Fish Center published this training manual on “Improved Rice-Fish Culture and Dyke Cropping” considering different ecological, socio-economic risks faced by the farmers and present demand as well as evolving problems.

This training manual on “Improved Rice-Fish Culture and Dyke Cropping” is to train the field workers of different government and non-government organization and farmers. During the project period, it is expected that the manual will be beneficial for extension workers and relevant farmers. Based on the result and experience in the field, the manuals will be reviewed and further developed in future. It can be expected that various government and non-government organizations 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 persons and organizations who have directly or indirectly contributed to the development and publication of the manual.

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RICE-FISH CULTURE and DYKE CROPPING

Training Manual

Introduction and uses of the manual

Currently nationwide including the southern part of the country rice-fish culture along with vegetable cropping on the dykes is becoming popular, however due to lack of technical knowledge and training most of the farmers are not getting expected result and therefore they are facing economical losses. With special emphasis on this point, CSISA-BD has developed this training manual on “Rice-Fish Culture and Dyke Cropping”. This manual will be especially helpful to develop the integrated rice cum fish culture and dyke cropping system.

Duration of Training:

This manual is designed to help conduct a 2-day basic training course, however depending on the needs of the trainees, the course timing may be adapted within the 2-day period. Usually the training will be from 10 am to 2 pm. The training venue is preferred to be within range of the rice field of the farmer trainee's locality 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 farmers and ensures everyone's easy participation. In all the sessions, following experience-based and participatory methods are included: 1) Brain-storming, 2) group discussion, 3) open discussion, 4) analysis of field experiences, 5) practical demonstration using existing materials, 6) speech with discussion and 7) question and answer sessions.

Number of trainee participants:

Each training session employs methods that can ensure proper participation and instruction for 25 trainees. If the number of trainees is more than this, it will create problems in communication between facilitator and trainees while conducting the sessions effectively.

Role of trainer in training:

The main role of the trainer is to create a friendly learning environment whereby the trainees will feel easy and can actively participate in the training. The trainer is at the same time a facilitator and a trainee. In this process, while relating the topic with the knowledge and experience of the trainees, the trainer will learn at the same time can rectify them where needed with correct information. In this manner, both trainer and trainees will complement each other and achieve the objective of learning.

Training topics and trainer's manual:

The training topics have been developed according to the practical needs of the farmers which at the same time have been scrutinized by experts and adapted with their advice. For each of the sessions described in the training manual, handouts have been also developed. These handouts will assist the trainer to better prepare him/herself which will help better participation of trainees in subject-specific discussion. 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 the 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:

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

TRAINING MANUAL ON RICE-FISH CULTURE and DYKE CROPPING

Training schedule

Period: 2 days

Day	Time	Discussion topic
1	10.00 – 10.30	Registration, introduction and course inauguration
	10.30 -11.30	Overall knowledge of Rice-fish culture and dyke cropping
	11.30 -11.45	Tea break
	11.45 – 13.00	Land selection and preparation for fish and vegetable culture in rice field and management of rice cultivation
	13.00 – 14.00	
	10.00 - 10.30	Prior management of rice-fish culture
2	10.30 -11.30	Discussion of previous day's session
	11.30 – 11.45	Management of fish in paddy field during stocking
	12.45 – 12.30	Tea break
	12.30 -13.30	Management of fish in paddy field after stocking
	13.30 – 14.00	Cropping on rice-field dykes
		Preservation of Income-Expenditure and info of rice-fish culture and dyke cropping.

GROUP SESSION PLANNING

Day 01

Time – 10.00

Duration: 30 minutes

- Target group : Farmers of rice-fish culture
 Title of session : Registration, introduction and course inauguration
 Aim : To inaugurate training session on 'Improved rice-fish culture and dyke cropping' so that trainer and trainees are introduced with each other and get a basic understand of the training
 Objective : At the end of this session, the participants
- The trainer and themselves will be introduced with each other and will have a positive understanding about the training course.
 - Will register their names in a given form and 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	Speech	
Topic		25 minutes
<p>Registration and distribution of training material Notebooks, pen etc will be distributed among the trainees and their names registered in a given form</p> <p>Introduction Trainer through discussion and interaction will complete introductions with the trainees</p> <p>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 and Greeting speech from trainees. Greeting speech from trainers and inauguration of training.</p> <p>Establishing Training objectives Trainer will listen and list farmer participants expectation from training</p> <p>Course contents and time schedule The trainer will distribute the course contents and timing and will explain any questions the trainees have about the course contents</p> <p>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 and collect them and will attach in the board</p> <p>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</p>	Speech, Discussion, Individual work, VIP card	
Summary		3 minutes
Thanks from the trainers to the trainees	Q & A	

Link up to the next session

Supporting Training Material Banner, registration form, flip chart aims and objectives of training, time schedule and other material for distribution

FLIP CHART DESIGN

(Follow the handouts for detailed discussion)

Aim and Objective of Training Course

RICE-FISH CULTURE and DYKE CROPPING TRAINING MANUAL

Aim of the training course

This training course aims to properly enhance knowledge and skills of participants in rice-fish culture and dyke cropping so that they are able to obtain maximum production from their paddy fields and dykes

Overall objectives

At the end of this course the participants will -

- Be able to state and write the importance of rice-fish culture
- Be able to select and prepare the land for rice-fish culture
- Be able to select rice variety, select seeds, prepare and manage the seed-bed
- Be able to prepare the land and sow the seeds
- Will be able to carry out management after planting seeds (irrigation, fertilization, weed control, harvesting and preservation of seeds)
- Will be able to describe about integrated pest management.
- Will be able to select the fish species and maintain proper stocking density
- Will be able to select cultivable crops for the dyke and manage crop cultivation.
- Will be able to record income-expenditure data and other information.

GROUP SESSION PLANNING

Day -01

Time- 10.30 am

Duration – 60 minutes

Target group : Farmers of rice-fish culture
 Title of session : Overall knowledge rice-fish culture and dyke cropping
 Aim : To give an overall understanding about rice-fish culture and dyke cropping so that the farmers can perceive the importance and benefits of these activities and can get optimum production of rice, fish and vegetables.

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

- Will be able to describe importance of rice-fish culture and dyke cropping
- Will be able to explain the role of rice, fish and vegetables in food and nutrition, livelihood and economics.
- Will be able to plan on how to productively utilize household-centered resources
- Will be able to explain the types and techniques of rice-fish culture.

Discussion topic of the session	Training approach	Duration
Introduction		5 minutes
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 and encourage them for the session	Q&A and discussion	
Topic		50 minutes
<ul style="list-style-type: none"> • Importance of rice-fish culture and dyke cropping • Role of rice, fish and vegetable in food and nutrition, livelihood and economics. • Types and techniques of rice-fish culture. 	Q&A Discussion and Flipcharts	
Summary		5 minutes
1. Summary discussion of main topic 2. Assessment of session objectives <ul style="list-style-type: none"> • What do we know about rice-fish culture? • What are the benefits of rice-fish culture? • What is the importance of fish culture in national economy? 3. Distribution of handouts	Q&A	

Link up to the next session

Supporting Training Material flipchart, white board, marker and handout

PLANNING OF FLIP CHART

(Follow the handouts for detailed discussion)

BASIC KNOWLEDGE ON RICE-FISH CULTURE

- Importance of rice-fish culture and dyke cropping
- Advantage and disadvantage of rice-fish culture
- Role of rice, fish and vegetable in food and nutrition, livelihood and economics.
- Type and technique of rice-fish culture

IMPORTANCE OF RICE-FISH CULTURE and DYKE CROPPING

“Machhe bhaathe Banagali” – a popular saying that means eating fish and rice makes a Bengali. Both fish and rice are important for us. For this we need vast tracts land for rice cultivation and water bodies for fish cultivation, which is very limited in a country with population of 160 million. Therefore it is necessary to use same plot of land in multiple ways. Rice-fish culture is the system of cultivation of different crops in the same field at the same time, where the maximum use of land is ensured while maintaining ecological balance and achieving economical benefit. Moreover by dyke cropping there are opportunities for farmer to fulfill nutritional demand of the family as well as an opportunity to earn excess money.

Necessity of Rice-Fish Culture and Dyke Cropping

- Saving land
- Maximum and different use of same land
- More benefit and income
- Ensuring nutrition and addressing lack of nutrition
- Different use of resources
- Increasing market supply of food items
- Higher production of various crops in shortest possible time at low cost.

Advantage of Rice-Fish Culture

It enables production of different crops in the same field at the same time.

- One crop complements the other
- Maintains ecological balance
- Maintains fertility of the land
- Decreases pest infestation rate and minimizes cost for pesticide and fertilizers
- Facilitates year round income from different sections of the land
- Minimizes the risk by cultivating different crops in same field.

Disadvantages of Rice-Fish Culture

- Maintaining suitable water level for fish culture
- Fish might escape or die due to floods or drought.
- Theft of fish.
- Predators such as snake, frog, kite etc. might eat fish.
- Restriction of pesticide use in control of pests.

Role of fish in food and nutrition, national economy and livelihoods

- According to the nutritionists, one should take minimum 45.3 gm protein/day of which minimum one third (15.1gm) should be animal protein.

Fish contributes to –

- 3.74% of total national income
- 22.23% income of agricultural sector
- 2.70% of foreign income
- 65% of animal protein in Bangladesh
- In livelihoods- 8% people are directly or indirectly involved in fishing, culture, trading etc.

Importance of Rice-Fish Culture

- Rice is cultivated in three-fourths cultivable land in Bangladesh
- Bangladesh produces 5.49% of global production of rice.
- Bangladesh is 5th in world rice production, China stands first.
- There is 79.1% carbohydrate, 6.4% protein, 0.4% fat, 8% mineral and sufficient quantities of vitamin A and C in rice.
- 100 gm rice creates body heat of 364 kcal
- Rice husk, hay, bran are best animal food.

RICE-FISH CULTURE TECHNIQUE

Rice-fish culture is the culture of fish in the same field with rice. The main objective of this technique is to use the land of farmer in an integrated way and gain profit. Cultivable land in Bangladesh is decreasing every day. Side by side natural water sources are also decreasing for various reasons, but food demand is increasing continuously. Considering these, the importance of rice-fish culture is greater than ever for farmers.

Rice-Fish Culture Systems

Based on the land characteristics and source of water there are two different systems of rice-fish culture.

1. Concurrent system- Rice and fish are cultured simultaneously
2. Alternate system - Fish is cultured after harvesting of rice

There is also another system where rice and fish culture started at the same time but fish culture continues for the next season after harvest of rice.

Steps of rice-fish culture

To conduct a successful production cycle of rice-fish culture, certain activities have to be carried out sequentially. The sequence of these activities however varies according to system of rice-fish culture. The steps of concurrent and alternate system are discussed below:

Concurrent

In this system fish are cultured in both Boro and Aman season. This depends on soil quality and availability of fish fry. Fish Cultivation is less in Boro season compared to Aman season.

The steps for cultivation in brief in Boro season:

Step 1- Land selection: When farmer decides to cultivate fish in the Boro season, he should select land in comparatively low area where soil type is loamy. Loamy soil has high water holding capacity, should be well connected and close to home.

Step 2- Soil Preparation: To cultivate fish in paddy field it is necessary to increase water holding capacity of land. Therefore some initial steps should be carried out for soil preparation. This is usually done in December- January. These include raising the dyke a minimum of 2ft and creating a pond or ditch of 4/5 feet at the lowest side of the land. The area of the pond should be 5% of the total land. For free movement of fish through whole area, canals are made with the ditch. The canal should be made along the periphery of the land and be connected to the pond.

Step 3- Preparing paddy seedling: Before the onset of season, that is, from last week of November to mid- December farmer should make seedbed for production of paddy seedlings. Usually in integrated rice-fish culture high yielding variety of rice such as BRRI-Rice 28 or 29 is selected. After preparing the seedbed seeds are sown. Here seedlings are grown for 40-50 days. Depending on the climatic condition farmers irrigate the seedbed.

Step 4- Soil preparation to sow seedling: This is done between last week of January till mid-February. During this time the soil is ploughed 3- 4 times and irrigated. Before the last plough, organic fertilizer 5-10kg, TSP 300gm, MP 250 each per decimal are applied.

Step 5- Transplanting seedling: The seedling are transplanted between last week of January to mid- February. Seedlings are planted in rows so that the fish can move easily.

Step 6- Weeding and fertilizer application: Weeding is done twice. The first time 15-20 days before planting and second time 45-50 days after planting. Fertilizer is applied at the second weeding. The rate of fertilizer is Urea 300-350gm and MP 250 gm per decimal.

Step 7- Irrigation and pest control: Irrigation is regularly given until harvest. Normally in rice-fish culture pesticide is used once at the beginning. However if the paddy is diseased or there is pest infestation then safe pesticides which are not very poisonous should be used.

In that case fishes are gathered in small ponds in the rice field during pesticide use. It is preferable to use biological pest control system.

Step 8- Paddy harvest: Paddy is harvested depending on the time it was planted, usually within last week of April to mid-May.

Steps for Fish culture:

Step 1- Preparation of small pond/ditch: 15-20 days after planting paddy seedling, lime should be applied in the small pond/ditch in rice field at a rate of 1kg/decimal.

Step 2- Stocking of fish fry: 25-30 days after planting paddy, fish fry is stocked in the small pond. The density of fry stocking is 15-20 pieces of 4-6" fingerling per decimal.

Step 3- Post-stocking management: Fingerlings are kept in the small pond up to 10-15 days after stocking. Here they are fed at a rate of 4-5% of total biomass. After 15 days the fry roam inside the paddy field where it also feeds. At this stage there must be at least 4-5" water in the field. Sometimes supplementary feed is given at the rate of 1-2% of total fish biomass.

Step 4- Fish harvesting: Fish should be harvested immediately after rice or 1 or 2 days before rice harvesting.

Cultivation steps in Aman season

The concurrent system is most commonly practiced. Following steps are followed for rice:

Step 1- Land selection: When farmer decides to cultivate fish in the Aman season, he should select land in comparatively low area where soil type is loamy, well connected and close to home for easy management.

Step 2- Soil Preparation: To cultivate fish in paddy field it is necessary to increase water holding capacity of land. Therefore some initial steps should be carried out for soil preparation. This is usually done in April-May. These include raising the dyke a minimum of 2ft and creating a pond or ditch of 4/5 feet at the lowest side of the land. The area of the pond should be 5% of the total land. For free movement of fish through area, canals are made with the ditch. The canal should be made along the periphery of the land and be connected to the pond.

Step 3- Preparing seedling of paddy: Before the onset of season, that is, from last week of May to mid-June farmer should make seedbed to produce rice seedling. Usually in integrated rice-fish culture high yielding variety of rice such as BRRI-11 is selected. After preparing the seedbed seeds are sown. Here seedlings are grown for 55-60 days. Depending on the climatic condition farmers irrigate the seedbed.

Step 4- Soil preparation to transplant seedling: This is done between last week of July till mid-August. During this time the soil is ploughed 3-4 times and irrigated. Before the last plough, organic fertilizer 3-5kg, TSP 100-150 gm, MP 100gm each per decimal are applied.

Step 5 - Transplanting seedling: The seedlings are transplanted between last week of July to mid-August. Seedlings are planted in rows so that the fish can move easily.

Step 6- Weeding and fertilizer application: Weeding is done 30-35 days after planting paddy seedling and urea fertilizer is applied at the rate of 100gm per decimal.

Step 7- Irrigation and pest control: Normally there is no need of irrigation in monsoon, however if there is drought then irrigation may be required. Normally in rice-fish pest control is natural. However if the paddy is diseased or there is pest infestation then safe pesticides which are not very poisonous should be used. In this case fishes are gathered in small ponds in the rice field during pesticide use. It is preferable to use biological pest control system.

Step 8- Paddy harvest: Paddy is harvested depending on time of planting, usually in November.

Steps for Fish culture:

Step 1- Preparation of small pond/ditch: 15-20 days after planting of paddy seedling in July , lime should be to be applied in the small pond/ditch in rice field at a rate of 1kg/decimal.

Step 2- Stocking of fish fry: 25-30 days after planting paddy in the last two weeks of July, fish fry is stocked in the small pond. The density of fry stocking is 15-20 pieces of 4-6" fingerlings per decimal.

Step 3- Management after stocking: Fingerlings are kept in the small pond up to 10-15 days after stocking. Here they are fed at a rate of 4-5% of their total biomass. After 15 days the fry roam inside the paddy field where it also feeds. At this stage there must be at least 6-10" water in the field. Sometimes supplementary feed is given at the rate of 1-2% of total fish biomass.

Step 4- Fish harvesting: Fish should be harvested in November/December immediately after paddy is harvested or 1 or 2 days before paddy harvest.

Alternate system of Rice-Fish culture:

In this system, depending on the availability of water in April-May, fish culture is initiated after paddy harvest and it ends in November-December. In certain cases it starts in Boro season and lasts till November/December. In this system

- Rice and fish are cultured alternately one after another.
- Depth of water is higher
- Fish is kept for 6-7 months before rice plantation.
- The fish species selected for this system is Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigel (*Cirrhina mrigala*), Silver carp, Mirror carp and Thai Shorputi .

Rice cultivation: In Boro season following steps are followed:

Step 1- Rice seedling production: Before the onset of season, that is, from last week of November to mid- December farmer should prepare seedbed to produce paddy seedlings. Usually in integrated rice-fish culture high yielding variety of rice such as BRRI-28 or 29 is selected. After preparing the seedbed seeds are sown. Here seedlings are grown for 40-50 days. Depending on the climatic condition farmers irrigate the seedbed.

Step 2- Soil preparation to sow seedling: This is done between last week of January till mid-February. In this period soil is ploughed 3- 4 times and irrigated. Before the last plough 5-10kg organic fertilizer, 300 gm TSP and 250 gm MP per decimal are applied.

Step 3- Transplanting seedling: The seedling are transplanted between last week of January to mid- February. Seedlings are planted in rows so that the fish can move easily.

Step 4- Weeding and fertilizer application: Weeding is done twice. The first time 15-20 days before planting and second time 45-50 days after planting. At this time fertilizer is applied for the second time. The rate of fertilizer application is urea 300-350gm and MP 250 gm per decimal.

Step 5- Irrigation and pest control: Irrigation is regularly given till harvesting. Normally in rice-fish culture, pest control is natural. However if the paddy is diseased or there is pest infestation then safe pesticides which are not very poisonous should be used. In that case fishes are gathered in small ponds in the rice field during pesticide use. It is preferable to use biological pest control system. .

Step 6- Rice harvesting: Paddy is harvested depending on the time of planting , usually last week of April to Mid-May.

Step 7- Preparation of land for fish stocking: In this system land is prepared after harvesting of paddy in April/May. To do so in May/June following are applied per decimal of land- 1 kg lime, 4-6kg cow dung, 150 gm urea and 100 gm TSP.

Step 8- Stocking of fish fry: 5-7 days after land preparation of fingerlings of carps such as Rohu, Catla, Silver carp, Mrigel, Shorputi, Carpio are stocked in small pond/ditches. The density is 30-40 pieces of 4-6" fingerlings per decimal

Step 9- Post- stocking management: After stocking of fingerlings, some farmers give feed at a rate of 2-5% of total biomass, while others do not give any supplementary feed and only apply fertilizers 7- 15 days after stocking (cow dung, urea, TSP). Plant health is checked often and this continues periodically.

Step 4- Fish harvesting: Fish should be harvested immediately after paddy harvest or 1 or 2 days before paddy harvest.. Usually depending on the water supply, fish are kept up to November/December. But they should be harvested within December, which is before next cropping season.

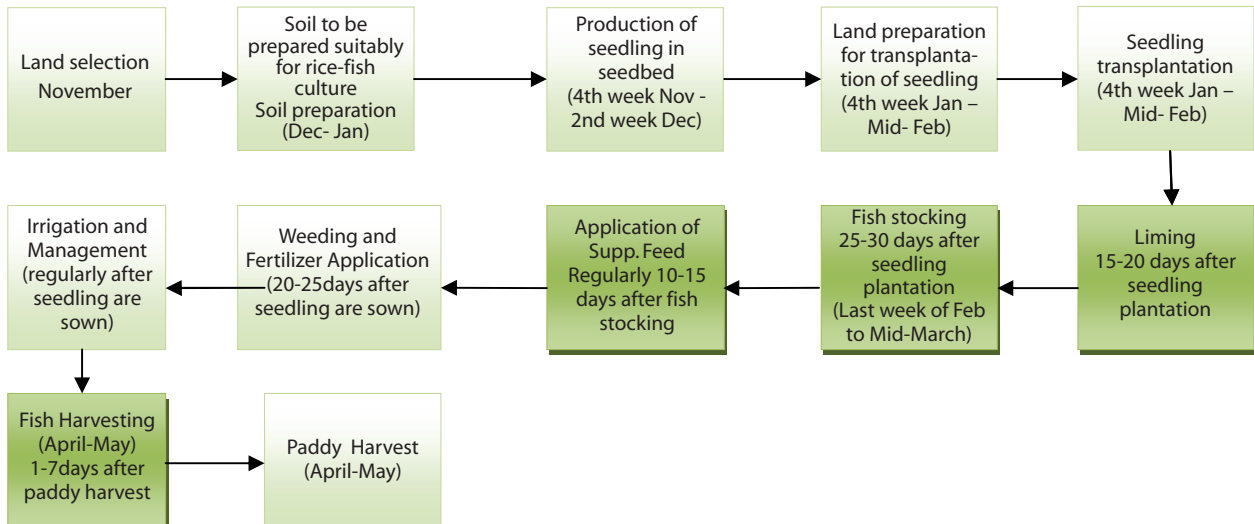


চিত্র: ধানক্ষেতে মাছচাষের পুট

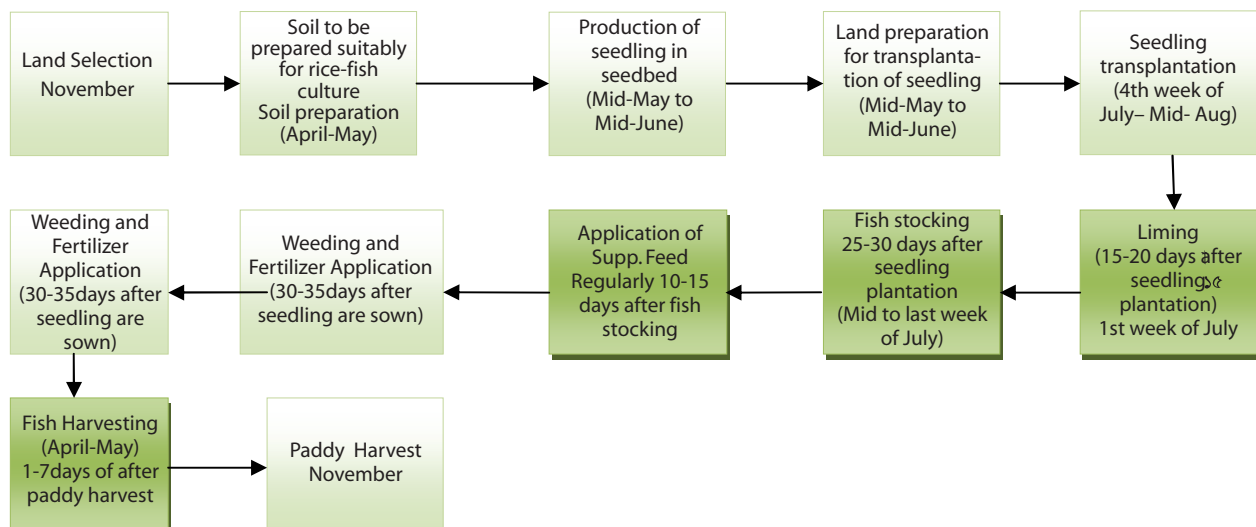
YEARLY MANAGEMENT OF RICE-FISH CULTURE

Concurrent System

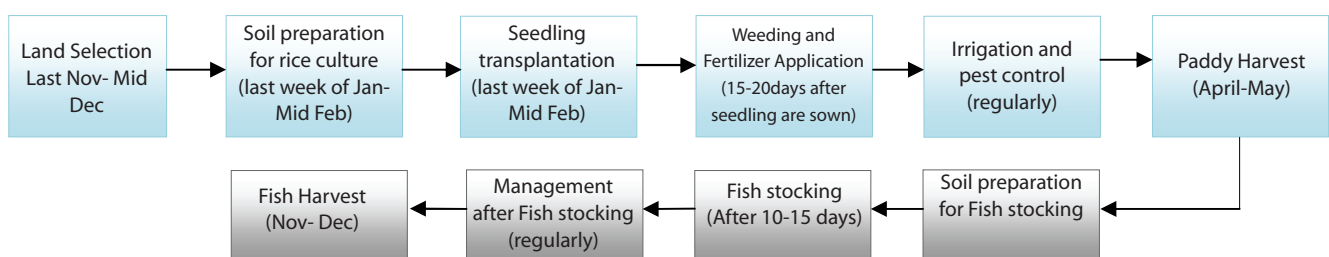
BORO SEASON



AMAN SEASON



Alternative System



GROUP SESSION PLANNING

Day 01

Time – 11.45

Duration: 75 minutes

- Target group : Farmers of rice-fish culture
- Title of session : Suitable land selection for rice-fish culture, dyke cropping and management
- Aim : To enhance the knowledge of trainees about land selection, preparation for rice-fish culture and dyke cropping so that they can prepare the land properly, can pick the seedling from seedbed the right way and transplant them properly, can take proper care and harvest appropriately.
- Objective : At the end of this session, the participants
- Will be able to select appropriate land and prepare small pond, canal and dyke
 - Will be able to select right of high-yielding variety of rice.
 - Will be able to select the seed for seedbed, can check rate of germination and also be able to transplant seedling properly.
 - Will be able to do management after seedling is sown (irrigation, weeding, fertilizer application, pest management and rice harvesting)

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
<ol style="list-style-type: none"> 1. Selection and preparation of land for rice-fish culture and dyke cropping 2. Selecting high-yielding variety of rice 3. Selecting seed for seedbed, checking germination rate and seedling transplantation 4. Preparing soil for rice cultivation (plough, fertilizer application and irrigation) 5. Transplanting seedling from seedbed to field 6. Management after transplantation (irrigation, weeding, fertilizer application, pest management and rice harvesting) 	Q&A, Speech and Flip chart	
Summary		10 minutes
<ol style="list-style-type: none"> 1. Re-discussion 2. Assessment of session objectives <ul style="list-style-type: none"> • State few causes of pond preparation in rice field • What are the processes of weeding • State the distance between rows and bundle of rice seedlings 3. Distribution of handout 	Q&A	

Link up to the next session : plugging of seedling from seedbed and seedling sowing

Supporting Training Material flipchart, white board, marker and handout

FLIP CHART DESIGN

(Follow the handouts for detailed discussion)

<p>Selection of suitable land for rice-fish culture and vegetable cropping, soil preparation and management of rice cultivation</p>	<p>Soil preparation for transplantation of rice seedling Management during picking of seedling from seedbed Distance of seedling plantation Depth and quantity of seedling to sow Age of seedling</p>
<p>Land Selection Characteristics of appropriate land Soil preparation Rice of high-yielding variety</p>	<p>Management After seedling transplantation Irrigation Weed control Application of fertilizer Management of disease/pest Rice harvesting Things to do to preserve the rice seed</p>
<p>Technique of seedling production in seedbed Selection of seed for seedbed Checking the rate of Germination Seed planting</p>	<p>Accounts of income-expenditure of ricecultivation</p>

SELECTION OF SUITABLE RICE FIELD FOR FISH & VEGETABLE CULTURE

Rice is the main crop of our country and is grown year-round in 80% of the agricultural land. In this case fish can be cultured as extra crop. Fish can be cultured in rice fields located in low or very low land where there are dykes on all sides. Following aspects should be kept in consideration while selecting a land for rice-fish culture:

- There should be 4-5" of water for at least 3-4 months.
- Sticky and loamy soil is the best because of water retention capacity
- The land should be close to home to facilitate better management
- Consideration should be given that high dykes do not create barrier in water movement for other farmers.
- 2/3 farmers can culture together and in this case there should be written agreement.

Area:

- It is easy to manage if the area is 30 – 100 decimals
- Land should be evened during soil preparation
- The dyke should be of such height that it is 8-12" above the local flooding height.
- The dyke should be strong enough so that it does not collapse due to water pressure.

Soil preparation:

Soil preparation is very important for culture fish in rice field. Primary soil preparation starts usually in the Boro season (November-December). The better the soil prepared the higher the production of rice and fish. The aspects to follow during soil preparation:

Excavation of pond/ditch and canal:

- If there is no pond or canal prior to culture, it needs to be excavated
- It is better to make the pond in the lowest part of the land
- The pond should not be more than 4-6% of the total land; if it is a land of 50 decimals then 2-3 decimals is enough for the pond.
- The depth of the pond should not exceed 2-3ft; If it is deeper then the fish will not go to the field and it will hamper the fish growth.
- One or more canals should be made so that the fish can roam in whole field.
- The canal should be directly connected with the pond
- The canal should be 1-1.5 ft deep and 1-1.5 ft wide.

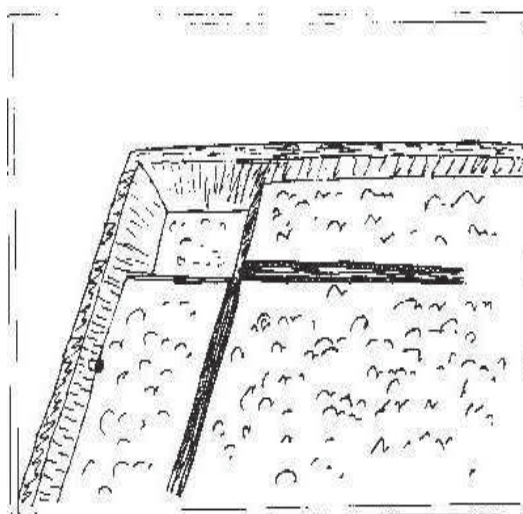


Fig: Field diagram for rice-field culture

The objective of preparing pond and canal in rice fields:

There should be always water in rice field for fish. So –

- For any reason if the water level decreases the fish can take shelter in the pond through the canal
- Fish can take shelter in canal and pond's cooler waters if the field water becomes hot.
- If there is infestation of rice pest, to control the pest the fish can be gathered in the pond and canal by drying the field.

Field preparation for rice planting:

Though there is no direct effect of plough on rice, it makes management easier. Normally the soil is softer in low land as it remains moist, therefore, the expected production can be achieved by planting seedling after weeding (without plough). Normally top 3.5-4 inches of soil is used repeatedly for cultivation, which makes the soil infertile. Therefore a slightly deeper plough can produce better production. Depending on the soil type plough and laddering of 3-5 times is enough. Depending on the type of soil after adequate irrigation, 2-3 ploughs should be done to make the soil as thick and muddy/clayish. If the field is not plain, it should be made plain using ladder and spade. If the soil is prepared properly and timely, it is easy to control the primary weeds. The benefits of proper soil preparation are as follows:

- It lessens the misuse of irrigation and rainwater if the soil is made clayish.
- Water should be retained in the field for 7 days after 1st plough. This helps decompose the weeds and hay in the field. As a result of decomposition the ammonium nitrogen produced are stored as nutrition for rice in the field.
- Clayish soil creates layer of soil without oxygen, which enhances the effectiveness of nitrogen as fertilizer.
- In properly made clayish soil it is easy to sow seedling by hand
- Helps to even the land and irrigation is also evenly distributed and retained throughout the field at the same level.

During last plough and hoeing make sure that the land is properly evened. During last plough fertilizer should be applied in recommended quantity. If Aush rice is harvested late it makes the next crop of Aman rice immature, which is the result of low production of Ufshi rice. This is why without waiting for the decomposition of waste after harvesting of Aush rice, plough and hoeing should be done immediately and within 1-2 days Aman rice should be planted. This has no adverse effect on Aman rice.



চিত্র: উত্তমরূপে কাঁদা করা তৈরি জমি

Amount of fertilizer to be applied: Balanced fertilizer should be used for good production. Two things should be taken in consideration during fertilizer application. Firstly, amount of fertilizer should be adjusted based on climate, fertility of the soil, variety of rice, its life span and production rate. Secondly, to enhance the effectiveness of fertilizer, the appropriate fertilizer should be selected and applied at the right time and method. Some fertilizers have a longer-term effect and can thus effect the next crop. Therefore, the fertilizer that has effect on multiple crops should be selected rather than that can effect only one crop.

Following is the approved amounts of fertilizer for high-yielding variety of rice per acre:

Name of fertilizer	approved dosage (kg/acre)	Time for application
Urea	70	In three installment
TSP	54	During last plough
MP	27	During last plough
Gypsum	45	During last plough

P.S.: - If the land is fertile the approved doses for rice is sufficient to produce feed for fish. Where the soil has low fertility then 15% extra fertilizer should be applied.

Table 1: Quantity of different fertilizer based on season and variety of rice

Rice Variety	Rice Variety				
	Urea	TSP	Potash (MP)	Gondhrok (Gypsum)	Led (Zinc sulfate)
Broadcast Aush					
Nizami, Niyamot, Rahmot, BRRI rice 27	52.63	36.43	28.34	24.29	4.04
Transplant Aush					
Chandina, BR-6, Gazi, BRRI-Balam, Srabonee, BRRI rice 27,	54.65	22.26	28.34	-	-
Biplob. Mala, Asha, Sufola, Moyna, Mohini, Shahi balam	60.72	22.26	28.34	-	-
Transplant Aman					
Brishail, Progoti, Mukta, Biplob, Kiron, Disharee, BRRI Rice 30, BRRI Rice 31	60.72	22.26	34.41	24.29	0
BR 5, Noyapajam, BRRI Rice 32, BRRI Rice 33, BRRI Rice 34, BRRI Rice 37, BRRI Rice 38, BRRI Rice 39	60.72	22.26	34.41	24.29	-
Nabi Transplant Aman					
Kiron. Disharee	52.63	22.26	28.34	24.29	-
Boro					
Chandina, BR 6, BRRI Rice 28, BRRI Rice 36,	89.06	30.36	36.43	24.29	4.04
Gazi, Bilpob. Asha, Shufola, Moyna, Mohini, Shahi Balam, BRRI Rice 29, BRRI Rice 35	109.31	40.48	48.58	28.34	4.04
Hashi, Shahjalal, Mongal (for Haor area)	54.65	30.36	34.41	24.29	4.04

Ref: Rich-fish culture system, FTEP-2, DoF, 2001

Recommendations:

1. The quantity of potash (MP) should be doubled in sandy soil and piedmont soil.
2. The amount of fertilizer could be decreased for haor area as the soil of haors are fertile. In case of local variety of rice it should be used at half of above mentioned rate.
3. If the soil lacks zinc it should be applied. In area of alluvial soil along Ganges and in area of irrigation projects there is deficiency of zinc in the soil. If there is no deficiency of zinc in soil, no need to apply it.
4. Care should be taken in use of organic fertilizer, such as, Doincha or pulse-type crops, cow dung, decomposed garbage etc. If it is possible to use 2 tons of organic fertilizer/ acre, the mentioned quantity of fertilizers in Table-1 can be reduced by 30-40%.

Method of fertilizer application:

Nitrogen or urea is needed in different quantities and in different stages of growth of the paddy plant. If urea is applied during tilling until initiation of heading, that is if the plant gets enough nitrogen then quantity of healthy grain increases per stalk. At the end the nitrogen taken by the plant during flowering helps the grain to be healthy and this result in weight gain for rice grain.

Urea is used to increase the tiller number in the initial stage. Because the heading grows better on initial tiller. Thus to increase the tiller number and to maintain their health, urea and other fertilizers should be applied in the initial stages. This has to be done during the last stage of soil preparation of right after the seedling stands strongly after transplantation. There should be enough fluid in soil during fertilizer application. Fertilizer should not be applied when the soil is dry or there is excess water or water paddy leaves. If weeding is done using a nirani after top application of fertilizer it enhances effectiveness of fertilizer. There should be enough water in the field 2-3 days after mixing of fertilizer with the soil.

- If it is possible to use organic fertilizer, it should be applied evenly in the field during 1st plough. Organic fertilizer should be used in Kharif season.
- Other fertilizer except urea, such as, TSP, murate of potash, gypsum, zinc sulfate should be broadcast over the field during last plough and mixed well with the soil. Though it is better to divide the dosages of potash for 2 applications if the soil is sandy.

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- For Rabi crop where TSP, murate of potash, gypsum, zinc sulfate are used the quantity of fertilizer should be used at half the recommended dosage in Kharif season.
- In the rice-rice cropping cycle if the above mention fertilizer are used in the first crop, then the quantity of fertilizer should be half during the 2nd crop.
- If Zinc sulfate is used in the 1st crop cycle, its application is not required in the two following crops.
- In the 1st Kharif season of the crop cycle if Dhaincha or string beans is used as green fertilizer, then in the 2nd Kharif season the dosage of urea can be given 60-70% lower than the recommended dosage. Green fertilizer should be mixed with the soil 15-20 days before seedling transplantation.
- The effect of urea for one crop does not last for the next crop, so it should be used at approved dosage for every crop.
- Urea is low lasting and possibility of wastage is very high. Therefore, in rice cultivation it should be used in 3 installments. In all cases the 3rd installment should be applied 5-7 days before grain formation stage.
- Urea should be broadcast when there is adequate water in the field and it should be mixed with the soil by hand or nirani.
- In the soils where there are deficiencies of zinc and gypsum, these should be applied during soil preparation. If it is not done during soil preparation, then deficiencies will manifest.

If the rice plant is still yellowish after application of urea and the growth is slow then it is evident that there is deficiency of gypsum. In that case the water should be removed immediately from the field. Then gypsum should be broadcasted as topping at a rate of 60 kg/hectare or 24-25kg/acre. It is better to broadcast gypsum mixed with soil/ash or mixed with urea while urea is to be broadcasted as topping.

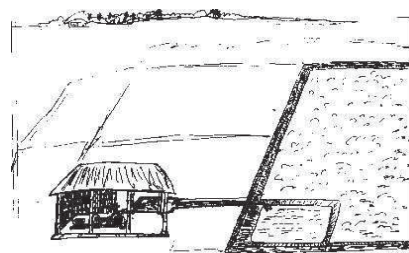
If the plant's growth is stunted and a rust-brown to orange color is observed on old leaves and the number of tillers (Kush) is fewer than usual then it is evident that there is zinc deficiency. In this case too, water should be removed from the field and zinc should be broadcasted as topping at a rate of 10 kg/hectare or 4 – 4.25 kg/acre. Otherwise, to get faster result 1- 1.25 kg zinc should be mixed with 50-60 gallon of water and should be sprayed in two installments - at 10-15 days and 30-35 days after transplantation. This should be sprayed over the leaf to get good production. This also prevents wastage of zinc.

Management of Irrigation:

In Bangladesh Boro and advanced variety of Aush cannot be grown without irrigation. In Boro season normally during cultivation of rice 3.5-4 ft water is needed in the field. During panicle initiation up to milking, water is essential in rice field. Therefore if in this stage of growth the water is insufficient than there is a possibility of crop damage and low production. Therefore Boro and Aush should not be cultivated in areas where there is no irrigation facility.

Boro needs maximum irrigation as there is insufficient rain in this period. On the other hand if advanced variety of Aush is cultivated in Falgun-Chaitra-Boishakh (Feb-April), then irrigation is a must as this is the hottest time with very little or no rain. Aush and transplanted Aman rice need no irrigation. Normally the water need can be fulfilled by storing the rain water in the field. But if there is drought in Shrabon or Kartik (July-August), extra irrigation must be managed. Otherwise the crop will be damaged.

Normally in case of transplanted Aman, panicle comes out at the end of tillering and flowering is observed after 25 days. Like Boro and Aush, water is essential from flowering to milking in transplanted Aman. Water deficiency in this period damages the crop. Therefore to get better production, irrigation must be arranged. The quantity of water needed after transplantation in different stages of growth is listed below:



চিত্র: সেচ ব্যবস্থাপনা

Period/stage of rice plant growth	Quantity of water needed
During transplantation	1- 1.5 inch
Next 10 days after transplantation	1.5-2 inch
From 11th day of transplantation till heading	1 – 1.5 inch
After heading up to flowering	2- 4 inch
10 -12 days before harvesting	Water should be removed from the field

Normally in rice field irrigation is given or the rain water is retained in a indiscriminate way. It should be remembered that the field should be flat and even, otherwise the amount of water will vary as well will the growth of the plant. If the rice field is too inclined, the dyke should be made at appropriate places to hold the water. The dyke should normally be 12-13 inches in width and 7-8 inches in height.

Water should be removed from the field before top application of urea and during weeding. The field should be irrigated again 2-3 days after broadcasting urea. It is recommended to remove water a week before heading and the field dried for 3-4 days and then re-irrigated. There is no such rule that water should be retained for entire period in the paddy field, however there should not be water shortage for good growth of crop.

Weed control:

Weed competes with rice plant for water, light, nutrition etc. Weeds adjust easily with adverse climate, and grows faster than rice. So if the weed growth is much better than rice it will adversely influence growth rice. It inhibits growth of rice and production is thus hampered. Moreover, weed acts as a hiding place for pest and disease and indirectly damages rice. Normally in Aush season, especially in broadcasted Aush, weeds proliferate faster than in Aman and Boro season. During Aush season if the field kept untouched for few days after 2-3 ploughs, grass grows all over the field. After few days it should be ploughed and laddered again to reduce weed growth and only then the rice can be sown. Water retention of 1.5-2 inch in transplanted rice field lowers the growth of weed.

A variation in competition with weeds is observed with different variety of rice and in different season. Normally, if the field can be kept weed free for 1/3 of the period of paddy growth in the field (after transplantation till ripening of rice) expected production can be achieved. The rice field should be kept weed free for 30-40 days after seed broadcasting or seedling transplantation in Aush and Aman season and for 40 -50 days in Boro season. The damage it causes in this period cannot be retrieved by keeping the field weed free rest of the season. Care should be taken during urea application so that there is no weed during this time. Otherwise weed infestation will increase.

Weed can be controlled by various ways, such as, retaining water in field after weeding, by sorting by hand, using weeder etc. To use weeder the rice should be planted in rows. This weeder can remove only weeds between the rows and weeds between the bundles of rice plants should be removed by hand. If the weeds are kept inside the soil after weeding and if there is no seed in it then they become decomposed and act as organic fertilizer.

Bangladesh Rice Research Institute has developed a weed-removing tool weedier and named BRI-weedier. It can remove weeds of 10 decimals/ hour. It costs Tk. 220 only. To use this machine the rice should be planted in rows of a distance of 25 cm from each other. It is 4-5 times effectively removes weed than weeding by hand.

Weeding can also be done with different weedicides. Among these are: Ronstar 25 EC which should be sprayed at a rate of 1 liter/acre 6-8 days prior to seed broadcasting or seedling transplantation or Ronstar 12L at a rate of 1 Liter/acre directly on transplanted field. The weedicide Setoff 20 WG at a rate of 40.5 gm can be sprayed during transplantation.

High Yielding Variety (Ufshi) paddy seed:

The rice which has a high capacity of nutrient intake and with high production is known as High-yielding variety or UFSHI. Because of these unique qualities the rice plant also exhibits two characteristics i.e. : 1) hardy plant and 2) straight leaves. On the other hand the plant of local variety is weaker and the leaves also inclined downwards. The capacity of nutrient uptake and production is also lower. The presence of necessary characteristics in Ufshi rice, such as better production, disease resistance, shorter life cycle, fine rice, drought resistant etc. is called modern variety of rice. So it is evident that not all Ufshi variety is modern rice variety, however modern rice must have Ufshicharacteristics.

In this country the scientists of Bangladesh rice Research Institute and different educational institutes invent new varieties of Ufshi or Modern rice by hybridization of two or more varieties of rice. After hybridization it takes 7-10 years to select a genetic strain which after being field tested is established as a variety. In nomenclature of BRRI-invented varieties BR is written before the number. Like BR 1 which means Bangladesh Rice 1. Other than this name these rice have popular names too. Presently in nomenclature BRRI rice has been added in place of only BR. This rule started with the BRRI rice 27 and these do not have other popular names.

High-yielding rice variety suitable for Rice-fish culture:

BR 11 (Mukta)
BR 14 (Gazi)
BR- 3 (Biplob)
BR- 16 (Shahi Balam)
BR- 20 (Nijami)
BR- 20 (Rohmat)
BR- 26 (Srabinee)
BR- 27
BR- 28
BR- 29
BR- 32
BR- 33 etc.

Among the high-yielding variety in Boro season BR11 28 and BR11 29 and in Aman Season BR 11 is cultivated the most

Seed selection for seedbed, checking germination rate and sowing

Seed selection system

To get good production, good quality seed is a must. Before selecting the seed it should be checked that they are disease-free, clean, healthy, sterility-free and with humidity 10-20%. Before selecting seeds they should be cleaned using winnowing fan. To get rid of sterile seeds they should be soaked in solution of 1-1.5 kg urea in 40 liters water.

Testing rate of germination:

- **Ragdoll Technique-**

On an old handkerchief or old piece of cloth, 100 seeds should be spread evenly and the cloth should be rolled using a stick and soaked for 24 hours in Aush season, 48 hours in Aman season and 72 hours in Boro season. If the germination rate is 80% or above, then it is considered as good quality seed, but if it is less than 80% then the seed should not be used.

- **Banana Bark Technique:**

The inner layer of banana trunk is perforated in which 100 seeds can be placed in these holes and the germination rates checked season-wise.

- **Ash or sand technique**

100 seeds can be kept in ash/sand and rate of germination tested season-wise as described above.

Sowing seeds in seedbed: Period

80% germination-rated seeds which are clean and healthy should be soaked in water for at least 24 hours and then kept in a corner of dark room in a sack or large earthen pot or drum to artificially heat and germinate the seeds. After germination it takes about 40-48 hours or almost 2 days in Aush and Aman season, and 60-70 hours or 3 days in Boro season to be ready to sow in seedbed. The seeds germinated in this way can be only sown in wet clayish, floating and Dapoge seedbeds. To sow in dry seedbed artificially heating and germinating the seeds is necessary. Seed should be sown at a rate of 3-4kg per decimal. If there is not enough room in seedbed then the sowing rate can be increase to 4-4.5kg/decimal except in Dapoge seedbed. The excess quantity the quality of seedling does not affected and seedling grown in minimum area can be transplanted in larger areas. On the other hand, if the quantity of seed is less then there are possibilities of weed growth. Seedling grown in 1 decimal can be transplanted in 25-30 decimal of rice field. For Dapoge type of seedbed seed, should be sown at a rate of 2.5-3kg/decimal.



চিত্র: ধানের চারার বীজতলা

Taking care of Seedbed:

To get healthy seedling, special care of seedbed after seed is sown is required. In wet seedbed there should always be water and in dapoge seedbed it should be watered everyday using a sprinkler and then the seeds should be pressed into the soils using a flat piece of wood. In Boro season growth of seedling is slow due to cold weather. Therefore, the seedbed should be covered with a polythene sheet at night.

Irrigation:

3-4 days after seed is sown and until seedling emerges, the canal should be irrigated. If seedbed becomes dry in this period then roots grow big and these seedlings become difficult to pick for transplantation.

De-watering:

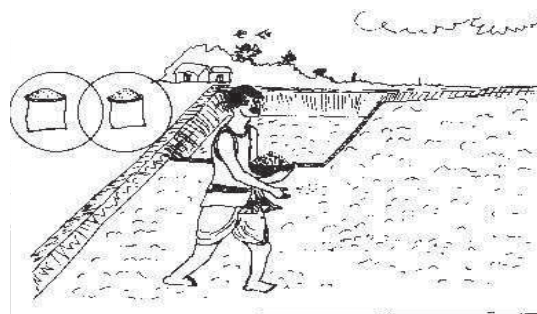
There should be accurate quantity of water (not exceeding 1-2 inches). Excess water hampers seed growth and they become weak. Therefore sometimes the old water should be removed and re-irrigated with fresh water which will makes the weak seedlings stronger.

Control of Weed and Pest:

Proper measures should be taken if there is weed, pest or disease outburst in seedbed. Thrips and GLH (Green Leaf Hopper) are pests that commonly attack seedbeds. In case of Thrips 7 gm granular urea is broadcasted and then irrigated to give good results. In case of GLH light trap works better.

Fertilizer application

There is no need of fertilizer in seedbed of fertile and semi-fertile soil. In unfertile and low fertile soil 80 kg cow dung or decomposed fertilizer per decimal is sufficient application. Other than this, if seedlings become yellowish, 285-300 gm urea fertilizer should be broadcasted as topping. If the seedling is still yellowish after application of urea, and it is definite that there is gypsum deficiency. In that case gypsum should be applied as topping at the rate of 400-425 gm/decimal.



চিত্র: ধানের জমিতে সার প্রয়োগ

Picking seedlings from seedbed and transplanting to field:

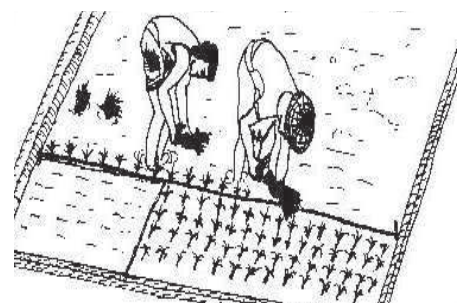
Picking Seedlings:

Enough water should be given to seedbed so that the soil becomes moist and soft before seedlings are picked. Care should be taken to pick the seedlings to prevent stem breakage. Forced picking and cleaning the soil with strong jolts damages the seedling and the growth after transplantation. Research shows the torn part of root does not hamper the growth of seedling but torn leaf or twisted stem is very harmful for seedling. Seedling should be picked from seedbed within 40-50 days. Sometimes it is difficult to pick seedling if it kept in seedbed for longer period (70-75 days) as knob/nodule forms within this period. In that case the seedling should be cut off with one knob and then transplanted in the field. This will also give expected result of production.



চিত্র: বীজতলা থেকে চারা উঠানো

Seed transplantation The production of rice varies depending on the rainfall, duration of day time, temperate difference between day and night etc. During panicle (kaisthor) formation climatic condition greatly influences production. In Aush season transplantation is dependent on rainfall. If there is enough rainfall or irrigation facilities, the seedling should be transplanted or seed should be sown directly in the field in first half of Boishakh (April). In Aush season, in case of transplanted rice variety, it is better to chose short-duration variety of rice, such as, Chandina, BR 6, Asha, Shufola and Srabonee. In case of sowing seed directly in the field, the rice varieties should be like Nijami, Niyamot, Rahmot, and BRRRI Dhan 27.



চিত্র: ধানের জমিতে চারা রোপণ

If Aush variety is transplanted or broadcasted late, it will delay the Aman cropping in the same field. As a result the production of Aman decreases. In this case, if possible crops like pulses should be cultivated after rainfall and these should be used as green fertilizer which can enhance the production of next Aman rice

In Aman season all varieties of rice should be transplanted within Srabon (July-August). If this is delayed in case of light sensitive variety, after flowering the grains cannot emerge or if they do emerge they might be sterile. In that case low light-sensitive variety, such as, BR 11 (Mukta) can be transplanted up to middle of Bhadra (August-September). Moreover, two new varieties- Kiran and Disharee and Nigershaile can be transplanted up to last week of Bhadra in North-Western region and up to second week of Ashshin (September-October) in the South-West region of the country. The more delayed the transplantation of Aman is the less production obtained.

Boro rice should be transplanted in Poush-Magh (December-February). Its cultivation is completely dependent on irrigation. So the production cost is highest for this crop. Moreover, as it is planted in winter, it takes longer time to grow i.e. 5-6 months. Care for extra time costs a lot. It has therefore been deduced that if transplanted at the end of February, even is production is low, better profit can be achieved with little production cost. Affluent farmers who can bare a higher cost can transplant Boro rice in Poush. Otherwise it is preferable to transplant at the end of Magh.

Transplantation process

There should be free flowing water in the field during transplantation. Seedlings should be planted in rows maintaining a specific distance. It takes same time to plant in rows as it does scattered, so it is better to plant in rows. Each panicle (gucchi) gets same nutrition if planted in rows. It also helps in later management, especially weed control and saves production cost, 2-3 seedlings should be planted in the same hole.

Depth for seedling plantation

As the soil is very soft, seedling might come out from the hole or become tilted due to slight wind and if the seedlings are old enough, then double the amount of seedlings can be planted in a bunch in deeper hole. If not planted deeply, the number of tiller (Kushi) increases

but end the production decreases. On the other hand if planted deeply, the number of tillers are few but each tiller gives off productive panicles (chora).

Distance to plant seedling

In case of Ufshi variety, the distance between rows should be 8-12 inches and the distance between bunches also should be 8-12 inches. In fertile land seedling should be planted sparsely while in unfertile land they should be planted densely. It should be remembered that In Aush and Aman season disease and pest problems are more. So as to control their fast spreading in this season seedling should not be planted densely. In all parts of Bangladesh, the rows are east-west or north-south faced or even in oblique rows. In case of Aman, 5-6 seedlings should be planted in each bunch.

Seedling Age

The age of Biplob, Chandina, Asha, Shufola variety should be 20-30 days in Aush season and 40-50 days in Boro season during plantation. For transplanted Aman the age should be 30-35 days. In case of short-duration variety, such as, Purbaci and BRRI Balam the age of seedling should be lesser at time of transplantation.

MANGEMENT AFTER TRANSPLANTATION, HARVESTING, PROCESSING and PRESERVATION

De-weeding and Fertilizer application: In concurrent system, after transplanting seedlings, weeds are cleared and 250-300 gm Urea and 250 gm TSP per decimal are applied. Weeds are cleared twice, first time is after 15-20 days and second time after 45-50 days of transplantation. In Aman season, weeds are cleared after 30-35 days of transplantation and the 100 gm urea per decimal is applied.

Irrigation and Pest control: Irrigation is continued up to harvesting. There is no need of irrigation in Aman season, that is, in monsoon. But if there is drought for any reason or if the field becomes dry, irrigation is a must. Normally in rice-fish culture pests are naturally controlled. However, if the paddy is diseased or pest infestation occurs then safe pesticide (less poisonous) should be used. In this case, during both seasons, fishes should be gathered in small ponds in the rice field during pesticide use. It is preferable to use biological pest control system.

15-20 days after transplantation of seedling weeds are cleared and 250-300 gm urea per decimal are applied in the field. Weeds are cleared twice after 15-20 days and secondly after 45-50 days of transplantation. At this time, the rate of fertilizer application is 300-350gm Urea and 250gm MP per decimal .

In Alternative system: 15-20 days after transplanting seedlings, weeds are cleared and 250-300 gm urea per decimal are applied in the field. Weeds are cleared twice, first time after 15-20 days and second time after 45-50 days of transplantation. At this time, the rate of fertilizer application is 300-350gm Urea and 250gm MP per decimal.

Normally in rice-fish culture pests are naturally controlled. However, if the paddy is diseased or pest infestation occurs then safe pesticide (less poisonous) should be used. In this case, in both seasons, fishes should be gathered in small ponds in the rice field during pesticide use. It is preferable to use biological pest control system.

Integrated Pest Management:

To control harmful pests by preserving beneficial insects and adopting different systems in combination is known as Integrated Pest Management. This Integrated Pest Management is very efficient for rice-fish culture.

Ways of Integrated Pest Management:

There are 4 ways of Integrated Pest Management. These are-

- Modern cultivation system
- Mechanized control
- Biological control
- Chemical control

(It is better not to use chemical control in rice-fish culture)

Modern Cultivation System

In this system pest could be controlled by

- Deep plough of field
- Alternate cropping
- Proper irrigation
- Maintaining spacing in planting
- Cultivating improved variety of crops
- Cyclic cropping (Shoshoborton)

Mechanized control

- Control of pests physically i.e. by hand
- By trimming tips of leaves
- By removing infected plants
- Using light trap to control pests.

Mechanized control of pests

1. Control of pests physically i.e. by hand:

The insects and pests can be controlled by removing them, including their eggs and larvae by hand. The yellow stem borer or 'Majra poka' of rice and sugarcane can be controlled in this way. Other pests like Gandhi, Pamri, Green Leaf Hooper could be caught and removed with catch net (Dhora Jall). Hipsa (Pamri), Green Leaf Hooper can also be caught using a hand net.

2. Trimming leaf tip:

Some pest normally attack the leaf tips at first, such as, Hipsa (Pamri), and leaf-curling insects, These attacks can be prevented by trimming the leaf tip and by burning or burying the cut portion.

3. Light Trap:

In this way the insects are trapped by attracting them to light. At night time if a pot is placed in the field filled with kerosene or pesticide and a kerosene lamp in hang over it, different insects are attracted to the light. The insect falls in kerosene/pesticide and dies. A number of pest can be controlled using this light trap, such as, Adult yellow stem borer (Majra poka), Shish kata leda poka, Green Leaf Hopper, Gandhi etc.

4. Uprooting infected plant:

Diseased/ pest infested plants should be uprooted. It prevents the spreading of disease and pests in the crop field. The parasitic pests/insects play an important role in Integrated Pest Management or to control harmful insects. Among these, Wolf Spider (Nekre makorsa), Grasshopper, damselfly, Ladybird beetle, Myrid bug etc. are important.

Biological control

Parasitic insects and bird can control pests. They consume harmful insects from the crop field. Among these parasitic insects are- Wolf Spider (Nekre makorsa), Grass hopper , Damselfly, Ladybird beetle, Myrid bug and among birds are Shalik, Doel, Moyna etc.

1. Wolf Spider:

They live most of the time in the basal part of rice plant. They do not create web, rather directly attack the insects. Adult Wolf spider consumes different insects, among which are the adult moth of yellow stem borer (Majra poka) is the most common.

2. Grass Hopper:

The live on plant leaf and panicle. They consume larva of sucker type insects, Majra and Gandhi poka as food.

3. Damselfly:

Mature damselfly flies live around the space between leaf to leaf. This fly consumes different insects as food, such as, many types of dragonflies, patamora poka etc.

4. Ladybird beetle:

These are seen in all crops including cucumber like crops and rice. They prey on insects which move slowly. They eat sucker type insects, patamorano poka, and yellow stem borer as food.

5. Myrid bug:

This insect is seen in huge quantities in fields which are infested with pata foring and ghash foring. They look for eggs of pata foring in leaf bark and stem and suck the inside the egg by inserting their sting in the egg.

Consideration for rice disease and its prevention

Disease is a general problem in rice culture and different types of disease can occur. Through improved management, disease can be prevented. Especially if the following can be done properly, good results can be achieved, such as, good quality seed selection, necessary amount of fertilizer application, irrigation management, de-weeding etc. Some important diseases are briefly discussed below:

Tungro Disease of rice

This is a viral disease which is spread by Green leaf hopper

Source of Disease- Grass, hopper

Management - To destroy the diseased plant after uprooting.

Leaf rot (Pata mora) disease

Symptom- young leaves become yellowish and eventually die.

Management- Application of balanced fertilizer, to use quality seed, and remove the diseased leaves.

Leaf Blight Disease (Pata pora)

Symptom- Leaf looks like dry hay and dies, eventually all leaves dry up and dies. If this disease occurs in seedling stage whole plant falls and dies.

Source of Disease- Continuous rain, attack of Hipsa (Pamri) and other leaf attacking insects and bruising of leaves due to wind is responsible for the spread of this disease.

Management- If the humidity is low and there is plenty of sun light, then the occurrence of this disease is low. After storm, rains and after the onset of disease urea should be applied as topping.

Ufra

Source of Disease- It is caused by little nematode worm. They suck the fluid from the plant and as a result small white spots appear on leaf base.

Management- Burn the stem base and roots of plants after harvesting and keep field weed free and use quality seed.

Blast

It is a fungal disease, which attacks the node of leaf and base of panicle.

Sheath blast

It is a fungal disease. First attack starts with the hyphe (Shutika) floats in water. The prevalence of this disease is greater in hot and humid weather.

Management- To plant seedlings well-distanced and irrigate after drying the field; use fertilizer at balanced rate. In localities where this disease is encountered every year, the rice variety should be long-duration type. After harvesting from diseased field the plant root and base should be burnt once a year. Besides this the crop types should be alternate rather than just monoculture of paddy.

Period of harvesting, sign of maturation and collection

Harvesting should not be delayed when the rice becomes mature or when the plants become dry. Otherwise grains will fall, get lost or there will be attack of "Shish kata leda poka" or other animals. Rice grain starts ripening from the tip of panicle. It should be checked thoroughly by physically walking through the field to check whether the rice has ripened. If 80% grain of upper panicle becomes hardened and transparent and if 20% of lower grain is semi hardened and transparent then the crop can be considered properly ripened.

Depending on the variety of rice and transplantation time, harvesting performed from last week of April up to mid-May in Boro season and in Aman season in November.

Using threshing machine to thresh Ufshi paddy is easy. Clean area should be selected for threshing. The threshing should not be done on open earthen space, it should always be done on mat (chatai/hogla) and should be threshed using bare feet slowly. Threshing in this way keeps the grain clean and less damaged. Seed grain threshed in this way should be sun dried minimum 4-5 times. It is very difficult to thresh and dry rice grain during rains. In this case panicle should cut in small pieces and hung inside the room to dry. Otherwise the rice will be damaged. After drying the grain, the rice should be winnowed properly and kept in clean "gola" or bin – the paddy storage container which should be closed tightly.

Rice and fish harvest in Alternate system: Depending on the variety of rice and transplantation time, harvesting is carried out from last week of April up to mid-May. Normally depending on the water supply fish are kept up to November- December. Though for next crop the fish should be harvested by December.

Things to do to store seed rice:

Good production requires good quality seed. The seed should be stored from the rice of that field which is disease, pest and weed free and the grain properly ripened. Seed rice should not be mixed with other rice. Because, if seed from mixed rice is used the next production will not be as expected. If the seed rice is not properly stored, they will be damaged by insects and rodents and the germination rate spoiled which results less seedling production.

Seed rice should be properly stored after harvest and threshing and steps below should be followed:

- Before storing the seeds should be dried in sun for several times. If it crackles when bit humidity is below 12%.
- Larger seed grains should be sorted using winnowing fan or by large mesh (1.75-2.50 mm) strainer.
- Seeds should be stored in leak-free, dry and clean pot. For this metallic containers like oil drum, container of biscuits or kerosene can be used.
- To store seed earthen pot "Motka", kolshi or polythene bag can also be used. If the pot is made of clay, the outer surface should be double-coated with tar.
- The sun dried seeds should be kept in container after cooling. The container/pot should be completely filled up. Seeds should never to be stored in wet or damp places.
- Seed pot should be kept on raised rack "macha" so that it does not touch the soil of floor.
- Stored seed should be checked often whether there is insect or rodent attack and should be dried periodically if needed.

GROUP SESSION PLANNING

Day 01

Time – 13.00

Duration: 60 minutes

- Target group** : Farmers of rice-fish culture
- Title of session** : Pre-stocking management
- Aim** : To give the training participants a basic understanding on pre-stocking management of fish in rice field so that they are able to get better fish production by proper management.
- Objective** : At the end of this session, the participants -
- Will be able to tell the importance of liming in small pond/ditch
 - Will be able to state types of lime
 - Will be able to apply the lime in appropriate quantity.
 - Will be able to describe the considerations and precautions in liming

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. Explanation of importance of current session 	Q&A and discussion	
Topic		45 minutes
<ol style="list-style-type: none"> 1. Importance of liming 2. Types of lime 3. Quantifying lime depending on soil type 4. Consideration about lime 5. Precautions during liming 	Lectures, Q&A Group work Discussion	
Summary		5 minutes
<ol style="list-style-type: none"> 1. Re-discussion of main topic 2. Assessment of session objectives <ul style="list-style-type: none"> • What is lime • Types of lime 3. Distribution of handouts 	Q&A	

Link up to the next session: Uprooting seedling from seedbed and transplantation in rice field

Supporting Training Material : ➤ flipchart, white board, marker and handout, Lime

FLIPCHART DESIGN

Liming

- Importance of liming
- Types of Lime
- Quantifying lime according to the types of soil
- Consideration about liming
- Cautions for liming

LIMING

Lime is calcium enriched inorganic compound which helps in decreasing and neutralizing acidity as well as physiological development of animal body. The main reason of liming is to increase the carbonate ion in water. The availability of carbonate ion can be obtained other than liming, such as, through washed in rain water which is evident by the production of plankton. Whether liming is needed can be determined based on following remarks:

- a. If the water hardness is more or less 20 mg/Lit then liming should not go untreated (Boyd, 1979).
- b. If the water hardness is above 20 mg/ Lit, then there is no need of liming.
- c. Liming will not be fruitful if the water hardness is low but alkalinity is high (Delience 1992). Therefore pH should be determined scientifically before liming.

Cause of liming: Normally lime is applied in the pond for two reasons-

Firstly: To keep the soil and water pH suitable for fish and to keep the water hardness more than 20 mg/liter.

Secondly: During pond preparation, especially by applying quicklime to prevent infestation by parasites and germs and to increase decomposition of organic matter at pond bottom so as to increase availability of nutrition.

What is pH?

pH is the unit to determine the acidity or alkalinity of any material. By water pH it means the acidity or alkalinity of water which ranged from 1 to 14. Seven indicates neutrality. It indicates acidity if the pH is below 7 and alkalinity if pH is above 7. pH is very important in fish culture. For fish culture water pH should be 7-9.

Testing Water hardness and pH:

Water hardness and pH can be determined in different ways. Such as,

- a. Water properties testing kit (hacc kit)
- b. pH meter
- c. Chemically (by titration)
- d. pH paper
- e. Using soap- if the alkalinity is above 40 mg/lit then it indicates the presence of hard water, where there is little or no foam formed with soap. Again if the alkalinity is below 40 mg/Lit then it is soft water and there will be large amounts foam with soap.
- f. Betel leaf juice - If the color of betel leaf juice does not change if dropped in water, then the pH is above 5. But if the color becomes blackish then the pH is below 5. This is a very useful way for old pond and for derelict of clear water pond.
- g. Observing water color- In many cases acidic water is blackish or bronzed colored.

The ways a, b, and c are not suitable for applicability everywhere. Before new farm is established, the pH of the soil and surroundings should be assessed. There are tools to test water parameters (HACC kit) in all Upazila Fishery Offices. Water can be tested in the Upazila Fisheries offices.

Besides this, the pH and alkalinity can be determined by asking farmers of the locality about surrounding situation, such as, whether any farmer suffered due to acidic water supply; if there is problem in productivity; whether the water tastes slightly sour; whether phytoplankton grows or not after applying the fertilizers, or whether the soil of the locality is bad or there are reddish secretion or acidic soil.

Procedure of soil pH testing: One handful of soil should be taken from the bottom of the small pond/ditch in the rice field, dried and powdered by grinding. This powder should be dissolved in double amount of cooled and boiled water for a minimum of 24 hours. Then pH of precipitant water should be tested using the pH paper.

Sources of acidity: Black or acid sulfate mixed soil, decomposed organic matter and polluted garbage are the main sources of acidity.

Effect of acidic water:

- If water pH is less than 5 the sodium and chloride is secreted from fish body by osmosis. As a result fish becomes weak and eventually dies. The situation gets worst if the quantity of calcium is less in water.

- Fish secretes large amounts of slime and the gills are affected.
- The immunity of fish and appetite decreases and the fish does not move even they get hurt.
- Eggs and fry of larger fish are most affected.

Source of alkalinity:

1. Soil rich in calcium and silica
2. If the water is deep green due to excess photosynthesis, pH at day time increases.

Effect of alkaline water: If pH exceeds 11 fish will die quickly. If pH increases then fish will suffer as follows –

- Gills will be destroyed.
- Lens and cornea of eye will be damaged
- Natural food in the pond will decrease
- Osmoregulation capacity decreases
- Immunity and appetite of fish decreases
- Reproductive capacity of fish also decreases

Benefit of Liming:

- Helps to maintain neutral pH which creates favorable condition for plankton growth
- It supplies calcium and important ions for better growth of plankton. Calcium and silica helps in body formation of animal and plant.
- It increases the supply of Carbon dioxide for photosynthesis
- It releases blocked phosphorus in the soil for plankton growth.

Types of Lime:

Name of Lime	Chemical structure	Availability
Limestone	CaCO_3	Normally not available in market
Burnt Lime/Quick Lime	CaO	Available in market as stony lime
Hydrated Lime (Koli chun)	Ca(OH)_2	Available in powdered form
Dolomite	$\text{CaMg(CO}_3)_2$	Available in area in prawns culture
Gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	Found in some markets

Uses of Lime:

Name of Lime	Effectiveness
Burnt Lime	Burnt lime is excessively alkaline. The pH quickly increases after its application. Prevents from disease and germs. Its use is safe in dry pond.
Limestone/ Dolomite	It is very effective to use dolomite in clay reached with organic matter, when the pH is below 7, alkalinity and hardness is below 20mg/Lit.
Gypsum	Gypsum is very effective in turbid water due to siltation. Gypsum is very effective when water hardness is low and alkalinity is high (if carbonate/bi-carbonate/hydroxyl ion is attacked with other ion, such as aluminum).

Determining Lime amount

Before liming it is necessary to know the pH and alkalinity of water as the productivity of pond depends on acidity/alkalinity of water. From a country-wide survey in 1993, conducted by BAFRU in the fish farms of

Directorate of Fisheries and Grameen Bank, it was found that in all ponds of the farms in the country except North-West region, the alkalinity is above 20mg/Lit and in maximum cases it was above 70mg/Lit and the average pH was 7-7.5.

Amount of lime to be applied

Depending on the soil pH and type of lime the dosage is calculated. When only pH is taken into consideration to determine the dosage of lime, then burnt lime should be used twice the amount of limestone and 1.5 times the amount of hydrated lime. In the following table recommended dosage rate is given-

pH	Burnt Lime	Hydrated Lime	Limestone
	6 kg/decimal	9 kg/decimal	12 kg/decimal
	4 kg/decimal	6 kg/decimal	8 kg/decimal
	1-2 kg/decimal	3 kg/decimal	4 kg/decimal

P.S.: In water and soil of pH 3-5 fish culture is very expensive. In this case farmers should be discouraged.

It is very difficult to suggest dosage for lime as the water environment is always changing. An example is discussed about the changing dosage of lime with changing water environment. If the primary pH of clay is 5 and water pH is 7 and water pH of another source is 7.9 then to get water alkalinity 20 mg/Lit the dosage of limestone will be 5,080 kg and 504 kg respectively. This means that, to bring the alkalinity to same level for two different pH, the dosage difference of lime is 10 times.

The dosage rate per decimal of burnt lime for different soil type is given (for the farmer) here-

Soil type	New pond	Old pond
Loamy	1 kg	2 kg
Sticky	4 kg	6 kg

Method of Lime Application

During pond preparation

Required quantity of lime should be broadcast all over the pond including the pond edges either by sprinkling the powder or solution in earthen pot or drum.

While fish in the pond/ditch

Required quantity to be divided in 2/3 parts and soaked for minimum 12 hours and to be sprinkled at 2-3 days interval.

Liming Time

Lime should be applied 2-3 days after plough of pond/ditch bottom in dry field and then 3-4 days after removing predatory fish from watered pond or 7 days before fertilization. Extra lime should be applied at least once in a year during preparation of the pond/ditch or if there is no plankton after first application of fertilizer,. It should be kept in mind that liming is effective in bright sun light. Therefore liming should be done in sunny weather.

Cautions for Liming:

- When dissolving and broadcasting lime, nose and mouth should be covered using gamchha (Bengali for cotton Bangladeshi towel).
- Never dissolve lime in plastic container
- The opening of the container must be covered by gunny bag or jute sack before pouring water in lime.
- Lime should be broadcasted in favor of wind direction.
- If lime goes into eyes, it should be washed with clear water repeatedly.

GROUP SESSION PLANNING

Day 02

Time – 10.00

Duration: 30 minutes

- Target group** : Farmers of rice-fish culture
- Title of session** : Topics discussed the previous day
- Aim** : To discuss and revise previous day's topics with the trainees so that they can remember the course and can rectify their knowledge and increase the effectiveness of the session
- Objective** : At the end of this session, the participants -
 Will be able to revise the topics of the previous day and by rectify mis-concepts can come to a common decision.

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. Re-discussion about previous session 3. Liking with present session 4. Explaining the objective of present session and encouraging 	Q&A and discussion	
Topic		25 minutes
<ul style="list-style-type: none"> • Revision of previous day's topics by one participant • Every body's opinion about the topics of last day (Q&A) 	Lectures, and Discussion	
Summary		3 minutes
<ol style="list-style-type: none"> 1. Re-discussion of main topic 2. Assessment of session objectives 	Q&A	

Link up to the next session

Supporting Training Material > white board and marker

GROUP SESSION PLANNING

Day 02

Time – 10.30

Duration: 60 minutes

- Target group : Farmers of rice-fish culture
- Title of session : Management during fish stocking
- Aim : To give the trainees a basic understanding on selection of fish species, determining stocking density, fry transportation and stocking so that they are able to select right species and determine required density for stocking to get better fish production by rice-fish culture
- Objective : At the end of this session, the participants -
- Will be able to state name of the species suitable for rice-fish culture
 - Will be able to identify quality fry
 - Will be able to determine the stocking density for rice-fish culture
 - Will be able to describe fry transportation
 - Will be able to stock properly by the knowledge of stocking density

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 5. Explanation objective of current session 	Q&A and discussion	
Topic		50 minutes
<ul style="list-style-type: none"> • Selection of fish species suitable for rice-fish culture • Stocking density of fish fry • Identifying quality and bad fry • Stocking time • Consideration during fry transportation • Procedure of fry stocking 	Lectures, and Discussion	
Summary		5 minutes
<ol style="list-style-type: none"> 1. Re-discussion of main topic 2. Assessment of session objectives <ul style="list-style-type: none"> • What are the suitable fish species to culture in rice field • What are the stocking density of different species? • After how many days of rice transplantation fish could be stocked? 3. Distribution of handouts 	Q&A	

Link up to the next session

Supporting Training Material > flipchart, white board, marker and handout

FLIPCHART DESIGN

(For detailed discussion follow the handout)

- ▲ Fish Species
- ▲ Quality Fish Fry
- ▲ Cause of fry death
- ▲ Density of fry to transport
- ▲ Cautions during transportation
- ▲ Acclimatization and fry release
- ▲ Period of fish stocking
- ▲ Procedure of fry releasing
- ▲ Stocking density
- ▲ Time of fish stocking

SUITABLE FISH SPECIES FOR RICE-FISH CULTURE

Fish Species

To culture fish with rice, fish species should be –

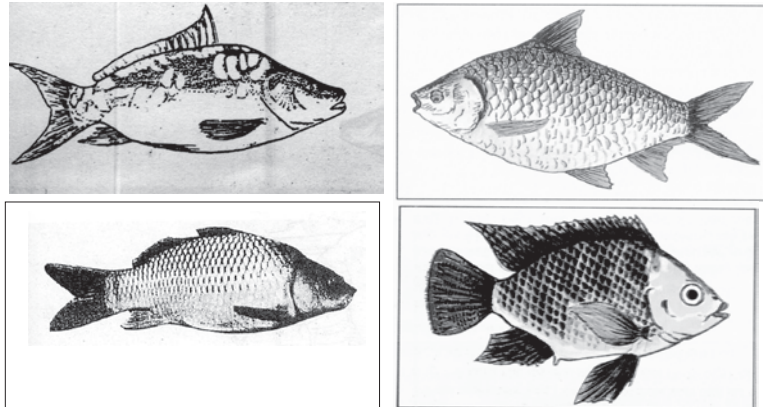
- Fast growing species
- Can survive in shallow water
- Can withstand temperature and environmental fluctuation
- Can be managed easily, such as, Tilapia, Common Carp, Ruhi, Mrigel, Thai Sorpunti and Bata fish . It can be mono or poly culture in rice field.

Species selection, collection of quality fry and size of fry

Identification of quality fish: Correct stocking density alone does not ensure good production. To get good production, along with correct stocking density, quality and healthy fry has to be stocked.

Fry source and handling affect the fry quality. Whatever the cause might be, farmer will face big loss if they stock low quality fish fry. If quality fry is not stocked –

- Large mortalities of fry will be incurred after stocking
- Growth rate decreases
- As they do not reach marketable size in time, will get low price



চিত্র: ধানক্ষেতে চাষযোগ্য মাছ

Therefore before stocking, the quality of fry should be ensured.

Comparatively larger fry should be stocked. This decreases the rate of fry death. Some characteristics to identify good and bad fry are given in the following table -

Identifying Good and Bad Fish Fry

Good quality	Poor quality
<ul style="list-style-type: none"> • Body color bright and glossy • Slippery scales • No marks on body and gills • If tail is held in a pinched manner then head moves quickly • Very agile in movement • Normal body structure 	<ul style="list-style-type: none"> • Dull body color • Scales are rough • Red marks on the body and gills • If tail is held pinched then moves head very slowly • Does not move and moves with current if water is stirred in container • Body structure is not normal

FRY TRANSPORTATION and STOCKING

In our country presently fish fry and prawns PL are transported in oxygen-filled polythene bags (Modern system) and prawns juveniles and fish fingerling in Drum or Aluminum Pot (Traditional system). 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.

Cause of Fry Mortality: Fry dies during transportation or right after stocking for a number of reasons. Among them few important causes are described below:

Oxygen depletion: The oxygen demand of fry and juvenile is greater than larger fish or prawns. Therefore if carried in high density there may be oxygen shortage and the fry or juvenile will die.

Physical injury: During handling, such as, during netting, weighing, counting, transferring from one container to another the scales of fry can come off or it can be wounded. Similarly, the antenna or appendages of juvenile prawns can get broken. These wounded fry and juvenile die during transportation.

Production of Ammonia: Ammonia is produced during transportation due to fecal excretion of fish seed and juvenile prawns which pollutes the water. If pollution crosses the tolerance limit, then fish/prawn seeds die quickly.

Distance of transportation: The longer the distance the greater physical stress on seed. So they can die.

Physical weakness: If the seed are weak and diseased then the transportation mortality is higher than that of those in normal and healthy condition.

Not doing Acclimatization: If seeds are not acclimatized before transportation they will be weak and vulnerable. These vulnerable seed cannot take the transportation stress.

Consideration during Transport:

- The transportation density depends on the species, size, weight, temperature, physiological condition etc. Such as, the density of Catla and Silver carp should be 30% less than other species during transportation.
- With increase of temperature, oxygen demand of fish and prawns and increases. Therefore, the temperature of the container during transportation should kept low. At low temperature and slightly high pH the digestion rate of fish and prawns is slow. To keep the water temperature low 10 gm ice/ liter of water/ hour should be mixed with the water.
- Density during transport should be less in case of larger fry and juvenile and the oxygen supply should be greater.
- If stomach is full then the oxygen demand increases and feces is excreted. Therefore before transportation they should be starved. Otherwise the ammonia increases because of bacterial attack on the fecal matter.
- During transportation of carps to minimize the stress due to unfavorable weather, edible salt should be mixed with water at a rate of 3 gm/liter. But salt should never be used in case of Pangasius and prawns.

Transportation density of seed: Whatever the transport mode - modern or traditional, the density depends on the size, weight of PL, juvenile or fry and on the distance to transport. Normally polythene bag of 36"x 12" are used to carry PL or fry. The sustainable transport density for traditional and modern system is given in the following table-

Transportation density of carp fry:

Transportation Method	Size (inch)	Density/Lit. water	Transportation Distance (hour)
Oxygen Bag	1.4 inch	33-35 pcs	10-12
	1.8 inch	20 pcs	10-12
	2 inch	13 pcs	10-12
	2.5 inch	5 pcs	10-12
	2.8 inch	4 pcs	10-12
Aluminum pot/ Container (Handi)	1-2 inch	15 pcs	3-4
	2.5-4 inch	5-6 pcs	3-4

Procedure of Traditional transport

- In the transport container 2-3 liters good quality pond water should be mixed with 10-12 liters of tube-well water.
- The opening of the container should be covered tightly with fine mesh net after loading the fish seed.
- During transport, 2/3 parts of water should be changed every 2-3 hours.

Procedure of Modern transportation

The modern method of packing and transporting fish and shrimp/prawn seed is about the same, however in case of shrimp/prawn seed some additional arrangements are needed. Following are points on stocking and transport that need to be taken into consideration for shrimps/prawns:

1. At least two hours before transport, feeding should be stopped however if the prawn are being carried long distance, PL can be fed Artemia nauplii or for every 500 PL one –eighth of a boiled egg yolk
2. Polythene bag should be checked carefully for holes. One bag should be placed in another and the corners tightly bound so that fish/shrimp/prawn seed do not get stuck anywhere. One-third of the bag should be filled with water
3. Only in case of transporting shrimp PL and juveniles, some weeds should be added to the water for shelter
4. Apart from PL and water, two-thirds of the bag should have oxygen and the bag should then be tightly bound.
5. If transporting many bags at the same time, it is safe to use a container where the temperature can be maintained

Precautions in transport

- Need to be careful that polythene bags have no pressure from the outside
- The pot being used to transport fish/shrimp seed should be covered with wet cloth or jute sack
- The pots and bags should be in shade during transport
- Polythene bags should not be subject to be hit by hard objects
- Within the same bag, size of PL and fry should be the same
- To keep the water cool, every hour, 10 gm of ice per liter of water should be added.

Acclimatization and stocking

Fish seed or PL may die because of high temperature or insufficient oxygen. Before releasing into pond if the fish seed and PL can be acclimatized with the new environment, then the mortality rate after release can be reduced.

For this the temperature of transport container and that of pond should be as much as possible the same, then it will be easier for the fish seed/PL to adjust to the new environment. The steps to be followed in the release of fish seed/ PL, juveniles and fingerlings are:

- Float the transport container in pond water for about 15-20 minutes
- After opening the container, by exchanging water gently from the pond to the container, the temperature should be the same
- Use hand to test the difference in temperature of water in transport container and that of pond water

- Need to ensure that the difference in temperature of the two environments 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 fish/prawn seed will swim out against the water current that is created gently by hand.

Time of seed release

In cool weather the seed can be released at any time of the day, however it is better to release in morning or evening time. The fish fry or PL should not be released in pond or Gher in mid-day sun, cloudy day or hot and humid weather (especially during depression).

Stocking density

This can be both mono or polyculture in both concurrent or alternate culture systems. There are differences in culture type and stocking density depending on type of land, fish species, size of fish seed and quantity of water. Integrated poly culture of different species is profitable. The per-decimal stocking density practiced in rice-fish culture is as below:

Fish Species	Model- 1	Model- 2	Model- 3	Model- 4	Model- 5
Tilapia	8	8	0	0	4
Thai Shorpunti	0	0	8	8	0
Ruhi	6	4	6	6	6
Mrigel/ Common carp	6	4	6	0	2
Bata	0	8	0	8	0
Golda	0	0	0	0	10
Total	20	24	20	22	22

- In concurrent system fish seed could not be released right after rice seedling are transplanted
- After seedling transplant it takes 10-15 days to grow roots strong enough to hold soil and to grow tiller.
- Therefore fish seed should be released 10-15 days after transplantation
- Though in case of large ditch filled with required quantity of water fish could be released right after transplanting of paddy seedlings.

Procedure of fish seed release

The transport container should be kept floating in the pond water for 15-20 minutes. Then using hand slowly small quantities of pond water should be added to the bag. Water of container and pond should be gently exchanged until the temperature of both container/bag and pond reach in equilibrium. The bag/container should then be tiled and current created by hand against which the the fish seed will swim out of the container.

Species selection for Alternate system

Species	Density per decimal
Rohu	3-4 pcs
Catla	2-3 pcs
Silver carp	3-4 pcs
Mrigel	2-3 pcs
Mirror carp	3-4 pcs
Thai Shorpunti/ Bata	6-7 pcs
Total	19- 25 pcs

As there is less water in Boro season, it is not profitable to release fingerling and rear to table fish is not profitable. Instead it is more profitable to release hatchling or fry and rear to larger fingerling stage.

Stocking time

Fish should not be released right after transplant of rice seedling since fish seed release requires a minimum of 4-5 inches of water, but this quantity of water is harmful for primary stage of rice. It decreases tiller number. Therefore, after 10-15 days of seedling transplantation, when tiller comes out, 4-5 inches of water can be filled in the field to release fish seed. If there is larger pond in rice field, then fish can be released before seedling transplant.

Sometimes it has been seen that when the field is left derelict after Boro harvesting and before Aman planting and there also remains water of required quantity. In this case, 6"-fingerlings can be released, which would be of marketable size by time of field preparation for Aman paddy. After planting of Aman seedling farmer can again release fish seed and can get more fish production.

GROUP SESSION PLANNING

Day 02

Time – 11.45

Duration: 45 minutes

Target group : Farmers of rice-fish culture

Title of session : Post-stocking Management fish culture in rice field

Aim : To enhance the knowledge of the training participants on fertilizer application and feeding after stocking, about diseases of fish, harvesting and marketing the fish so that they are able to determine fertilizer and feed quantity, are able harvest and market properly to get better fish production through rice-fish culture

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

- Will be able to manage feed in rice-fish culture
- Will be able to determine fertilizer quantity for rice
- Will be able to apply feed properly
- Will be able to control fish disease
- Will be able to harvest and market fish properly

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. Explanation objective of current session 	Q&A and discussion	
Topic		40 minutes
<ul style="list-style-type: none"> • Feed Management • Fertilizer management • Fish health checking • Controlling fish disease • Harvest and market fish properly 	Lectures, and Discussion	
Summary		3 minutes
<ol style="list-style-type: none"> 1. Re-discussion of main topic 2. Assessment of session objectives <ul style="list-style-type: none"> • Which fertilizer could be applied? • What is the necessity of supplementary feed? • What diseases can be occurred in fish culturing in rice field? 3. Distribution of handouts 	Q&A	

Link up to the next session

Supporting Training Material > flipchart, white board, marker and handout

FLIPCHART DESIGN

(For detailed discussion follow the handout)

Feed and fertilizer management

Checking fish growth and health

Preventing and treatment of fish disease

Density of fry to transport

Causes of fish disease

Preventing fish disease

Medicine/Treatment

Fish harvesting and Marketing

POST STOCKING MANAGEMENT

Feed and Fertilizer Management

Normally little extra feed is required for fish in rice-fish culture. Fish consume algae on rice stems, phytoplankton, insect larvae, some insects and small weeds as feed. However, to increase the fish growth or if there is depletion of natural food in rice field, then supplementary feed should be applied. Such as fish feed rice bran, wheat bran, duckweed, Agolla can be given at a rate of 2-3% of total fish biomass. In case of using mustard oilcake and rice bran, it should be applied in 1:2 ratio daily in for the whole pond or in mini pond. For rice the fertilizer should be given as per rules of rice cultivation. By applying fertilizers in following rates 15-day intervals good results could be achieved –

Fertilizer	Type	Per decimal/fortnight (for 15 day)
Organic fertilizer	Cow dung	2kg
Inorganic fertilizer	Urea	75-100 gm
	TSP	40-50 gm

Checking fish growth and health

Whether fish are growing properly and to check their health it is needed to check them by sampling every month. Whether fish are diseased should be checked properly and often fish health should be checked.

Prevention and treatment of fish disease

Fish disease is a great threat in success of fish culture. Sometimes fish disease in fish-rice culture becomes a reason of great anxiety for farmer. The treatment of fish disease is very difficult and costly and therefore care should be taken so that the disease cannot take place, that is, prevention is better than cure. Successful farmers must have complete knowledge of symptom, causes, prevention and

Diseased and dead plants should be 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

Symptoms of Diseased fish

- Fish are dull
- Excess secretion of mucus
- Normal fish color becomes pale or dark
- Scales become swollen or fall off
- Color of gill will be pale
- Fish belly will be swollen.
- Ulceration seen on the scale, skin and fins.
- Head becomes larger than the body
- Whitish spot on fish body.
- Sometimes extensive mortalities like epidemics.

Causes of fish disease

The causes of fish diseases are–

- Virus/bacteria/fungus
- protozoan parasites
- Parasitic worms
- Deficiency of food and nutrition
- Environmental stress

Prevention of fish disease

- Liming before fish stocking and after 50-60 days of stocking.
- Not to stock excess quantity of fish
- Using required quantity of feed and fertilizer

Medicine/Treatment

1. Fish ulcers (Epizootic Ulcerative Syndrome -EUS): In 1988 the prevalence of this disease observed for the first time in this country and later it became an epidemic. This disease can cause a great losses in fish culture.

Symptom

- Primarily small red spots are seen on fish body
- Later these spots creates deep scars
- Fish losses balance
- Fish dies in large scale

Treatment

- 1kg burnt lime and 1 kg edible salt to be applied in combination
- Diseased fish should be soaked in 2% saline solution for as long as it can tolerate and then released to the pond
- 60-100 mg Oxytetracycline or Terramycin should be mixed with feed and applied for 7 days consecutively.
- 20-25 mg Oxytetracycline or Terramycin per kg body weight of fish should be injected once in a week for consecutively 3 weeks.

2. Echthyophtheriosis: This is a protozoan parasite. Maximum carps are attacked by this parasite. It attacks the skin, fin and gill of fish

Symptom

- Small white rounded spots are observed on body and fins
- Fish tries to scratch against hard substances
- Secretion of excess mucus
- Respiration rate increases in fish
- Fish does not take food
- Fish dies in large scale

Treatment

- Lime should be applied at a rate of 1kg per decimal of pond
- Fish density should be decreased
- Diseased fish should be dipped in 200 ppm saline solution for 10-15 minutes and then released in clean water.

3. Arguliosis (fish lice): It occurs due to infection of multicultural Argulus species. Normally big carps are attacked by this parasite, though smaller fry can also be infested.

Symptom

- The parasite can be seen with naked eyes attached at the base of fins and between scales
- Diseased fish moves and jumps impatiently.
- Fish scratches itself against hard substances
- Bleeding starts in parts of fish body
- Fish dies in short time

FISH HARVESTING and MARKETING

Fish Harvesting Process and Post Harvest Care

Fish harvesting process differs depending on culture process, that is, depending whether it is concurrent or alternate system.

In case of Concurrent system

- Rice should be harvested right after it has ripened. The rice ripening and harvest depends on the type of rice. However for fish culture, after rice harvest paddy stems should remain in huge quantity. The decomposition of these organic matters results in plenty of natural feed in pond for fish.
- If there is no water after rice harvesting, then the fish should be ready for harvest. If the water dries up long before rice harvest, then fish should be harvested but if there is enough water in the field after rice harvesting then the fish can be kept for few more days. To harvest the fish the pond and canals should be de-watered. Fish should be harvested in early morning which keeps the fish fresh and gets a better price.
- If there is enough water in field then fish should be harvested after rice. If water dries up while still there is rice in the field, then by de-watering the canal and ponds, fish can be harvested.

In case of Alternate system

In this case as there is no rice in the field, the fish can be harvested by seine net (Ber Jal) . Moreover fish also could be harvested by Jhaki Jal or by drying up the pond. The harvesting process depends on the total area of field, depth of water, fish species etc.

Post-harvest care of fish

- Dirt and clay should be washed off the fish using by clean water after harvesting.
- Fish should be sorted out according to species
- Fish should be kept in cool place after harvesting
- Fish should be covered with banana leaf or other such substances during transportation so that fish is not exposed in sun
- Fish should be sold as early as possible.



চিত্র: মাছ আহরণ

Fish Marketing

- Local market should be contacted before fish harvest
- Better price can be obtained from markets where fish prices are higher
- Selling fish during local or national festival gets better price because in during these seasons fish price increases.

GROUP SESSION PLANNING

Day 02

Time – 12.30

Duration: 60 minutes

- Target group : Farmers of rice-fish culture
- Title of session : Vegetable cropping on dyke of rice field
- Aim : To give hands on knowledge to the trainees on cropping of different vegetables on dyke of rice field so that they are be able to grow highly productive and valuable vegetables and fruits on the rice field dykes and can fulfill family nutrition needs as well as can gain economically.
- Objective : At the end of this session, the participants -
- Will be able to explain the importance and benefit of cropping on rice field dyke
 - Will be able to explain the selection criteria of crop to cultivate on dyke
 - Will be able to tell the model of dyke cropping
 - Will be able to produce, processing and preserving the crop seeds
- Will know about the insects of crop and their control measure

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. Focusing on current session 	Q&A and discussion	
Topic		50 minutes
<ul style="list-style-type: none"> • Importance, benefit and basic subjects of dyke cropping • Consideration of dyke cropping • Crop selection and culture process on dyke • Production, processing and preserving the crop seeds • Insects of crop and their control measure 	Lectures, and Discussion	
Summary		6 minutes
<ol style="list-style-type: none"> 1. Re-discussion of main topic 2. Assessment of session objectives <ul style="list-style-type: none"> • What is the importance of dyke cropping • Name some beneficial crop suitable for culture on dyke 3. Distribution of handouts 	Q&A	

Link up to the next session

Supporting Training Material ➤ flipchart, white board, marker, handout, seeds of different vegetable crops

FLIPCHART DESIGN
Cropping of Rice field Dyke
(For detailed discussion follow the handout)

- Importance and benefit of integrated culture
- Consideration of crops cultivation on rice field dyke
- Consideration to select suitable crops to cultivate on rice field dyke
- Model of cropping on rice field dyke and dyke preparation
- Suitable seasonal vegetable for dyke cultivation
- Management of dyke cropping
- Cultivation procedure of different crops on dyke
- Production processing and preservation of vegetable seeds
- General pests of vegetable in dyke cultivation and their control

VEGETABLE CROPPING ON RICE FIELD DYKE

Dyke cropping is a type of integrated culture. By maximum utilization of land, maintaining the environmental equilibrium and getting maximum benefit from the same land, culturing more than one crop is known as integrated culture. Such as, fish-prawn culture, fish cum poultry/duck culture, rice-fish-vegetable culture, fish and livestock culture etc. Though integrated culture is a recent concept in our country, it has been practiced historically in other parts of the country. For faster growth of our rural economy integrated culture should be popularized.

Benefits of integrated culture

- From the same land at the same time farmers can get more than one crop at low investment .
- Opportunity for alternate income
- One crop complements the other
- Environmental equilibrium is maintained
- Maintains the fertility of the land
- Decreases the harmful pests of crops.
- The cost of pesticide and fertilizers decreases, therefore, can produce chemical/poison- free vegetable
- No need for excess labor to control the weeds of dyke
- Ensures proper use of labor
- Can get year round income from different sectors
- Can minimize cropping risk
- Decreases the need of taking loan.

Importance

Dyke cropping along with rice-fish culture is a highly standard integrated culture. It ensures maximum use of minimum land. By cropping alternately on rice field dyke –

- Can fulfill year round family need and nutrition deficiency.
- Is a source of extra income
- Can take care of fish, rice and vegetable together
- Can increase the participation of women in agriculture
- Vegetable intake can change the feeding habit
- Can prevent unhealthy environment.
- Increases the market supply of food item
- Different crops can get from minimum expense and less time.

Consideration of dyke cropping

- Success of integrated culture
- Intensive labor in integrated culture
- Investment for integrated culture comparing with mono culture
- Management procedure
- Crop selection
- To introduce size, area and design for integrated culture

Consideration of selecting crops to cultivate on dyke

Crops to cultivate on dyke should be selected based on the situation of dyke, availability of sunlight, market price, soil type or characteristics, farmer's financial condition, seed availability, consumer's demand and no damage to dyke. Again, crops of same family should not be chosen to cultivated together because they are affected by similar type of disease and pests and they compete with each other with same nutrition. Therefore to select crops following should be taken into consideration:

- Crop of deep roots should be chosen together with those of shallow roots
- With bean type of crops should choose Ashimbi type.
- With crops that require high nutrition should choose those that require less nutrition
- With tall crops should choose short crops
- With more creeper should choose less creeper type
- With crops that give shade, choose crops that grow in the shade
- With crops more prone to pest attack should choose hardy crops that prevent pest attack
- With long duration type should choose short duration type

Other aspects to be considered for vegetable cropping –

- 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

Care should be taken in every step from seed sowing to harvesting. In case of creeper there should be peg or support, or trellis. Taking proper timely care will give healthy crops. It will decrease disease incidence and expect good crop production can be achieved.

Dyke cropping Model

Suitable land	Rabi	Kharif (monsoon crop)
Dyke of rice field	Tomato, Beans, Kohlrabi	Bitter gourd, cucumber, Wax gourd, okra, sweet pumkin

Preparing Dyke

Though the concept of cultivation on rice field dyke is new, but the cultivation procedure is not new. It is the same way of cropping which has been practiced for years in the field and on homestead. Though, the selection of crop for dyke cropping differs. Crops should be chosen depending on the type of dyke. Any vegetable/crop can be cultivated on any type of dyke. However the dyke should be prepared as per that crop. Depending of the nature of the field the type of dyke can vary, Such as –

- High dyke of rice field
- Medium high dyke
- Low dyke
- Medium low and wide dyke
- Narrow dyke, etc.

These are made by bringing soil from other places during field preparation. However, it is not necessary to make the dyke high for all cases, since, in some places high dyke already exists. In that case the soil should be made soft, free of soil clumps, and loose. The cultivation procedure of crops cultivable on dyke is described below:

According to the following table the area based suitable crops should be discussed

Culture Procedure of Different Crops

Crop name	Variety	Spacing of sow/plant (inch/feet)	Rate of seed/shotok or 40 m ²	Duration of cropping (Days)	Production kg/decimal	Comments
1. Okra	BARI-1, Modified and hybrid varieties	Row to row: 2 ft Plant to plant: 1ft 6 inch	25-30 gm	60- 90 after sowing	35-40	Seeds to be soaked for 24h before sowing
2. Tomato	Modified and hybrid varieties	Row to row: 2 ft Plant to plant: 1ft 3 inch	1.5 gm/ 90- 100 seedling	70-90 after planting; 100-120 after sowing	70-100	28-35 days old seedling to be planted
3. Wax gourd	UARI Wax gourd-1 and Modified and hybrid varieties	Row to row: 6.5 ft Shape of pits 5x5x4.5	2gm, 4-5 seeds/pits	120 after sowing	70-90	Trellis is needed, keeping 2 seedling /pits rest to be uprooted
4. Bitter gourd	BARI Korolla-1	Row to row: 3 ft 3 inch Plant to plant: 3 ft 3 inch, Shape of pits 17.5x417.5x17.2	25 gm, 4-5 seeds/pits	50-60 after sowing	20-25	Trellis is needed for loner variety. For smaller variety mound with hay is enough
5. Bottle gourd	BARI-1 (Winter) BARI-2 (Winter and Summer)	Row to row: 5 ft Plant to plant: 5-6.5 inch Shape of pits 5x5x4.5	3-4 gm, 4-5 seeds/pits	100- 120 after sowing	80-100	trellis is needed
6. Sweet pumpkin	Modified and hybrid varieties	Row to row: 5 ft Plant to plant: 5 ft Shape of pits 1.5x1.5x1.5	3-4 gm, 4-5 seeds/pits	100-120 after sowing	80-100	Trellis is needed during monsoon, otherwise it can be cultivated on ground
7. Cucumber	Modified and hybrid varieties	Row to row: 2 mt Plant to plant: 1.5 mt Shape of pits 2x2x1.5	2-3 gm, 4-5 seeds/pits	70 -80 after sowing	40-60	Seeds must be soaked for 24h before sowing
8. Hyacinth Bean	BARI Sheem-1 BARI Sheem -2 White IPSA-1 White IPSA-2	Row to row: 2.5 mt Pits to Pits: 1.5 mt, Shape of pits 1.5x1.5x1.5	25-30 gm, 4-5 seeds/pits	110 -130 after sowing	30-40	Seeds to be soaked for 8h before sowing
9. Kohlrabi (Olkopi)	Modified and hybrid varieties	Row to row: 25-30 Plant to plant: 15-20	3-4 gm, 230-260 seeds	45-60 after sowing	70-100	Can be sown directly, but it is better to 25-35 day old plant seedlings

MANAGEMENT OF DYKE CROPPING

In case of vegetable cropping, for better growth and expected production, the sequential job or care taken after seed sown or seedling planting is known as Crop Management. The crop managements includes the following:

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

Some of the above managements are briefly discussed below:

Mulching: Covering the crop bed or base of a plant with rotting hyacinths, dry grasses, and other vegetations 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 need 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 30-40 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. Therefore after plants emerged out it becomes dense. To maintain spacing, the weaker seedlings should be uprooted keeping the healthy ones at the right distance from one another after 8-10 days of sowing.

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.

Setting up Trellis

Creeper cannot grow freely on ground. These crops can grow fast if a support or hold up can be given above the ground level e.g. a trellis which can be made bamboo, split bamboo, jute stick, Dhoincha etc.



চিত্র: সীম গাছে মাচা

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 dundul 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.

Pollination:

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 pollination, 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.



চিত্র: কুমড়া ফুলের কৃত্রিম পরাগায়ন

Pest and disease management:

Diseases and pest are serious enemies of plants. If plants are not kept diseases 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.

PRODUCTION AND PRESERVATION OF CROP 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 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 dries 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 dies, 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 vegetables 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

GROUP SESSION PLANNING

Pest name	Crop name	Damage symptoms	Control/ management
1. Jab poka	Been, bottle gourd, sweet pumpkin, cucumber	<ul style="list-style-type: none"> Suck up the juice of flower and fruits Flower, fruits fall off 	Biological pesticide eg., Neem oil and Tobacco give good results. Pest should be made with 20 ml neem oil and 60 gm soap foam and then should be mixed with 10 lit water. Then this solution should be strained and sprayed. Grounded tobacco leaf should be soaked overnight and then should be mixed with water after straining and spraying will control the pest. Moreover, 10 ml Melathion 57 EC or Admire-200 ML should be mixed with 10 Lit water and sprayed.
2. Fruit borer	Bean, Tomato	<ul style="list-style-type: none"> Nymph/Larvae bore into the fruits and eats its pulp. Fruits rotten out 	Primarily the diseased fruits should be picked up and to be buried in soil. Even after the infestation increases, 10 ml of Lebacide 50 EC or Sevin 85 SP could be mixed with 10 lit water and sprayed.
3. Fruit fly	Bottle gopurd, Sweet pumpkin, wax gourd and other pumpkin	<ul style="list-style-type: none"> Fruits rotten out very young Flower, fruits fall off 	By poison trap: 100 gm mature sweet pumpkin should be cut into small pieces and grounded and then mixed with 0.25gm Mipcine or Sevin 85 powder and 100 ml of water and should be taken into a earthen pot and placed above 1.5 meter of the ground by 3 poles in the field. After 3-4 days new mixture should be placed in. By Sex Pheromone: By placing poison trap or sex pheromone in 13 yard interval this pest could be controlled
4. Red Pumpkin beetle	Bottle gopurd, Sweet pumpkin, Cucumber Better gourd	<ul style="list-style-type: none"> Adult and larvae of this pest bores stem from the base, so the plant declined and die out 	The seedling should be covered up by mosquito net for initial 20-25 days. If infestation rates increases, then 2-5 gm should be mixed with the soil surrounding each Pits and then should irrigate.
5. White fly	Okra, Tomato	<ul style="list-style-type: none"> Disease spread by virus 	10 ml Melation 57 EC or Admire-200 ML should be mixed with 10 lit water and sprayed underneath leaf.

Main Diseases of vegetable cultivable on the dyke and their management

Disease name	Crop name	Damage symptoms	Integrated pest Management
Virus	Broad beans, tomato	Leaf becomes thickened and wrinkled	White fly is a virus carrier and so that his 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.
Root and stem rot	Okra, sweet pumpkin	Stem becomes rotten at seedling stage and 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.
Anthro-nose	Bean	fruit, stem, tip ruptures and fruit falls 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
Leaf spot or rust disease	Bean	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

GROUP SESSION PLANNING

Day 02

Time – 13.30

Duration: 30 minutes

- Target group : Farmers of rice-fish culture
- Title of session : Maintaining records of income-expenditure and information of rice-fish culture and dyke cropping
- Aim : To teach the training participants on how to maintain the information of expenditure and income of rice-fish culture and dyke cropping so that they can gain knowledge to keep the accounts properly and can gain from the culture.
- Objective : At the end of this session, the participants -
- Will be able to calculate income – expenditure of fish and vegetable culture in rice field
 - Will be able to preserve/ record the information of rice-fish cultivation

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. To explain objective of current session and to encourage them 	Q&A and discussion	
Topic		25 minutes
Fish harvesting process and post harvest caring <ul style="list-style-type: none"> • Accounts of income-expenditure • Record keeping of income-expenditure 	Q&A, Lectures, and Flipchart	
Summary		6 minutes
<ol style="list-style-type: none"> 1. Re-discussion of main topic 2. Assessment of session objectives <ul style="list-style-type: none"> • Way of accounts keeping on income-expenditure? 3. Distribution of handouts 	Q&A	

Link up to the next session

Supporting Training Material ➤ flipchart, poster paper, marker, leaflet/handout

FLIPCHART DESIGN
Income-Expenditure of Rice-fish Culture and Dyke Cropping
(For detailed discussion follow the handout)

Accounts of Income-expenditure
Record keeping of Income-expenditure

INCOME-EXPENDITURE OF RICE-FISH CULTURE and DYKE CROPPING

Keeping records of income-expenditure is very important for any business and cultivation process. It is not possible to assess profit/ loss of any business or culture without income-expenditure record. To keep the record each and every income or expenditure should be written down immediately. Income –expenditure does not differ much between concurrent and alternate systems of cultivation. However, in the alternate system if the fish stocking density is high and feed and fertilizer are given accordingly then income will increase. The possible per hectare/acre income-expenditure of rice-fish culture is given below:

Different materials	Rice-fish (concurrent)		Rice-fish (alternate)	
	Description	Taka	Description	Taka
Expense				
a) Land preparation				
Dyke making	1 Labor	200	1 Labor	200
Porikha excavation	1 Labor	200		
Ditch excavation	2 Labor	400	2 Labor	400
Canal making	1 Labor	200	1 Labor	200
Total		1000		800
b) Soil plough and fertilizer application				
Soil plough (2 ploughs by tractor)		1800	1 labor	1800
Fertilizer application	1 labor	200	1 labor	200
Urea 20/- kg	80 kg	1600	80 kg	1600
TSP 26/- kg	62 kg	1610	62 kg	1610
MP 22/- kg	32 kg	705	32 kg	705
Gypsum 8/- kg	52 kg	415	52 kg	415
Lead 120/- kg	2 kg	240	2 kg	240
Total		4,770		4,770
c) Rice cultivation				
Seed	10 kg	250		250
Expenses for seedling transplantation	15 labor	3,000		3,000
Caring	20 labor	4,000		4,000
Pest control	2 labor	400		400
Expense for harvesting	10 labor	2,000		2,000
Dhan Marano	4 labor	800		800
Total		10,425		10,450
d) Fish culture (Model-3 Alternate Model)				
Fish seed- Shorputi	800 @4	3200	600 @ 4	2400
- Mirror carp	600 @ 5	3000	300 @ 5	1500
- Rohu/carp	600 @ 4	2400	1000 @4	4000
Feed				
Fish harvest	4 fishe	800	4 fisher	800
Total		9,400		8,700
e) Irrigation Cost		800		1000
f) Miscellaneous		1320		1275
Grand Total (a+b+c+d+e+f)		27,715		26,795

Income				
Rice price	2500-3000kg or 67-80 mon (per maund 600/-)	40,200 – 84,000	2500-3000kg or 67-80 mon (per maund 600/-)	40,200 – 84,000
Fish price (Average production with rice and after rice respectively 1,5 kg/decimal and 2 kg/decimal)	150- 200 kg (average per kg @ 100/-)	15000- 20000	150- 200 kg (average per kg @ 100/-)	15,000- 20000
Total Income		55,200- 68,000		55,200- 68,000
Net Profit (Income – expense)	27485-40285 (Taka)		28400 – 41200 (Taka)	

INCOME-EXPENDITURE OF DYKE CROPPING

We have already learnt the crops should be selected based on type of dyke. Moreover Income –expenditure of monoculture is different. The production cost of some crops is very low, such as Red amaranth, water spinach etc, and the production cost of some crop is very high, such as, Tomato, Bitter gourd etc. Similarly, the income of monoculture also varies. The income –expenditure of some crops cultivable on dyke are given below:

1. Income-Expenditure details of (per decimal) of Bottle gourd/Sweet pumpkin/ Wax gourd/ bottle gourd/Cucumber

SL.	Cost item	Amount	Taka	Comments
	Plastic thread (Jangla/ Macha) & Bamboo	1kg & 1 pcs	250	
	Soil preparation	0.5 person	100	Family labor will be 0.5 person
	Seed/seedling	5-20gm	50-130	
	Fertilizer	Urea 2kg, TSP 1.8 kg, MP 1kg, Borax 50 gm	100	
	Pest & other management		100	Poison trap/Sex Pheromone & other pest control
	Irrigation	3 times	60	
	Total		670-740	
	Income			
১.	Yield	100-170 kg	2000-2550	15-20 taka/kg
২.	Leaves & tips	30 kg	300	In case of Bottle gourd
	Total		2000-2850	
	Net Profit		1330-2110	

* Land price, cost of organic fertilizer & family labor not taken into account.

2. Income-Expenditure details of Broad Beans:

SL.	Cost item	Amount	Taka	Comments
1.	Bamboo for support	2 pcs	200	
2.	Seed/seedling	50 gm	50	
3.	Fertilizer	Urea 350 gm, MP 300gm, TSP 100 gm, Borax 40gm	30	
4.	Pesticides & others		50	If needed
5.	Irrigation	3 times	60	
6.	Others		10	
	Total Expense		500	
	Income			
1.	Yield	90 kg	1530- 1800	17-20Tk/kg
	Net Profit		1030- 1300	

* Land price, cost of organic fertilizer & family labor not taken into account.

3. Income-Expenditure details of German turnip

SL.	Cost item	Amount	Taka	Comments
1.	Soil preparation	0.5 person	100	
2.	Seed/seedling	250 pcs of seedling	150	1000 Tk/kg
3.	Fertilizer	Urea 0.8-1 kg, MP 400gm, TSP 400 gm, Gypsum 0.75 gm, Led 20 gm	55	
4.	Pesticides & others		35	If needed
5.	Irrigation	3 times	60	
	Total Expense		400	
	Income			
1.	Yield	150 kg	1500- 1800	10-12Tk/kg
	Net Profit		1100- 1400	

* Land price, cost of organic fertilizer & family labor not taken into account.

4. Income-Expenditure details of Lady's fingers:

SL.	Cost item	Amount	Taka	Comments
১.	Soil preparation	0.5 labor	100	
২.	Seed	25 gm	40	
৩.	Fertilizer	Urea 600 gm, MP 600gm, TSP 400 gm, Gypsum 280 gm, Boron 60 gm, Led 20 gm	60	Cow dung/compost personal (cost not counted)
৪.	Pesticides		40	If needed
৫.	Irrigation	3 times	60	
	Total Expense		300	
	Income			
৬.	Yield	55 kg	825- 1100	15-20Tk/kg
	Net Profit		525- 800	

* Land price, cost of organic fertilizer & family labor not taken into account.

5. Income-Expenditure details of Tomato:

SL.	Cost item	Amount	Taka	Comments
1.	Soil preparation	0.5 labor	100	
2.	Seed	150	200	
3.	Supporting plants	3 bamboo	300	
4.	Fertilizer	Urea 800 gm, MP 1 kg, TSP 1.8 kg, Borax 50 gm	80	
5.	Pesticides		100	If needed
6.	Irrigation	If needed	60	
	Total Expense	50 gm	840	
	Income			
1.	Yield	210 kg	825- 1100	8-10Tk/kg
	Net Profit	7228	840- 1260	

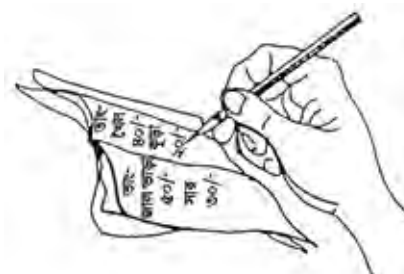
* Land price, cost of organic fertilizer & family labor not taken into account.

In rice-fish culture and dyke cropping profit is definite, depending on management and type of crops. As the value of materials for fish culture may vary place to place, so the income-profit may also vary.

Record keeping:

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:

- Record of physical properties of the rice field
- Depth of water
- Detailing of pond preparation & expense
- Cost of fish seed collection/transportation/stocking
- Number of fish seed
 - Information of fertilizer application – type/weight/cost
 - Information of feed application – type/weight/cost
 - Information of sampling
 - Quantity / income from fish harvest 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.

SOME NECESSARY MEASUREMENT UNIT FROM 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 litres
1 meter ³	1000 litre
1 kg	2.205 pounds =1.07 sher
1 metric ton	26.7924 maund
1 gm	1000milligm
1 liter	1000 ml
1 ppm	1 milligm/liter =1 gm/m ³
ft ³	Gm/ milliliter
35.31 x ppm	

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