

Participatory training and curriculum development for Farmer Field Schools in Guyana and Suriname

A field guide on Integrated Pest Management and aquaculture in rice

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CURRICULUM FOR FARMER FIELD SCHOOL ON INTEGRATED PEST MANAGEMENT AND AQUACULTURE IN RICE-BASED FARMING SYSTEMS IN GUYANA AND SURINAME

PREPARED AND PRODUCED BY THE TRAINEES AFTER THE SEASON-LONG TRAINING OF TRAINERS CONDUCTED AT THE NARI/GRDB RESEARCH STATION, LESBEHOLDEN VILLAGE, BLACK BUSH POLDER, CORENTYNE, EAST BERBICE, GUYANA (5 DECEMBER 2004 TO 18 MARCH 2005)

Preface

"I.P.M is not for trainers. It's by trainers."

This curriculum, developed and edited by the trainees of the IPM rice-fish ToT, is not a cooking recipe, but an inspirational document which is free for modifications based on local needs. Its contents are a blend of actual ToT experience and other sources, prepared under the guidance of the two FAO TCDC consultants for IPM and aquaculture, and the participants of the season long IPM/FFS training program held in Guyana from 5 December 2004 to 18 March 2005.

This curriculum emphasizes the strategy of integrating fish into rice production systems in Guyana and Suriname, through IPM, under the Farmers Field School participatory approach.

This curriculum presents procedures of activities to be undertaken aimed at providing an opportunity for rice farmers in realizing additional income, higher crop yield and reduced cost of production, by reducing their spending on the purchase of pesticides, through farmer education based.

It is hoped that both trainees and facilitators of FFS would find this curriculum enlightening and handy to use.

H. Ramlall
Participant
Training Program

Acknowledgement

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Special thanks are likewise extended to the Ministries of Agriculture of Guyana and Suriname, Guyana Rice Development Board, and the Guyana Rice Producers Association for sending its extension officers to attend and become a part of this training program.

Most of all, thanks to our two dedicated and hard working consultants: Mr. Godardo Juanich, Aquaculture Specialist, and Mr. Wahyu Sutisna, IPM/FFS Specialist, for conducting this training in a simple, memorable and enjoyable way.

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PART I

CURRICULUM FOR INTEGRATED PEST MANAGEMENT (IPM) AND FARMER FIELD SCHOOL (FFS)

General Topics

1. BACKGROUND

The Farmer's Field School (FFS) has been an ongoing program for the past four seasons in Guyana. During this time facilitators have encountered problems with the poor attendance of farmers because of the limited knowledge in the management of the farmer's field school. A training program was conducted to enable facilitators to better conduct and correct difficulties encountered during the past FFS. As a part of the Training of Trainers (TOT) program it was envisaged that there should be better planning of the pre and ongoing FFS activities. This curriculum consists of two major parts: Pre and On-Going FFS. It was recommended that the following activities should be carried out before commencing the FFS:

- Site Selection
- Identification of Farmers
- Learning Contract
- Training Needs Assessment
- Regional Support System

2. SITE SELECTION

Site Selection is important to the farmer's field school because of the various factors that have to be considered. Inappropriate site selection would hamper the farmer willingness to participate. However site selection should satisfy the following criteria:

- Rice growing area;
- Area - large concentration of farmers;
- Meeting place- should be comfortable for farmers;
- Farmer/cooperator - farmer should be cooperative, influential, have good leadership quality and must be willing to work with other farmers;
- Site - should be suitable for fish pond, have adequate drainage and irrigation;
- Rice/Fish plot-must be easily accessible.

3. IDENTIFICATION OF FARMERS

Persons selected for participation in FFS should be interested in learning new technologies, must be willing to share their knowledge with other farmers and be able to participate fully throughout the entire FFS.

Some additional points to consider when selecting persons are:

- participants can be either male or female;
- participants should be full time rice farmers;
- young farmers are preferable;
- any other interested persons.

4. METHOD OF IDENTIFICATION

There are several methods for identifying and selecting farmers for the FFS. However, it is important to use the most effective method, since FFS is a fairly new process.

Methods of selection are as follows:

- notification by individual contact;
- invitation of all prospective farmers;
- commitment of persons through a learning contract.

5. LEARNING CONTRACT

The Learning Contract is a meeting with prospective and potential FFS candidates in the community where the FFS will be conducted. The contract is a consensus between facilitator and farmers to better organize, to achieve goals.

The learning contract should convey the following:

- It is intended to make a compromise between the facilitator and farmers.
- The advantage should be given to farmers by facilitator to participate fully.
- The facilitator should explain to farmers that the FFS would be on going for the entire season, to enable them to learn all aspects of rice cultivation and the reduction of pesticide use. Trials would be done to examine crop performance for specific treatment. The farmer will be responsible for all activities pertaining to the trial.
- Facilitators should propose regular meetings each week (one day, for three hours).
- The facilitator should let farmers fix a day and time suitable for them.
- The facilitator should interact with farmers about what will be delivered and farmers should contribute and participate fully.
- The facilitator should inform farmers that all materials will be provided.
- Facilitators and farmers should be committed to the contract by consensus;
- The farmers should elect a contact person, who will remind all participants of the FFS.

The following activities should be carried out every week: AESA, Special topic "Rice/Fish", Group Dynamics, and evaluation.

6. PLANNING FOR THE FARMERS FIELD SCHOOL

Based on the life cycle of the crop, the FFS will be conducted for fourteen (14) sessions (four sessions before the crop and ten during the crop). Each session should be a maximum of three (3) hours and will consist of four parts:

- Agro Ecosystem Analysis 1 hour
- Special Topic "Rice" 1 hour
- Special Topic "Fish" 45 Minutes
- Group Dynamics 15 Minutes

Each special topic for Rice or Fish should be done at the relevant stage of the crop. The FFS will also consist of on farm trials. Each school should not exceed four (4) trials.

It should be explained to the farmers that they will be placed into groups and will be responsible for the monitoring and collection of data for each trail plot. Each group will be responsible for one trial.

7. REGIONAL SUPPORT SYSTEM

If the FFSs are located far from each other, it will be difficult to provide timely support. Long travel times and a lack of easy access are other constraints.

For this reason, it is advisable to set up a regional representative, who will be responsible for facilitating the FFS needs, and liaising with the overall coordinator. This system is also useful if progress reports are required.

8. TRAINING NEEDS ASSESSMENT (TNA)

The training needs assessment will enable the facilitator to have a better knowledge of the management practices of the farmers, and the constraints that need to be addressed in the area where the FFS will be taking place. This will help in the proper planning of the fourteen session's schedule of the FFS.

9. T.N.A. QUESTIONNAIRE

The following questionnaire can be used to easily gather the required information for the TNA:

Name of farmer:

Address:

Acreage:

Variety:

Burning of straw: Yes ☐ No ☐

Land preparation:

Plough	…..
Chip	…..
Rake	…..
Back blade	…..
Level	…..

Date sown:

Seed Rate:

Fertilizer:

Age of crop	Type	Rate

Crop protection:

Insect	Type	Method of control Amount	Chemical used
Weeds			
Disease			

Harvest Date:

Average yield per acre:

Grade:

10. MATERIALS AND SUPPLIES

The adequate and timely supply of materials will greatly assist the FFS in achieving its goals.

The following materials and supplies are required for each FFS:

a. Materials

- Flip charts
- Packs of crayons
- Meter ruler
- Plastic bags
- Pens
- Pencil sharpeners
- Magnifying glasses
- Box rubber bands
- Calculator
- 20 ft Length ½ inch pipe P.V.C.
- Sweep nets
- ½ Length 3-inch P.V.C pipe
- Supplies
- Markers
- Rolls of paper tape
- 30 cm Ruler
- Note books
- Lead pencils
- Pair scissors
- Ream paper
- Sheets of cardboard
- Knives
- ½ inch P.V.C. bends
- lbs polythene cord
- 3-inch P.V.C. bend
- Snacks for 15 persons

b. Inputs for use on the farm

The following materials are required at the Regional level for FFS:

- 30 meter measuring tape
- Spring scale
- Camera
- Lift net
- Roll barbed wire
- Buckets
- Gram scale
- Computer system
- Plastic mosquito Sprayer
- Happa net
- Scoop net

11. FISH POND

A fish pond 500 m² needs to be constructed, and 1 000 fingerlings need to be sourced. Feed for the fish should also be provided.

Materials and finance should be made available through the regional representatives and must reach the facilitators prior to the FFS session for which they are required.

12. ON-GOING FFS

a. Background

The Farmer Field School (FFS) is farmer education based, lasts for the entire cropping season and targets a group consisting of 10-15 farmers. The FFS consists of informal activities, which are hands-on and oriented towards improved decision making. FFS will have a better impact when it is well planned.

This FFS is specially designed to address the two issues of rice and fish. In short, this FFS will meet to the following objectives:

- Introduction of rice-fish farming practices;
- Improvement in the knowledge of rice cultivation based on IPM concepts.

b. Group formation

The FFS is group based, rather than individual contact based, because this approach has several advantages. The group formation is important to disseminate technology amongst the farmers. The following advantages result from group formation:

- Groups from a similar community facilitate better communication;
- Groups are useful for scaling up future activities;
- Groups are formed based on similar interests of farmer.

c. Field Study

It is important to conduct a field study along with FFS to provide wider knowledge about Integrated Pest Management (IPM). A field study does not serve research purposes but offers farmers first hand information on IPM by giving them the opportunity of setting up and managing their own study.

This study was designed as an "On-farm Study" to demonstrate the principles of IPM. This is considered essential to provide the farmer with relevant knowledge.

The following field studies are the examples how basic IPM could be applied by farmers.

i. Reduced tillage

Farmers in general practice 5 to 6 passes in preparing land for rice cultivation. In some areas farmers also do not pay enough attention to land leveling, which is a very important activity that leads to a healthy crop. This study is designed to give farmers wider experience about advantages in respect to passes.

1. Compare normal practices with reduce tillage;
2. Compare well level with normal practice.

ii. Seeding Rate

In general farmers are well aware of the different seeding rates applied in their own plots. Some of them reported the use of both more or less than the recommended rate. With regard to IPM concepts, both of these actions have advantages and disadvantages. Through this study, farmers will learn both, and make the correct decision accordingly. The field study will be set up during FFS period, so the farmer can learn about the effect of seeding rate on disease infestation, insect population and ultimately, to yield.

iii. Nitrogen

Nitrogen is an essential nutrient which boosts rice growth and increases yield. General farming practices indicate that farmers apply both less and more than the recommended dose. With regard to IPM concepts, both of these actions have advantages and disadvantages. If the dosage is too high, the crop becomes too succulent and therefore susceptible to insects and diseases. If the dosage is too low, the crop growth is retarded. Therefore, farmers should be encouraged to apply an adequate rate at their own plot for best results.

The study will be set up with different rates, as shown below:

- 25 % below recommended rate;
- 25 % above recommended rate;
- same as the recommended rate.

iv. Phosphate

Phosphate in form of Triple Super Phosphate (TSP) enhances crop growth by stimulating root development. Phosphate requires a long time to be fully absorbed by the soil and usually not all is absorbed by the time the crop is ready to be harvested. This leaves some of the phosphate in the soil for the next crop. Therefore, phosphate is not recommended for application every cropping season.

Is was reported that farmers were ignorant of this. Nevertheless, this study was designed to observe the effect of TSP on insects, disease infestation, yield and profit. The simple study could be set up as follows:

- plot treated with TSP at a rate the farmer normally applies;
- plot not treated with TSP.

v. Sequences and schedule

The FFS is carried out and lasts for the entire cropping season, following the crop stages. However each subject should be linked and interrelated to the real field situation.

To ensure farmers gain adequate knowledge, the FFS sessions will be following the farming schedule as indicated below.

Week	Subject Matter
1	Land preparation Special topic: • Snail identification • Introduction of Rice-Fish culture
2	Land preparation Special topic: • How to control weeds • Construction and modification of rice-fish farming
3	Land preparation Special topic: • Water management and leveling • Transporting of life fish and stocking
4	Sowing (broadcasting) • Identifying and control of water weevil • Construction of nets for use in rice-fish culture
5	Special topics: • Seeding rate and method of germination • Fish feed and feeding
6	General (Agro Ecosystem Analysis) Special topic: • Water management
7	AESA (Agro Ecosystem Analysis) Special topic: • Seedling anatomy • Pond and rice field fertilization
8	AESA (Agro Ecosystem Analysis) Special topic: • Early vegetative stage • Fertilizer application; TSP and urea • Fish predators and other pests
9	AESA (Agro Ecosystem Analysis) Special topic: • Tillering ability of the rice plant • Pond and rice fish culture system

10	AESA (Agro Ecosystem Analysis) Special topic: • Life cycle and food web • Fish stocking density
11	AESA (Agro Ecosystem Analysis) Special topic: • Root and plant vessels • Production of tilapia fry and fingerlings
12	AESA (Agro Ecosystem Analysis) Special topic: • Primordial stage • Second application of fertilizer • Fry nursing
13	AESA (Agro Ecosystem Analysis) Special topic: • Insect and spider identification • Fish pond rice field management
14	AESA (Agro Ecosystem Analysis) Special topic: • Insecticide effect on insects • Pesticide (beware of poison), avoid direct exposure, insect damage prevention • Fish harvesting
15	AESA (Agro Ecosystem Analysis) Special topic: • Weather effect on crop, disease and insect development • Post harvest technology
16	Special topic: • Ripening and harvesting • Cost and return analysis of rice-fish culture

vi. AESA, Special Topic and Group Dynamics Guidance

Agro-ecosystem analysis (AESA) is a tool to assist farmers to develop skills and knowledge about rice ecosystems and consequently, how to make better decisions. Working in the full group of 15 farmers:

- observe field situations;
- make notes about components seen e.g., rice crop, insects, diseases, weed, water, weather etc.;
- put in a pictorial sheet the situation that has to be examined and action decided upon;
- decide what practices should be applied.

The AESA is comprised of various components, with presentations in the form of drawings, as follows:

- Location
- Crop age (DAS)
- Beneficial insects
- Disease
- Plant height
- Average tillers
- Other specified factors
- Date
- Variety
- Harmful insects
- Weeds
- Water depth
- Weather conditions

vii. Special Topics

Special topics offer support to the AESA, where very simple demonstrations will carried out, either in the field or at the meeting place. The topic could be selected from the list provided, but an innovative and creative facilitator can develop more topics relevant to the farmer's needs. Therefore, it is suggested that some topics should be added to enrich this curriculum. The special topics proposed in general covers the following:

- Rice crop physiology
- Spiders
- Fish technology
- Insects (harmful and beneficial)
- Pesticides
- Diseases

viii. Group Dynamics

Group dynamics is that part of the FFS activities which helps to strengthen group cohesion and enhance cooperation. Various ways could be formulated that help the group to become enlivened and motivated, such as role playing, brain teacher, case story and short drama. The messages contained within the group dynamics comprise of communication, leadership mobilization, problem solving and planning. Below are examples of group dynamics that can be used for FFS:

- Nine dots
- Landing on the moon
- Broken square
- Sale of sheep
- Handcuff
- Story telling

ix. Field Day

A field day is an occasion organized by FFS farmers for the purpose of presenting and exposing all activities and achievements to other farmers in the community who did not participate in the FFS. The field day could also be a forum for interactions and sharing experiences. The field day is also useful in raising willingness and can facilitate increased activities and scaling up in the future. To make the field day more useful, the following should be followed:

- Venue: At the FFS site where most of the activities were done:
- Date: Determined by farmers, but at a time when the rice reaches maturity stage;
- Time: Within FFS period, preferably during rice maturing stage;
- Location: The FFS group leader should decide on the location and invite farmers from the surrounding community.

x. Exchange Visit

An exchange visit is an important part of the FFS. The purpose is to build up the relationship within the FFS group. During the exchange visit, the farmers can compare progress, achievements and even constraints. To some extent, exchange visits also disseminate new findings to other farmers for their benefit.

The exchange visit could be organized based on the local situation such as:

- FFS to FFS within district;
- FFS to FFS within region;
- FFS to FFS inter region, and
- FFS to FFS inter-country.

13. GENERAL AGRO-ECOSYSTEM

a. Background

Integrated Pest Management (IPM) is based on interaction among crops, pests, diseases and the surrounding environment (insects, diseases, rats, weeds, mollusks), and their natural enemies (spiders, parasites, snakes, birds and others). A healthy crop is determined by the surrounding environment (weather, soil, water, nutrients). In a sound agro-ecosystem, natural enemies will accompany harmful insects.

The rice ecosystem developed a long time ago. There are interactions in the rice ecosystem that have developed over the decades, and it can easily loose its strength by:

- practicing an intensive farming system;
- an imbalance between soil and crop;
- an imbalance between harmful insects and their natural enemies.

Fertilizers make the crop take up more nutrients from the soil, but pesticides kill natural enemies.

In understanding these factors and their interaction, it is important to know the ecosystem's contribution to crop yield. During the training we will look into these interactions within the rice crop.

The basic principles are:

i. The ecosystem is comprised of dynamic characteristics in terms of number, position, role, and intensity of each element/substance. It continues to develop and change constantly, as a living system.

ii. Every ecosystem is determined by a structure and a hierarchy. For example: the crop is the food source of insect pests. They feed on crops in various ways (sucking, chewing). Insect pests again are food for their natural enemies. In this regard, natural enemies are located at a higher position in the food chain of the rice ecosystem. Without them, the rice crop will not attain a good yield. However, without insect pests, the natural enemies will also disappear.

iii. These three components (crop-pests-natural enemies) in rice ecosystem are inter-related and inter-dependent. Our task as good farmers is to maintain the balance of these components and to ensure the crop gives the expected yield while the environment is also maintained

b. Objective:

To be able to describe and comprehend the balance of the ecosystem components in rice fields.

c. Materials

- Large plain sheet
- glue
- cardboard
- sweep net.
- marker pen
- board
- crayon

d. Procedure:

i. Each group enters the rice field at different places, and for one hour, closely observes

and records plants (rice), insects (terrestrial and aquatic insects), spiders (if none are found inside the field, then find from the field dikes), mollusks, etc. A sweep net is used to catch flies and tiny insects.

ii. Each group then goes to a shady place and draws and writes on a small piece of paper (2 inches wide and 4 inches long) what they have seen and recorded in the rice field.

iii. Each group then writes and draws on the same size of paper the following: "Hot Weather", "High Fertilizer Rate", "Cool", "Low Fertilizer Rate", "Sunny", "Cloudy", "Rainy"

iv. Each group then sticks those components that were written on the large plain sheet, and connect crop to pest and pest to predators, using arrows. The group then discusses amongst themselves how these components are related to each other.

v. Later, the groups discuss the consequences/situations given below during rice crop season:
   - Pesticides sprayed kills beneficial insects and spiders, and later pests migrate to the rice field.
   - If crops resistance to insect pests in the rice field is low, what will happen?
   - If the crop has been subjected to a high fertilizer rate, and hot weather (sunny days), what will happen?
   - If the crop has been subjected to a low fertilizer rate, and cool weather (cloudy and rainy days), what will happen?
   - If the crop has been subjected to a high fertilizer rate, and cool weather (cloudy and rainy days), what will happen?

vi. Each group then presents its opinion to the plenary group.

e. Questions

i. Why is it important to conserve natural enemies and maintain balance in the ecosystem?

ii. Why must the rice crop be monitored weekly?

iii. Why should pesticides be used wisely and as last resort?

14. AGRO-ECOSYSTEM ANALYSIS

a. Background

Decision-making in IPM requires analytical skill to correctly assess the field situation. The ecosystem analysis is field practice which is intended to focus on examining each component and taking the correct steps. We have discussed how these components are inter-related. We will now use a method of ecosystem analysis to lead discussion and make decisions.

Ecosystem analysis will be done on a weekly basis along with a list of activities such as field observation and carefully monitoring the rice ecosystem components. The result will be drawn on a large sheet of paper and use it to discuss with participants.

Group members must be actively taking part in each of the following steps: field observation, drawing, discussion and presentation. The presenter must be rotated each week, so everyone has equal chance to learn how to facilitate the session.

b. Objective

To monitor and familiarize participants with the rice crop situation, by making observations, drawings and participating in discussions. After these activities are completed, each group must be able to make decisions regarding the crop management for the week

c. Materials

Data from rice field, large sheet of paper, marker pen, crayon, sweep net, transparent plastic bags.

d. Procedure

i. Enter the rice field and walk diagonally; take samples of 1 meter square each, for a total of three samples at three different places, with one sample at the center. Each sample has to be observed and the result recorded, following the method below:
   - *Insects and snails*: Look at the bottom of rice crop for hoppers, water weevils and snails. Then observe the middle to upper part of rice plant for caterpillars, stem borers, egg masses, seed flies, paddy bugs and sucking insects. If leaves are damaged, open the leaves, find the cause and estimate the damaged percentage. Collect any eggs found and put into plastic bag for preservation to determine if it is a parasite.
   - *Diseases*: Observe the leaves, leaf sheath and stem if there is any deficiency symptom or diseases. Estimate the damage percentage, and record results.
   - *Natural Enemies*: Count the number of each natural enemy found, and the number of larva parasites.
   - *Tillers*: Count the total tillers per each sample site.
   - *Weed Density*: Record the type of weeds and densities of each.
   - *Water Level*: Estimate the water level in inches.
   - *Fish*: Examine the fish either caught in the rice field or fish pond; collect water sample to determine presence of plankton, aquatic insects, fish food and turbidity.

ii. Go back to shady place and sit in groups (four members each) along with data, and crayon.

iii. Following the steps below, draw pictures on a large sheet:
- Draw the rice crop with the average tillers from the three sampling sites that have been observed. A healthy crop will look greener and an unhealthy crop with disease infestation or nitrogen deficiency will look yellowish. Draw dried leaves using yellow colour.
- For weeds, draw estimated population and size in relation to rice crop, including weed type (broad leaf, grasses, or sedges).
- For insect pests, draw the insect found in the field on the right side of rice. Make tabulation at right edge also.
- Draw natural enemies and spiders as well as insect pests, but put at the left side of the rice. Make tabulation at the left edge also.
- If this week is sunny, draw sun at full; if sunny and cloudy draw sun half covered by cloud; if it is cloudy always, draw a dark cloud.
- If rice has been fertilized, draw hand-applying fertilizers. The picture should be above the rice.
- If pesticide has been used, draw sprayer with nozzle spreading drifts. Write what kind of pesticide has been used. If granular insecticide has been used, draw hand-applying pesticide.
- If the fishpond has been fertilized with manure, draw manure being applied. If supplementary feed has been used, draw to show this.

iv. Now discuss the following questions at each rice stages. One group member should be appointed as the interviewer. This person would pose questions to others within the group. (Please rotate each week).

v. After steps 2-3-4 have been completed, come to the plenary discussion where each group will present their results to another group and questions may be raised.

vi. Decisions requiring immediate intervention or steps that have to be taken will be made during plenary session. The group decides and concludes any activities that must be taken in the field relating to the IPM principles.

vii. Each group has to keep their drawing and use it in the following week as a reference.

15. QUESTIONS LIST OF AGRO ECOSYSTEM ANALYSIS (AESA) VEGETATIVE TO GENERATIVE STAGE (WEEK 1)

The following questions are expected to help participants improve their ability and interest to carry out agro-ecosystem analysis, while also maintaining learning enthusiasm. Participants are also expected to add any relevant questions based on their own farm experiences and other sources. Creative facilitators should take the initiative to develop other questions which are related to crop stages. The questions should cover key issues of agro-ecosystem components.

i. Did rice seeds germinate evenly? If so, do young leaves emerge? If seeds have not germinated evenly, ask a group member why.
ii. Did you find the young crop yellowish or stunted? If so, why? Do you think quality seed is the key point and important for direct seeding?
iii. Why it is important for crops to develop leaves rapidly?
iv. Did you find deficiency symptoms or disease infestations? What water level is needed at this stage? Too much or too little?
v. What effect does the weather have on crop development?
vi. Did you find snails and water weevils? What is the population? How much damage do they cause? Do you agree that only water weevil did not cause the damages? How about seed rotten due to mud depth?
vii. What kind of natural enemies did you find? How much was the population? Where did they come from? What do they eat before entering to rice field? Did you find any egg masses? Does the insecticide that was used kill them? It is important to enhance their population in this stage? How do you enhance them?
viii. What kind of insect pest was found and how much population is there? How important is the pest at this stage? What strategy is required to reduce their population? (Drain water, add water, add fertilizer, use pesticide, others) what is the reason behind this? What is the situation in the surrounding rice field? Do other rice crops influence yours?
ix. Pertaining to both insect pests population and natural enemies, does insecticide need to be applied? Why?
x. What is the general rice situation compared to last week?
xi. What do we expect next week? What needs to be carefully observed?
xii. What is your management plan for the rice crop this week?
xiii. Fish: How does fish grow? Is it healthy? Look into head part, belly and whole body. Does plankton grow in the fish pond and rice field? What will happen to fish and plankton if pesticide is used?

16. QUESTIONS LIST OF AGRO ECOSYSTEM ANALYSIS (AESA)-WEEK 2

i. At the moment do you find the crop stunted? If yes, what is a cause? Do you think it could survive and grow like a normal crop?
ii. How many plants did you find per m^2? Do you think the population is adequate? If not, how do we increase number of plants?
iii. Did you find any deficiency symptoms or diseases infestation? What is water level needed at this stage?
iv. Do you think weather affected the crop development at this stage?
v. Did you find water weevil at this stage? If yes, what is the population found? If not, where did they migrate?
vi. Why does seed fly mostly affect the young plants at lowest spots of the field? Why are some natural enemies late in coming to the field?
vii. What kind of harmful insects and beneficial insects are mostly found at this stage?
viii. What is a proper strategy to reduce insect pest damages and their population? (Blow water in, apply fertilizer, clean up the dikes, spray pesticides)
ix. What is a general situation compared to last week?
x. What do we expect in forthcoming week? What are the specific things that should be closely observed?
xi. What is your management plan for the crop in this week?
xii. Did you observe how the fishes are growing? Did you find plankton growing in the fish pond?

17. QUESTIONS LIST OF AGRO ECOSYSTEM ANALYSIS (AESA)-WEEK 3

i. Does the crop grow fully and produce new tillers? Did the old bottom leaf die? Assuming that the crop does not develop and new leaves do not emerge, what might be the cause?
ii. Do you see any disease symptoms or leaves looking abnormal in growth (yellowish, brownish or reddish)? If yes what was the cause? Ask what was the disease situation during the last crop season.
iii. What kind of natural enemies were found in the field? Do you think the population is enough? If too little, how can we stimulate them?
iv. What kinds of insect pests are found in the field? Which is the most adundant species? Where did they come from? (Look at surrounding vegetation "too bushy, plenty of weeds"). Some weeds are used as temporary shelter for both natural enemies and insect pest before entering to the rice field searching for the main host.
v. Do you think sanitation (clean up dikes, remove unwanted rice, weeding) is part of the IPM method? If yes can you explain what the advantages are?
vi. Specifically for Paddy Bug, did you find an early population? If yes, why do they come so early and what food do they take?
vii. What is the general crop situation this week (better, same as last week, worse)?
viii. What are the most important management practices for this week? (Water, sanitation, fertilizer, pesticide application)?
ix. How does the crop look compared to last week?
x. What crop situation do you expect in the forthcoming week?

18. QUESTIONS LIST OF AGRO ECOSYSTEM ANALYSIS (AESA)-WEEK 4

i. The rice crop has reached panicle initial stage. Where does the panicle develop inside the stem? Water and nutrient availability, presence or absence of diseases and insect infestation will contribute to the yield. However, continuous field observation and assessment is essential. With respect to this stage, what are some of the aspects needed to be assessed regularly?
ii. The local crop environment is fluctuating, sometimes with rain and low temperature, but mostly hot and sunny with a little cloud. As we know, some diseases and insects prefer this climate. What would be workable prevention to minimize the damage that might occur?
iii. Following the field observation, did you find any significant changing of specific insect or disease population?
iv. What issue needs more attention during the forthcoming week?
v. How many panicles on average of each sample were observed? And how many grains on average did each panicle contain?
vi. Why are some grains not filled?
vii. Can you explain why some do not reach the same number? Where were the numbers in some of the other tillers?
viii. Can you explain the advantages of practicing two and three urea doses in this crop season?
ix. What steps have to be taken for better rice at next crop?
x. Do you think the number of tillers at the site you been observed has a similar number of panicles?

19. QUESTIONS LIST OF AGRO ECOSYSTEM ANALYSIS (AESA)-WEEK 5

If AESA was done at two different crop stages (generative and vegetative), facilitators will have to develop questions to accommodate both. For example: in our plot the crop is still producing tillers, new leaves are being developed and the flag leaf is not yet present. In the farmer's field, new leaves are not being produced anymore and the present leaves will remain until the crop is harvested. Only few leaves will emerge and these leaves contribute to good yield. Healthy tillers in this stage are predicted to have high yield.

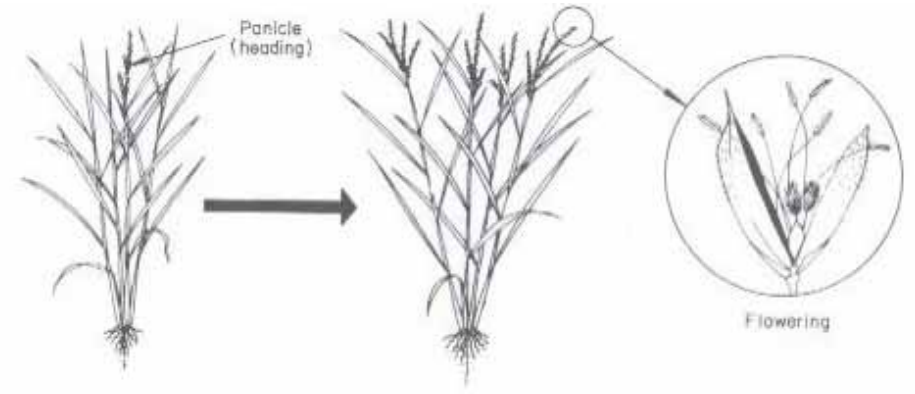
i. How is the water in the field? Does the soil have enough humidity or excess water? Fertilizer has been applied and water should be there. Why? Are weeds present in the field? How is the weed threshold in your opinion?
ii. How many total tillers did you find? Do the leaves seem dark? What will happen if other tillers become less active? Does another compensate or compete?
iii. Do pests attack, and in what level? Are there other insects called pests? Does the population increase, decrease or remain at the same level? Do you find rotten material in the soil? Preserve egg masses in a vial to examine the presence of parasites.
iv. What disease appeared this week? Do you think the weather condition is suitable for disease infestation? (Humid, windy, too hot or too cool)
v. What happened to the spider?

20. QUESTIONS LIST OF AGRO ECOSYSTEM ANALYSIS (AESA)-WEEK 6

i. Can we find the early primordial stage in the field? If not, can you predict when it will occur? What is the most important crop management practice during the primordial stage?
ii. Do you think any damages contribute to reduced yield when the crop is in the flowering stage? Is this a crucial stage?
iii. In reference to question ii, can you list what are the most important insects and diseases that might occur? (examine the general weather situation, rainy and sunny, short hot period and long wet, humid and windy, water stagnant in field)
iv. In reference to question i, do you think the rice crop is still producing leaves? How many leaves are expected? Why new leaves must be emerging? (After primordial stage the rice only produce 2 or three more leaves, including the flag leaf)
v. Can you explain, if no more leaves have grown or leaves have been damaged, and you apply the last top dressing, what happened to the nutrients?
vi. Are weeds too dense or not, what are the key factors that contributed to this? (Farmers sprayed herbicides more then once, soil ploughed using three passes, water kept stagnant, straw burned, crop dense)
vii. Can you explain weed characteristics (take one species, examine and discuss), root performance, reproduction system, leaf formation, dormancy period, and competitiveness to rice crop.
viii. With respect to some of the questions above, what are bad culture practices and how can they be addressed?
ix. Did you find a particular insect at a high population? Did you find or see pupa in the field? What is the role of parasites at this stage?
x. Did you find a particular disease infestation?
xi. How is the crop performance compared to last week?
xii. What is your decision in this week?

21. QUESTIONS LIST OF AGRO ECOSYSTEM ANALYSIS (AESA)-WEEK 7

i. In the rice plot, do you think that the rice is near primordial stage? If so, what is the most important management practice that must be done this week? (Please check the water level, weeds density, insect population and disease infestation.)
ii. If you will apply herbicide, what type will it be (broad spectrum or systemic)? If you decide to use it, can the herbicide affect the rice growth?
iii. If you delay applying the herbicide, do you think the second dose of fertilizer will have a positive impact on the rice crop?
iv. Some herbicides have a negative impact on the rice plant if applied at panicle initiation stage. Since our rice crop is at the early primordial stage, do you think that delaying weed control can also have similar effect?
v. In the case of the booting stage, did you find tillers that are not producing panicles? If yes, what is the cause?
vi. Do you think that diseases can be a major problem in the field? What disease might occur?
vii. Did you find filled grains? Which part of the panicle still has unfilled grains (basal, middle, tip)?
viii. What is the insect population in this week?
ix. In which week do you expect the rice to be harvested?
x. What is the crop situation compared to last week?
xi. What management practice should be applied this week?



Special Topics

22. INSECT COLLECTION AND IDENTIFICATION

a. Background

There are many insects commonly found in rice fields, ranging in size, characteristics and their role in the rice ecosystem. Some are living in the ground and above the ground (terrestrial insects), but some of them are also living in the water (aquatic insects). Some of them may eat small parts of the plant, but most of them are beneficial insects who are consumers of other insects, including those that eat the rice plant. Beneficial insects can be categorized into two big groups; predators and parasites. The others are detrivores or decomposers and can also be found in the field.

Spiders can be found as well. Often, spiders are predators that catch prey by hunting directly, but some of them also make webs to catch their prey. Aquatic insects catch their prey only in the water, but can also take their prey if it falls into the water. All of them are useful, and a low population of plant feeding insects provides food for beneficial insects.

b. Objective

Participants will be able to identify beneficial insects that help protect the rice crop.

c. Time Required

One to two hours.

d. Materials

Transparent plastic bag, sweep net, discarded plastic bottle, alcohol and cotton.

e. Procedure

- Each group enters the rice field and examines the bottom area to catch ground insects and spiders. The insects are collected, placed into a plastic bag and killed with cotton wetted in alcohol.
- Aquatic insects are also captured using a plastic bottle, and placed into another plastic bag. Collect as many as possible.
- Each group then returns to the classroom or a shady place, and places the insects onto a large paper.
- The insects and spiders, are then separated, and grouped based on similarity of physical characteristics.
- The specimens are then identified based on their local name and their function in the rice field; an entomologist is asked for names and functions of unknown insects.
- A table with two columns is made on the paper, and specimens are listed based upon their functions. A count is made for the number in each group.
- Specimens are preserved in vials and labeled.

f. Questions

i. How many of them are categorized as plant feeder insects?
ii. How many of them are categorized as beneficial insects?
iii. How many spiders did you catch?
iv. What will happen if there are no beneficial insects and spiders in the field?
v. Why it is important to conserve natural enemies?
vi. What will happen to them if pesticides are being used excessively?
vii. What lesson is learnt from this exercise?

23. SEEDLING ANATOMY

a. Background

In the early stage, rice has special characteristics and the ability to minimize the effect of leaf damage. As the leaves grow and die, new leaves emerge rapidly to replace the infected and damage ones. Attention should be paid to this stage, where sufficient water and nutrients are needed to grow a healthy plant and to utilize and compensate for the insect pests and diseases damages as well.

b. Objectives

i. To be able to describe early vegetative stage, leaf growth and dead leaves.
ii. To be able to describe rapid leaf development that compensates for the damages caused by diseases and insects.
iii. To be able to describe the importance of proper management that supports rapid growth and development.

c. Time required

One hour.

d. Materials

Rice crop of 20 DAS, 40 DAS and 50 DAS; magnifying glass, paper and pencil.

e. Procedure

i. Collect rice plants, examine them closely and draw each one as it is, at the different stages. Dissect the stems to examine the inner part.
ii. Pay attention to the new and old leaves of the plant.

f. Questions

i. How many leaves are there at each of the three different crops' age? Do the old leaves dry and die? What are the advantages of rapid leaf growth?
ii. What do we do if the young leaves die at the early stage? Do you think leaves can compensate for the damages caused by seedling flies?
iii. Do you think using pesticides at this stage is advisable?

24. LIFE CYCLE AND FOOD WEB, PART 1

a. Background

In the ecosystem section we have discussed the concept of interactions amongst associated factors. For instance, natural enemies attack harmful insects feeding on the crop.

This exercise will be used to help participants understand the interactions within a specific time frame. For example: the life cycle of the paddy bug begins with the egg stage on the crop; next is the nymph stage that sucks grain liquid; later is the adult stage that also sucks the same grain liquid. At the adult stage they mate and lay eggs in the same crop or migrate to other plots. Various natural enemies also attack each stage. During the egg stage, parasites (egg, larva, pupa, adult) feed inside the eggs and destroy them. During the nymph and adult stage, spiders, ladybird beetles, dragonflies, birds and other parasites also kill the paddy bug.

A combination of crop stage, paddy bug and natural enemies that interact, provides a perspective about the dynamic system of the rice crop. For example: spiders depend on available food (hopper, bug, etc). When there is no food available, the spider will not protect the crop. Therefore, insect pests at a low population level are required to keep natural enemies in the field. Do you think that the caterpillar is helping the farmer? It depends on how much is in the field.

For this exercise we have to think in terms of "guilds". Guilds are groups of organisms that have similar life cycles and share food; the paddy bug is an example.

b. Objective

To be able to describe the ecosystem using a life cycle and a food chain for at least one guild of insect pest.

c. Materials

Paper, pencil, crayon and source text.

d. Time Required

Two hours.

e. Procedure

i. Each group has to select one guild to be analyzed.
   - Group 1: Stem borer
   - Group 2: Caterpillar
   - Group 3: Heart worm
   - Group 4: Paddy bug

ii. Draw a big cycle and write the insect stages from the guild near to the relevant part of the cycle (see sample).

iii. In another part, write the insect stages on one column, and use the other column to make a list of natural enemies (with guild) that attacks every stage.

iv. On that cycle, draw another cycle for each of the natural enemies that attack in that particular pest stage. Also write their life stages. If there is natural enemy, make a third cycle for this.

v. Present your finding to other groups to share ideas.

f. Questions

i. What will happen to the system if pesticides are used indiscriminately?
ii. Why is it important to keep this system working?
iii. How do you maintain balances in the rice ecosystem?

25. LIFE CYCLE AND FOOD WEB, PART 2

This activity should be carried out at the rice field the following week.

a. Background

This training is designed to create a technically sound and professional field trainer who will be able to convince farmers through FFS. However, practice is essential to sharpen concepts, perspectives and skills that are essential in carrying out related jobs. This exercise provides opportunities where these concepts are tried and simulated to ensure participants meet the abilities needed.

b. Materials

Life cycle and food web drawing, live insects, source text.

c. Time Required

Two hours.

d. Procedure

i. Break down each group into two sub groups.
ii. Each sub-group enters into the rice field or the nearby plot. Each group has to find 2 insects species for analysis.
iii. One participant will act as a trainer, another pretends to be a farmer who is experienced and is a retired head of a research center, another an extension officer. All will raise the following questions:
   - What will happen to natural enemies if there is no pest insect?
   - Do you think insects pest are useful at a particular population?
   - What will happen if a broad-spectrum insecticide is sprayed?
   - How do we convince farmers?
iv. Rotate the trainer, repeat activities and create other questions related to the subject.

26. TILLERING ABILITY OF RICE AT THE VEGETATIVE STAGE

a. Background

During the vegetative stage the rice crop develops rapidly and produces tillers. High yielding varieties produce more tillers compared with local varieties. The advantage of having more tillers is in reducing the risk of damage caused by insects or diseases. New tillers have a stem, leaves, and roots and develop other tillers. This new tiller is classified as a primary stem; others that develop from them are called secondary and tertiary tillers, which then produce panicles. At this stage the rice crop is able to cure the damages, due to the production of more tillers. If some of them are damaged, the new ones can replace them, so that stem borer attack can be tolerated. Leaf damage can be tolerated as well, because the new leaves rapidly develop. Tiller and leaf development is determined by several factors including seed rate, water supply, rice variety, sun light and nutrients.

b. Objective

To be able to describe the crop's vegetative stages as well as tiller and leaf development.

c. Time Required

One hour.

d. Materials

Rice crop of 40 DAS and 50 DAS, cutter, paper and pencil.

e. Procedure

i. Collect samples of both rice crops and remove the soil from them.
ii. Observing the basal area, find the main stem, locate a primary tiller and separate it from the main stem. Find the secondary tiller from primary tiller and also separate. If the secondary tiller already has a tertiary tiller, separated this also. Continue this step until you have a tillering pattern.
iii. Look also at the leaves of each of the tillers (primary, secondary, tertiary).
iv. Draw the various tillering patterns on the paper, including the number of leaves of each tiller.
v. Have each group explain the crop structure to others.

f. Questions

i. Explain the crop tillering pattern from early growth until the vegetative stage.
ii. Why is continuous tillering important at the vegetative stage?
iii. What is the advantage of more tillers?

27. PLANT ROOTS AND VESSELS

a. Background

Nutrients and pesticides are usually applied to the rice field. How do these substances move into the crop? To get inside the crop, chemical components must be disolved in water. Without water the roots cannot absorb and distribute these components from the soil into the crop. After getting into the crop, these substances will move through two systems; the water moves up inside the crop and is processed through photosynthesis to become glucose. Glucose moves down and is distributed to all parts of the crop.

Systemic insecticides can control sucking insects as well as chewing insects, because the insecticide is present inside the entire plant.

After water moves inside crop tissues, at evening time, some of this water drips down from the tip of leaves. If insecticide has been applied, it can be present in this water, called gutation water, as well. Both harmful and beneficial insects can die if they drink this water.

b. Objectives

- To be able to describe how the systemic pesticides move through crop tissues.
- To be able to describe why systemic pesticides can control sucking and chewing insects.

c. Time Requirement

Two hours.

d. Materials

Water, food dye, two plastic cups for each group, crop and straw.

e. Procedure

i. Collect plant including rice seedlings, spinach, grass or others, ensuring that the roots are not cut off.
ii. Put water inside a plastic cup and several drops of food dye, until the water becomes red.
iii. Put the plants inside the cup with the roots in the water, place in the sunshine and wait for 90 minutes.
iv. Put the straw into another cup.
v. After the time is complete, observe crops color in the stem, roots and leaves. How does the red color move into the crop?
vi. Discuss following questions.

f. Questions

i. What is your opinion on the use of granular systemic pesticides? Are they safe? What happens to the insects that drink gutation water?
ii. Can you explain the advantages and disadvantages in using systemic insecticides?

28. THE EFFECT OF INSECTICIDES ON INSECTS

a. Background

Insecticides are poisons used to control harmful insects. In reality, insecticides also kill beneficial insects and other organisms like fishes, frogs, birds and even human beings. Based on the type of poison, insecticides are divided into two major groups: broad spectrum insecticides kill all insects; narrow spectrum insecticides kill only specific, targeted insects. Narrow spectrum insecticides are less toxic compared with broad spectrum insecticides. But they are still poisonous and can kill non-target organisms at high dosages. Therefore, there is no safe pesticide.

b. Objective

To demonstrate the effect of broad spectrum and narrow spectrum insecticides on insects and other non-target organisms.

c. Time Required

Two hours.

d. Materials

Insecticides (Monocrotophos and Bacillus thuringensis [BT]), plastic mosquito sprayer, plastic cup or discarded water bottle, mesh net, rubber band, insects and fish.

e. Procedure

i. Collect insects (harmful and beneficial insects), spiders, caterpillars and fish.
ii. Put insects into two different plastic cups (harmful and beneficial); also put spiders, caterpillars and fish into another cup, cover with mesh and tie with rubber bands. Use two cups each.
iii. Dilute insecticide into water at the recommended rate, and put into two different mosquito sprayers.
iv. Spray a cup with Monocrotophos and another with BT; apply similar treatments to all cups.
v. Examine the result after one hour.
vi. On a large paper, make two different tables (Monocrotophos and BT) and list how many organisms die and how many remain alive.
vii. Present your result to other group.

f. Questions

i. Which insecticide kills both target and non-target organisms?
ii. As a last resort, why should we encourage farmers to use only narrow spectrum insecticides?
iii. What will happen to beneficial insects and non-target organisms if broad spectrum insecticides are used excessively?
iv. What will happen to environment if too much insecticide is used?

29. PREVENTION OF INSECT DAMAGE

a. Background

Prevention is any means or effort that could be applied to prevent the crop from unexpected damages. Some farmers use pesticides as prevention against weather, insect or disease damages, to protect the crop. This kind of management however is not correct and leads to misuse of insecticides and waste of inputs. From an IPM perspective, prevention should be looking comprehensively at approaches where all means or measures are utilized to minimize the damages. The prevention components should be listed, arranged and practiced during the entire cropping season because this cropping season will be followed by another season. This topic can be discussed in mid-season, when damages occur in the field. "Next season prevention is better if it begins now."

b. Objective

To be able to describe workable prevention methods to minimize crop damage in forthcoming crop seasons based on current crop status.

c. Time required

One hour.

d. Materials

Large sheet of paper, marker pen.

e. Procedure

i. Record associated factors that could hamper crop growth development and physical performance, such as pest population, plant variety, nutrient status, etc..
ii. Record controlled ecosystem factors and management decisions.
iii. Describe both advantages and disadvantages, and therefore, constraints of decision making.
iv. Determine when the decision is to be carried out.
v. Select the proper time when each decision should be extended to the farmers.
vi. Based on the list of arrangements, make a definition of prevention.
vii. Present your group findings to others.

f. Questions

i. What do you think about prevention?
ii. Can farmers implement a comprehensive prevention strategy?
iii. Do you think prevention is part of crop management? If yes can you explain why?
iv. With respect to extension officers, how can you ensure farmers perceive this concept?
v. If the farmer is asking about spraying to prevent crop damage, what are you going to do?
vi. If the farmer asks which insecticide is better to spray for any insect, are you going to advise "use this or use that"?

30. PESTICIDES (POISONS) AND AVOIDANCE OF DIRECT EXPOSURE

a. Background

Applying pesticide requires skill in order to minimize the exposure of poison to the user, but ensuring that it properly reaches the targets. The best way to escape from exposure is to avoid direct contact as much as possible. If the field really needs treatment, use only a narrow spectrum insecticide in particular.

A pesticide's killing ability is determined by the LD 50 (Lethal Dosage). You should know about the LD 50 of pesticides usually recommended. LD 50 is represented in milligrams of active ingredient per kg body weight (mg/kg). Example: LD 50 of Monocrotophos is 20; this means to kill a target that has 50 kg body weight, 1 000 mg of Monocrotophos is needed.

Considering the danger of exposure, in order to avoid direct contact, proper uses must begin from: (1) transporting from market to the house and field, (2) putting into sprayer, (3) measuring from container before mixing, (4) mixing with water, (5) spraying and (6) washing sprayer after use.

This session is to demonstrate the LD 50 of common pesticides used and assess the ways of avoiding direct exposure during spraying.

b. Objective

To know the LD 50 of pesticides commonly used by farmers, and assess the way how to avoid direct exposure.

c. Materials

Sprayer, spoon, bucket, glove, plastic bag, food dye, weighing scale.

d. Procedures

i. Examine the pesticide list and find the pesticides commonly recommended or those available in the market.
ii. After finding the pesticides, determine the LD 50, and compute how much active ingredient is required to kill yourself (kg your body weight); compute for oral and dermal LD 50.
iii. Weight any objects around you, at different sizes (find stone, a spoon of soil, etc). Compare the weight of objects to the active ingredients that can kill yourself.
iv. Which active ingredients is the most hazardous? Can you find a pesticide which has a similar active ingredient but higher LD 50?
v. If you recommend that farmers apply a pesticide, while they have no adequate protective gear, who is responsible in case of poisoning? The extension officer or the farmer himself?

e. Avoiding Direct Exposure

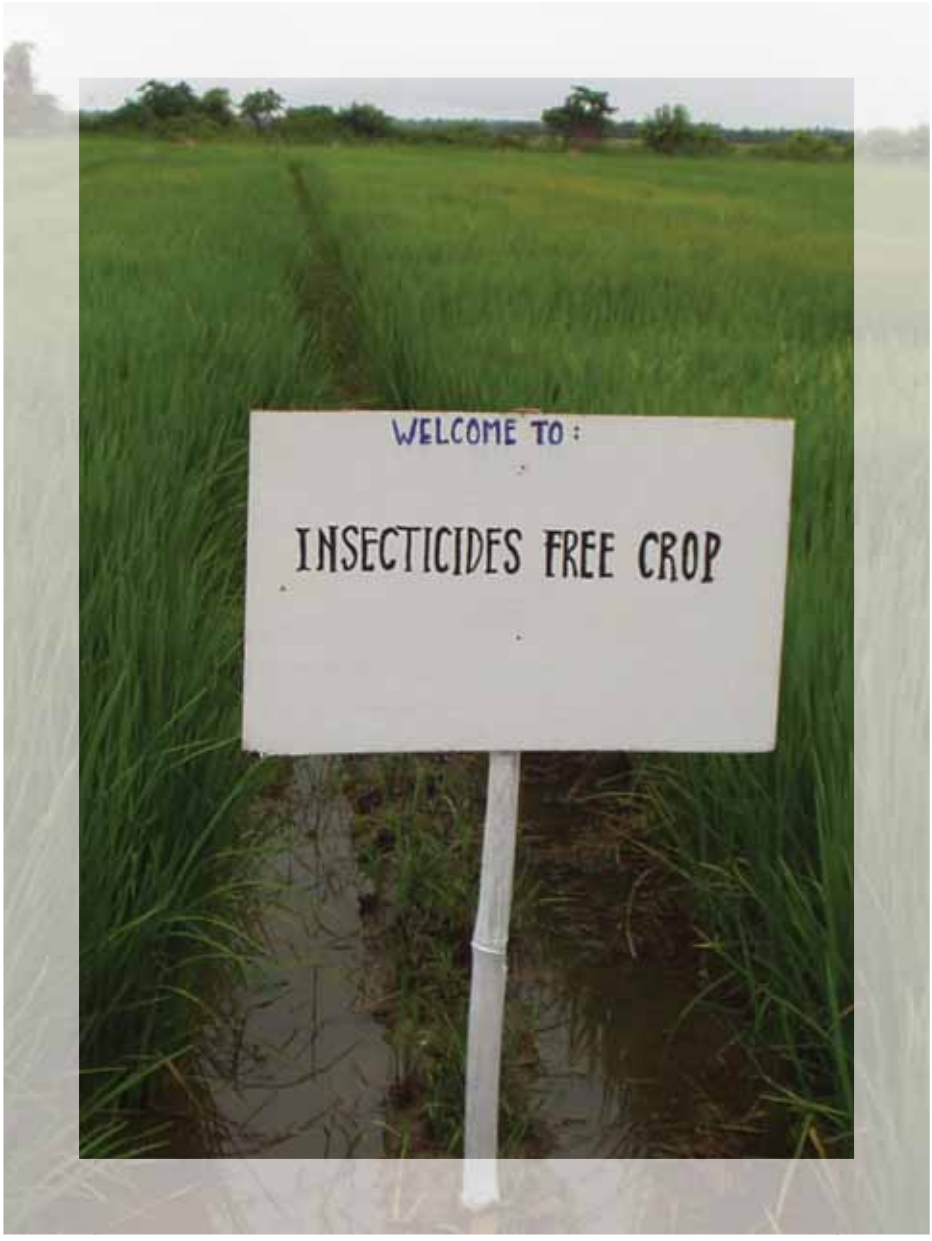
i. Select three persons from the group and assign them as "Safety Instructor." Give them a badge titled "Healthy and Safety Inspector".
ii. Select two other persons as "Sprayers" and give them a badge also.
iii. The Sprayer needs to prepare a knapsack sprayer, using a dose of 2 ml/liter and

500 liter/ha for a plot of 400 m². Compute the pesticide required correctly, mix with water and put into knapsack sprayer.

iv. The duty of Inspectors is to assess and monitor steps being taken by Sprayer, and make notes regarding exposures to the body, since preparations and operations began. Based on the notes being made, recommend improvements in each of the steps on how to avoid direct exposure.

v. Inspectors should present their finding and advise how to spray properly.

vi. Use red food colouring dye as a pesticide substitute.



31. EFFECT OF WEATHER ON DISEASE DEVELOPMENT

a. Background

We have already learnt about the development pattern of diseases. Weather is also a key component for disease infestation. Light intensity, local humidity and wind velocity are weather parameters that contribute to disease development and spread.

In addition, surface water is important for root growth, insects, and pathogen development. Water in the air in the form of dew contributes to humidity. Low humidity means dry air, and high humidity means more water in the air. Therefore, humidity is a key ingredient in the development of micro-organisms like fungi and bacteria.

Pathogens (sources of diseases) comprise bacteria, fungi, viruses and sometimes nematodes. Weather contributes a lot to the diseases' life cycle. The disease infection process is as follows:

i. Movement: Pathogen is transferred by air, rain drop, water flow, ground water or plant. Humidity, temperature and sunlight affect the life of the pathogen during movement before the host is infested.
ii. Germination: This is determined by host suitability. Germination ability is also determined by temperature, humidity, and surface water after rain fall or night dew, and radiation. Fungi and bacteria germination is a next step after infection, where the pathogen develops after entering the opened crop tissues or wounded part of the plant.
iii. Inoculation: Success or failure depends upon the host's growth velocity and resistance. If the pathogen develops more rapidly than the host, the host will be easier infected. If the host develops more rapidly than the pathogen, the pathogen could die before infecting the host.
iv. Incubation: Incubation is the time span required before symptoms appear. Symptom development is depending upon the type of crop and its situation. During development there is competition between the host and pathogen. If the weather is more suitable for the crop, the crop will not show major symptoms; if the weather is more suitable for the pathogen, it can develop quickly and symptoms will appear quickly on the crop.
v. Development: Influenced by temperature, humidity and radiation.

The above development steps are always repeated if there is disease infestation in any crop. In this session, we will assess the effect of weather on the appearance of diseases in the crop.

b. Objective

To be able to describe the effect of weather towards disease development in the rice crop (at least one pathogen).

c. Materials

Large sheet of paper, marker pen, plain paper.

d. Time Required

Two hours.

e. Procedure

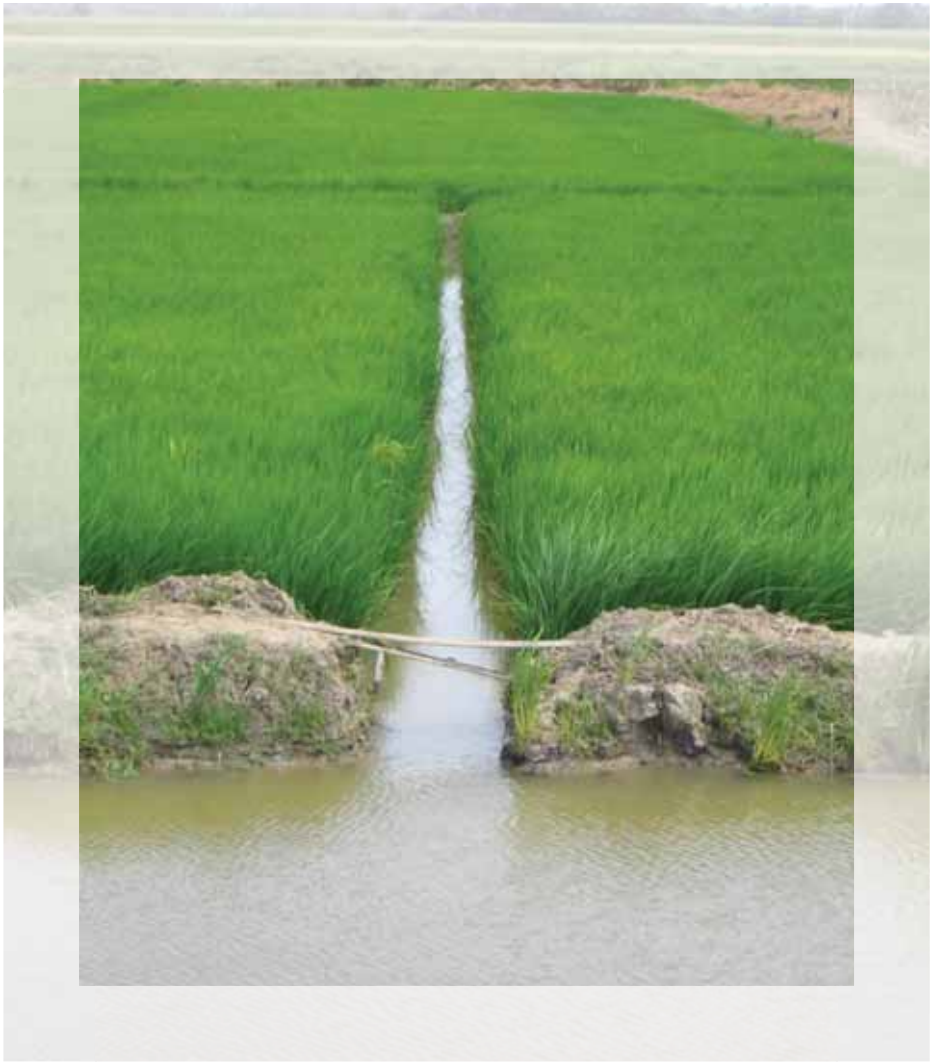
i. Select one important rice disease
   - Blast
   - Brown spot
   - Bacterial leaf sheath
   - Other local diseases

ii. On a large sheet of paper, write at the left side " process of diseases appearance" and list the whole process.

iii. At the right side, write "effect of weather", and state the effect of weather effect on the appearance of each disease. For example: wind affects the spore or conidia movement from leaf to leaf, and from the first plant to another.

iv. Complete both lists and analyze their relationship.

v. Present your finding to another group and lead discussion.



32. PRIMORDIAL STAGE IN RICE

a. Background

The primordial stage begins when the rice crop produces the initial flower inside the stem. This is the most crucial stage of rice crop, because the panicle formation also begins.

The length of the panicle, number of grains and flower quality are also being developed and will determine the ultimate yield. During this stage, crop growth and development is changing.

Leaves are the main energy producer; therefore, heavy leaf damage contributes to unfilled grains. Leaves will remain alive for about two months.

b. Objective

To be able to describe the rice primordial stage and take measures to protect the crop.

c. Time Requirement

One hour.

d. Materials

Rice crop, magnifying glass, cutter, paper and pencil.

e. Procedure

i. Determine the time of maximum tillering of the rice crop (crop duration minus 65 days); each variety may have different duration.
ii. Enter the rice field and select the highest plant, then search for the oldest tiller which has the highest leaf (it is better to remove a whole plant, for then you can see whether all the tillers are forming the primordial stage at the same time or not).
iii. Remove them carefully and bring to a meeting place, then gently dissect the stem using a cutter. Look into the upper internode and, observing closely with a magnifying glass, search for the ovule, which is usually like soft cotton, a few millimeters in length.
iv. Draw your findings on the paper.

f. Question

i. Can you predict the date of the primordial stage?
ii. Why does the primordial stage not occur at the same time, even on the same plant?
iii. What is the most important crop management factor at the primordial stage?
iv. Do you agree with the statement "fertilizing at this stage will lead to more broken grains"? If not, can you explain why?
v. If the weed population is dense, do you think competition will be a problem?
vi. Especially for duck weed, do you think it will take more nutrients than the rice crop? If yes, why? (Take duck weed from the field and examine the root system)
vii. How about your rice field? Do you think removing weeds now is a part of crop prevention strategy? Please explain.
viii. If you agree to question # vi, what are you going to do to your field?

33. EFFECT OF WEATHER ON CROP DEVELOPMENT

a. Background

We have discussed about the effect of weather on disease and insect development, and we also discussed prevention strategies. We begin by making a general pattern of insect development (egg, larva, nymph, pupa, adult) and disease development (movement, germination, inoculation, incubation, development).

However, we must take into account the whole process. Why this approach? The first thing we have to learn is to simplify a common problem, so as to have it become a specific problem. The second is proper composing or formulating, relating to the goal. No matter how much we have read about both issues, the important thing is how we compose the elements into a pattern that is interlinked with each other.

The major issue in this guide is more complex. However, it is expected that you will get more knowledge and skills. In this session we will assess the situation of importance to crop development and discuss this relationship to the weather effect.

b. Objectives

To be able to describe the crop development pattern and its relationship to weather effect.

c. Time Required

Two hours.

d. Materials

Large sheet of paper, marker pen, plain paper.

e. Procedure

i. On the large paper, make three columns “Crop development” “Weather patterns” and “Effect of Weather”.
ii. Under crop development write crop stages, like germination, vegetative stage, booting stage, flowering, ripening.
iii. Under weather parameters, write sunny and hot, cloudy and rainy, high humidity, low humidity.
iv. Under effect of weather, write the possible effects on crop stages.
v. Discuss within your group before sharing at plenary group.
vi. Select only one specific crop (rice).

34. INSECT ZOO

a. Background

Natural enemies kill their host in several ways. Predators are free-living organisms and consume a number of pests. Spiders prefer hunting and killing their prey, but some make webs over the crop to catch and suck body fluid out of their prey. Some organisms catch prey and consume the whole or a part of it.

Parasites do not eat prey; they are living at the expense of another organism. The adult female usually lays eggs inside host body by sticking the ovipositor into the host body; or, they put their eggs close to the insect host body. The larva hatched from their eggs feeds on host body, either externally or internally, usually killing their host during development. In the rice crop, we find a range of parasites, from wasps, flies, fungi and bacteria.

b. Objective

To understand how predators and parasites work to control insect pests by rearing them inside a cage or vial.

c. Materials

Rice crop, mesh net, stakes, vials and buckets.

d. Time Required

Depends on type of zoo.

e. Procedure

i. Predator zoo: Cover a one m^2 rice crop with a mesh net cage erected with sticks about one meter high. Remove insects from inside the cage, as well as a spider. Do not feed for up to two days. Put inside some insects inside the cage as prey, with the spider. Observe the cage twice a day morning and afternoon to examine the remaining prey. Record prey consumed during observation. This zoo is only for predator insects or hunting spiders. To demonstrate small predators like lady bird beetles use a vial or a discarded mineral water bottle following the method of the predator zoo.

ii. Parasites zoo: Collect larva, pupa, nymph or eggs found from the field and put inside vials or transparent plastic bags/cups. Place wetted cotton inside to maintain moisture. Cover with a mesh net and tie with a rubber band. Put them at the same place. Observe twice a day to examine hatching insects. Each vial or plastic bag should be used only once.

iii. Observation: Observe and make records on the individuals inside the cage or vial.

35. EFFECT OF WEATHER ON INSECT DEVELOPMENT

a. Background

We have discussed the effect of weather on disease development. Now, we will discuss these effects on insect development. Like pathogens, insects also need special conditions to grow and develop, such as humidity and temperature. The temperature is specific to where the insects are living e.g., the growth rate of insects that are living in a high temperature area is hampered when they live in a low temperature area. Therefore, they have their own suitable tolerable environment to support their life.

Another factor is wind, which also determines population. Wind contributes to the transfer of insects from one place to another. Also, the wind brings the smell of hosts, or the scent of females, to attract males. Crop fragrances also assist insects to find a host, e.g. wind blows cabbage fragrance where the natural enemies of cabbage caterpillar (*Plutella*) can smell, and therefore search for a main host.

Rain is an important part of the weather system, and has a large influence on insect development. Rain can also kill tiny insects. The first rain after drought makes nitrogen available for absorption, and the crop suddenly becomes greener, positively attracting insects. This session will discuss the effect of weather on insect development.

b. Objective

To be able to describe the effect of weather on crop and insect population development.

c. Materials

Large sheet, marker pen, plain paper.

d. Time Required

Two hours.

e. Procedure

i. Divide a large sheet of paper into two columns. In the left column write "Insect development process" and some other headings e.g.:
   - Migration (long distance)
   - Movement (short distance)
   - Fecundity
   - Mortality
   - Life cycle velocity
   - Hibernation

ii. In the right column, write the weather parameters and the effect of each insects' population and development.

iii. After all have been completed, discuss within your group before presenting to another at plenary session.

iv. In addition to this, try making a big drawing expressing the relationship between crop development, insect development and weather situation. For example, will it be different if: weather is drier, wetter, hotter or cooler? Discuss these differences and try making a forecasting model for one insect species (paddy bug).

36. ASSESSING THE SNAIL POPULATION DURING FALLOW SEASON

a. Background

Snails (*Panacea*) or Creketae, occasionally damage the eye of pre germinated seeds sown in flooded fields, resulting in very poor emergence. In some cases fields have to be re-sown. Snails can also cause complete destruction to the crop. Snails feed on dead leaves for about 6 weeks.

Most of the damage occurs in the deep area of the field. An adult snail is about 5 cm when fully grown, and it has a dark striped shell. The snail emerges from the water during the night and lays their eggs on the stem of the rice plant and on weeds such as beezibeesie, soap bush and on small pieces of wood located in the canals.

The colour of the egg mass is pink, containing 60-260 eggs, and will hatch in 17-20 days. The young snails fall into the water and start to develop, in a process which can last up to two years. Snails can get into the field through pumping of irrigation water.

b. Objectives

To enable farmers to perceive and take action to prevent snail the damage during the next crop, based upon observations in the current crop.

c. Time

Two hours.

d. Materials

Meter square, spade, shovel, field, bucket and water.

e. Procedure

i. Take a one $1m^2$ sample on a diagonal line, on low and high spots.
ii. Dig soil and smash it until you find a snail.
iii. Collect snail, put in bucket and cover with cloth mesh.
iv. Place bucket in cool place and observe for twenty four hours.
v. Record live and dead snails.
vi. Present to class.

f. Discussion

i. What action should be taken before cultivation?
ii. Screen with mesh during irrigation.
iii. Dry tillage assists in killing snails during land preparation.
iv. The tillage must be properly done.

37. WEED SEED BANK

a. Background

Weed seeds are present at different layers in the soil. Some weed seeds have a very long dormancy period and can remain in the soil for over 20 years e.g. red rice. Weeds usually emerge after broadcasting and can compete with the rice plant for sunlight, nutrients and space. In a highly weed-populated rice plot, the yield can be significantly reduced. Some weeds also serve as alternative host for either diseases insect pests. For effective weed control, farmers should know about weed types and the management practices to minimize the population.

b. Objectives

To determine the type of weed seeds present in the soil and at what depth.
To determine the dormancy of weed seeds.

c. Materials

Rice soil, fork, spade, shovel, cutlass, ruler, plastic bag, and soil box.

d. Time

Two hours.

e. Procedure

i. Dig the first layer of soil to two inches depth.
ii. Dig the second layer of soil to six inches depth.
iii. Dig the third layer of soil to nine inches depth.
iv. Place each layer of soil into separate plastic bags.
v. Take three samples diagonally in the field.
vi. Mix each layer together.
vii. Place in seed box, wet and observe for seedling emergence.
viii. Record the type of weed seedlings as they emerge.

f. Discussion

i. What cultural practices can minimize weed population?
ii. Weed control can be done by leveling the field, getting seed free of weeds, proper water management and the application of a pre-emergence herbicide.

38. THE PADDY BUG

a. Background

Paddy bug known as Gandhi, is very detrimental to the rice crop at the dough stage. The paddy bug has the capability of depositing two to three hundred eggs. The eggs are shaped like a barrel, and when deposited on the leaf or stem of rice plant, they are grayish. Their colour changes seven days after depositing, when they are about to hatch.

The young bug stage is called the nymph stage. Fourteen days after hatching, the paddy bug becomes a pest to the rice crop and attacks the grain in the dough stage. To differentiate from other bugs, the following can be used:

- the Paddy Bug stinks;
- the Paddy Bug has a shield shape on its back.

The life cycle of the bug can last up to forty five days, which is dangerous to the rice crop in terms of multiplication.

b. Objective

To determine if biological control is more effective then chemical control.

c. Materials

Sweep net, meter square, insect zoo mesh, stick, chemical, sprayer, plastic bag and bucket.

d. Procedure

i. Measure four one-meter square plots and demarcate with stick.
ii. Set up insect zoo in each one meter square plot that has been demarcated.
iii. Catch Paddy Bug nymph and natural enemy, e.g., damselfly, braconids, spider and lady bird beetle.
iv. Put Paddy Bug in each zoo along with one natural enemy.
v. Spray around one zoo with chemical and leave the other for biological control.
vi. Leave and observe on a twenty-four hours basis and record findings.

e. Discussion

i. Discuss findings with farmers and make recommendations or proposals about the experiment.
ii. What population of Paddy Bug can be a serious pest to the rice, which reduces yield economically?

PART II

FFS CURRICULUM FOR AQUACULTURE IN RICE-BASED FARMING SYSTEMS FOR GUYANA AND SURINAME

INTRODUCTION

Background:

Rice-fish culture is one component of aquaculture which has great potential for development in Guyana and Suriname due to the vast areas of irrigated rice fields. If properly implemented, it could increase rice farmer's production and income derived from rice and fish. Adoption of proper techniques in rice-fish culture is expected to help improve food security in the Caribbean Region and increase profit of rice farmers in Guyana and Suriname.

Objectives

The ultimate objective of this season long rice-fish culture FFS is to train rice farmers in the application of low-cost appropriate technology for the production of fish in irrigated rice fields in Guyana and Suriname.

a. General:
   - to increase rice farmers' food production and income through diversified utilization of rice field area for production of rice and fish.

b. Specific:
   - to introduce and promote rice-fish culture to interested rice farmers;
   - to establish farmers-based rice-fish culture trial and demonstration/training sites;
   - to train farmers/aquaculturists and other interested parties on the proper techniques of rice-fish culture;
   - to be able to extend technical assistance to farmers doing rice-fish culture.

Expected Output

- Increased rice field production through diversification of rice and fish.
- Farmers reduced dependence of chemicals in their rice production.
- Farmers succeeded in diversifying their farming activity aimed at increasing farm income and improving family nutritional status.

Strategy of implementation:

- Train farmers on the proper method of aquaculture in rice-based farming system through the FFS approach.
- Conduct two types of field trials on the culture of tilapia or *Hassar* with interested farmer-cooperators using available on-farm resources and compound artificial feed.

WEEKLY SESSION GUIDES

WEEK 1- INTRODUCTION TO RICE-FISH CULTURE

Rice-fish culture is the simultaneous or alternate production of fish in a rice field. It consists of stocking the rice field with fish of selected size and species to obtain a fish crop in addition to rice which is the main crop.

Rice in combination with fish forms an ideal food for both the Guyanese and Surinamese people. While rice is the main dietary source of carbohydrates, the fish supplies protein, being an important source of cheap and easily digestible animal protein.

Rice-fish culture is one component of aquaculture which has great potential for development in Guyana and Suriname due to the vast areas of irrigated rice fields. If properly implemented it could increase rice farmer's production and income derived from rice and fish. Adoption of proper techniques in rice-fish culture is expected to help improve food security in the Caribbean Region and increase profit of rice farmers in Guyana and Suriname.

Although, rice-fish culture has just been tried in Guyana, indications showed that it can be successful. It is relatively easy, low cost and a low risk entry point for rural farming communities to improve their livelihood and household income without jeopardizing the sustainability of rice production.

Rice fields to be used for rice fish culture have to be renovated to varying degrees to make them favorable for fish growth. The physical renovation includes the excavation of ditches and sumps as shelter for fish and building of higher and wider dikes to prevent escape of cultured fish, and at the same time to preventing flooding.

WEEK 2- MODIFIED RICE-FISH CULTURE FOR GUYANA AND SURINAME

Background:

Conventional rice-fish farming systems successfully practiced in Asia may not do well in either the Guyana or Suriname situation, unless the existing physical rice field conditions in both countries are modified, taking into consideration the constraints raised by farmers, especially their dependence on chemicals for rice production.

In this exercise, the area to be utilized for the project trial and demonstration is 2 000 square meters (less than half of an acre) for easy management, where one-fourth of it is developed into a fishpond. The fishpond is located at the lowest portion of the rice plot.

A rice field comprising ¾ of the total plot area is modified by raising and widening the bunds to hold enough water during the culture period of the fish. A center trench is constructed lengthwise of the rice field, one end connecting directly into the opening in-between the rice field and the pond. The trench does not occupy more than 10% of the total rice field area.

Objectives:

i. To know the advantages of having the modified system of rice-fish culture.
ii. To know how a modified rice-fish culture is managed.
iii. To be able to prepare the pond and rice field for the growing of natural fish food.
iv. To know and practice the calendar of activities for rice-fish culture.

Time Frame:

Whole rice-fish cropping season.

Resources Needed:

Fishpond, rice field, animal manures, one PVC pipe 5 ft. length 3" diameter with fine mesh screen at one end, one PVC pipe elbow 3" diameter with fine mesh screen at one end, seed paddy, fish fingerlings.

Activities to be undertaken:

i. For good pond rice field management: apply right amount of fertilizer, use appropriate fish stocking density (start at 2 fish/m^2), eliminate and control weeds, prevent entry and control of predatory animals and competitors of fish, practice proper water management, use supplemental feeds, and correct harvesting technique.
ii. Pond/rice field preparation: For old fishpond, dry the pond bottom under sunlight to kill fish predators and organisms that may cause fish diseases. In new pond, apply lime (if available) to pond bottom and dikes at 5 kg/100 m^2 to neutralize the soil, making it suitable for production of natural food for the fish and to kill bacteria harmful for the fish to be stocked. Apply animal manure to the pond at the rate of 50 kg/100 m^2. Let water in gradually to allow production of natural food for the fish until desired water level is attained.
iii. Present/discuss to the farmers a prepared calendar of activities for modified rice-fish culture for Guyana and Suriname and a prepared illustration for construction of a modified rice-fish culture farm.

WEEK 3- TRANSPORTING AND STOCKING OF LIVE FISH

Background:

The transport of live fish from the hatchery to any unit of water plays an important role in aquaculture management. Transporting fish involves the hauling of a large number of fish in a small quantity of water. Unless this is done properly, the length of time involved can quickly deteriorate the water quality which can cause fish mortality.

Objectives:

i. To know the different ways of transporting live fish.
ii. To know the causes of fish stress and prevent them.
iii. To know and apply the proper techniques of stocking fish.

Time:

10 minutes discussion and 20 minutes demonstration on actual stocking of fish.

Resources Needed:

Happa net for holding fingerlings, plastic bags, pandan bag, prepared fishpond or rice field with rice 21 DAS.

Procedures in stocking of fish:

i. Upon arrival, float the fish container into the pond water surface for 15 minutes to balance water temperature between the container and pond water.
ii. Let the pond water come inside the fish container and allow the fish to swim outside into the pond.

WEEK 4- CONSTRUCTION OF NETS FOR USE IN RICE-FISH CULTURE

Background:

Nets are among the basic gears and equipment in fish culture, and are indispensable in rice-fish culture operations. For ease of use, without harming the fish, it is important for a fish farmer to have knowledge on how to make the right net and its proper use. The types of nets most commonly used in rice fish culture are: happa net, lift net, and scoop nets.

A happa net, which looks like an inverted mosquito net, is used to nurse fry until fingerling size (fine mesh happa net) or used to hold or keep large sized fish alive before stocking or marketing (larger mesh size happa net).

A lift net is an assembly consisting of a plain net cut in a square shape measuring 2 m by 2 m seamed with a rope along the edges of its four sides. It is made ready for lift netting operation by stretching it, through the use of two bamboo splits measuring 3 cm wide by 8 m long, tied at the net's opposing corners forming a crossed arc position. It is very effective in catching fishes with no injuries sustained.

A scoop net is a device made of a fine netting material with all openings at the sides and bottom stitched together forming a purse and the upper opening stitched into a round or square shaped iron rod.

Objectives:

i. To know the different kinds of nets commonly used in rice-fish farming.
ii. To be able to construct and use the right nets in rice-fish culture.

Time:

One whole session for discussion and demonstration on construction of nets.

Materials needed:

- 4 square meters of ¼ inch mesh size net for making lift net;
- bamboo splits measuring 3 cm width by 8 m long;
- 1 bamboo pole 6 m long;
- 8 m of fine mesh net, 1 m wide (for making happa net of size 1 m x 1 m x 2 m);
- 8 m long small size rope for edging the happa net;
- 0.5 m x 1.0 m of ¼" mesh size net for making scoop net;
- 0.5 m x 1.0 m of fine mesh net for making fry/fingerlings scoop net;
- fine nylon twine for stitching the seam of nets;
- pieces ¾ inch iron rod 1.5 m long each, for ring and handle of scoop nets.

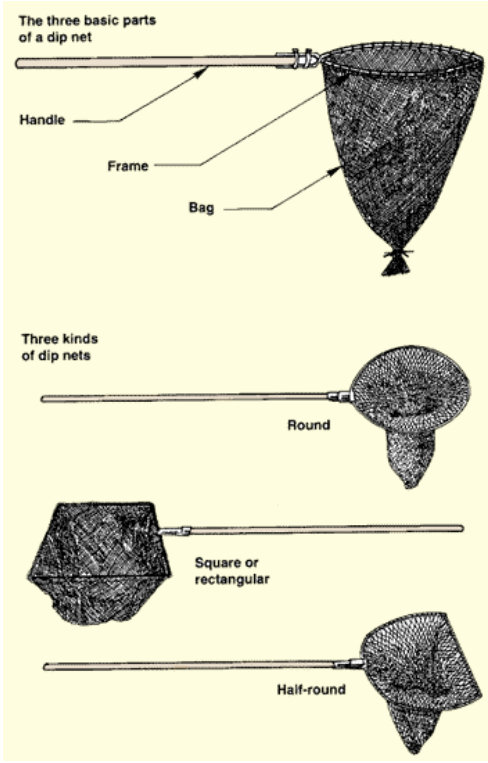
Activities to be undertaken:

i. Construction of a happa net:
    1. From the netting material measuring 1 m width x 8 m long, cut out a piece measuring 2 m long
    2. Stitch the remaining 6 m of net into the just cut 2 m length by joining their sides together until both ends met for final joining by stitching.
    3. After an inverted mosquito net shape is formed, fold one inch of the edges of the opening and stitch it all around.

4. Insert a small size rope into the folded edges of the assembled happa net and leave knots at each of the four corners for tying into wooden posts upon installation into the fish pond.

ii. Construction of a lift net:
   1. Prepare a ¼ inch mesh size net measuring 2 m by 2 m.
   2. Reinforce four sides of the net by inserting a small size rope all around at its edging mesh. Stretch the rope and distribute its length equally into four sides of the net. Make a knot in every corner of the net with the rope.
   3. To assemble the lift net, connect opposing corners of the net to each opposing ends of the bamboo split measuring 3 cm width by 8 m long. The remaining two corners are also tied to another bamboo split of the same measurement the same way as the previous one, making the net stretched out by the bamboo splits formed in a crossed arc position.
   4. After this assembly, the lift net is made ready for lift netting of fish operation by submerging it the inside the pond. It is lifted by using an extended bamboo pole of 6 m length hooked into the crossing portion of two bamboo splits.

iii. Construction of a scoop net:
   1. Make a circular or square frame out of a ¾ inch iron rod having a length of 1.5 m.
   2. From the netting material measuring 0.5 m x 1.0 m, join together by stitching its side and bottom to form like a purse. The upper opening is also stitched into a round or square shaped iron rod.



WEEK 5- FISH FEEDS AND FEEDING

Background:

Fishes cultured in ponds or rice fields get their initial source of food from the natural food present in the water. The natural food consists mainly of planktons, which are produced after thorough pond or rice field preparation. As the fishes grow, their food-needs increase, to the point where the natural food present in the water may not be enough to sustain them. At this stage, it is essential that supplementary feeding be applied to the cultured fish.

Objectives:

i. To know and use the different types of supplementary feeds available locally.
ii. To know and apply the proper and effective method of fish feeding.
iii. To know the growth performance of feeds comparing on farm and compound artificial feeds.

Time frame:

Feeding trial- one whole cropping season; lecture and discussions - 30 minutes.

Resources Needed:

Fishpond and rice-fish field, fish fingerlings, on farm feeds (rice bran, termites, leftover foods, wheat bran, sliced papaya leaves, vegetable wastes, crushed snail meat, etc.), compound artificial feeds, feeding box or pan, 1 happa net, scoop nets, gram scale, ruler, prepared illustrations on the different on farm fish feeds available locally.

Activities to be done:

i. Feed on farm feeds to the fish in the pond by using feeding box or pan at a quantity of 5% of the fish total biomass. Adjust the amount of feeds monthly based on the result of the latest fish sampling conducted. If floating type of on farm feeds (like termites) is applied, observe the fishes' daily consumption and make adjustments for the right quantity that the fishes are able to consume.
ii. Make another feeding trial by using a happa net suspended in the same pond using compound artificial feeds. The stocking density of the happa net should be the same as of the pond. Feed the fish regularly at same time of feeding the fish in the pond.
iii. Sample the fishes cultured in the pond using lift net, and those in the happa net using scoop net, on the same day every month to determine growth rate. Make adjustments of the fish feeds for the next one month feeding ration.
iv. Compare the results after a six month culture period and discuss with the farmers.

WEEK 6- WATER MANAGEMENT

Background:

Water is the only medium that makes the culture of fish with rice possible. Too little or too much of it would be detrimental to the fish. Therefore, proper water management in rice-fish culture is essential to make both rice and fish co-exist harmoniously in the same field.

Objective:

To know the proper management of water in rice-fish culture.

Time:

Actual field activities last during the whole rice-fish cropping season; lecture and discussions - 15 minutes.

Resources Needed:

A fishpond connected to a rice field, one 5–inch diameter PVC pipe with fine mesh screen at one end, one PVC elbow attached to the PVC pipe with fine mesh screen at one end.

Activities to be done:

i. Install the screened PVC pipe into the dike of the rice field with the rotating elbow located inside of rice-fish plot. The elbow should be tilted at an angle that would enable water to be maintained at the depth desired for the rice-fish plot.
ii. Water management starts at the point of letting water into the pond or rice field, and its preparation for growing of natural food. At this time (the pond and the rice field are still separated by a dike), gradually let the water come inside to the pond and maintain to the level of the rice field bed.
iii. During sowing of pre-germinated seeds in the rice field, irrigate water into the pond at 3" higher than the water level in the rice field.
iv. In the 2nd week after sowing, irrigate water into the rice field. As much as possible, maintain the pond water level at 3" higher than the water in the rice field.
v. In the 3rd week after sowing, when the rice is fertilized, stock the fish at a rate of 2 fish per square meter.
vi. On the 25th D.A.S. open the dike/blockade in-between the pond dike and rice field and let fishes swim out from the pond into the rice field through the center trench.
vii. On 45th D.A.S. raise water level in the rice field in 5 "to 8" deep (water level in the pond rises same level with the rice field).
viii. On 60th D.A.S. raise water level in the rice field from 8" to 12" deep (water level in the pond also rises at same level with the rice field).
ix. On the 80th to 85th D.A.S. drain the water gradually and let fishes inside the rice field go back into the fishpond through the center trench.

WEEK 7- POND AND RICE FIELD FERTILIZATION

Background:

Fertilizers stimulate the growth of plankton, which is the natural food of the fish. When the fish are still small, they rely on the natural food present in the water to sustain their growth. Therefore, since fertilization increases the availability of natural foods in the water, fertilization is a key factor for increasing fish yields. It is important for farmers to know which fertilizer to apply, and when to apply the fertilizer in his pond or rice field.

Objectives:

i. To know the different types of fertilizer and when to use them in rice-fish culture.
ii. To know and be able to apply simple methods of measuring pond water fertility.

Time needed:

15 minutes for lecture and discussion; 15 minutes for field demonstration.

Resources Needed:

Animal manure, chemical fertilizers (Urea and TSP), sample plankton inside a transparent plastic bottle, prepared illustration on how to measure fertility of pond water.

Activities to be done:

i. Demonstrate to the farmers the different types of fertilizers for use in fertilizing pond or rice field: organic animal manures, chemical fertilizers (Urea and TSP).
ii. Initial organic fertilization of the pond is done by applying animal manure at 50 kg/100 m² while the rice field is undergoing preparation. For maintenance fertilization, chemical fertilizer (TSP or Urea) could be applied at a rate of 0.6 kg/100 m² per week. It should be dissolved in a few liters of water using a bucket. Or, animal manure could be used, at a rate of 50 kg/100 m² every other week.
iii. Adjust the quantity of maintenance fertilizer applied (increase or decrease) depending on the greenness of the pond water. To measure the water quality to determine if there is enough natural food, submerge your hand under the pond water until at elbow level with palm facing upward
    - If the palm is seen very clearly, there is not enough natural food in the water; therefore, apply more animal manure or chemical fertilizer;
    - If the palm is not visible, there is over production of natural fish food, that may lead to bad pond water; reduce application of animal manure or chemical fertilizer and exchange about 6 inches of the pond water
    - If the palm is slightly visible, there is enough natural fish food present in the pond water, maintain the current amount of animal manure and/or chemical fertilizer.
iv. For the rice field, apply first doze of fertilizer to the rice on the 21st D.A.S. and second doze of fertilizer on the 48th D.A.S.
v. Show to the farmers the specimen planktons inside a transparent plastic bottle produced from a fertilized pond.

Week 8- FISH PREDATORS AND OTHER PESTS

Background:

Fish production in ponds and rice fields is commonly affected by some pests and predators. Predators are organisms which prey on the fish being cultured. The animals that compete for food or space are called competitors.

Objectives:

i. To know the predators and competitors of fish cultured in ponds and rice fields.
ii. To be able to control fish predators and competitors.

Time needed:

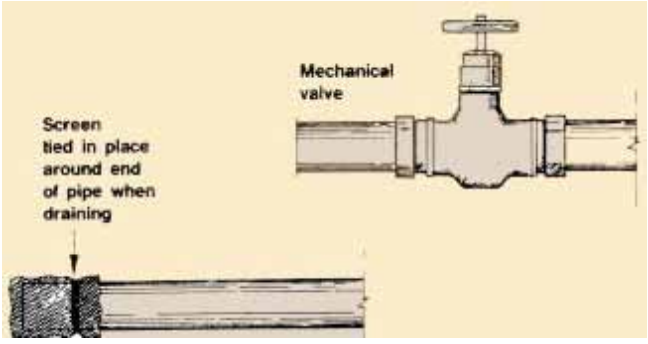
Lecture and discussions - 20 minutes; actual field demonstration - 1 hour.

Resources Needed for Field Activity:

Vicinity of a rice-fish plot, predator trap, screened PVC pipe for passage of water, barbed wire (to prevent fish poaching by use of cast net inside the pond).

Activities to be done:

i. Demonstrate to farmers how to assemble a trap designed for catching fish predators using locally available materials. Trap to be installed within the vicinity of the rice-fish plot located at a passageway of the fish predators.
ii. Demonstrate the way to control entry of unwanted fish competitors and some predatory fish species, at same time preventing escape of cultured fishes inside the pond, by the installation of a fine mesh screen at both ends of the water irrigation/ drainage PVC pipe.
iii. Show to the farmers a prepared illustration of most common predators and competitors of fish cultured in pond and rice fields.



WEEK 9- POND /RICE FIELD FISH CULTURE SYSTEMS

Background:

There are two systems of culturing fish in ponds or rice fields: monoculture and polyculture. Monoculture is the rearing of a single species of fish, while polyculture is the rearing of two or more non-competitive species in the same pond. The adoption of each system would depend on the farmer's choice and the availability of fish seed species to use.

Objective:

In the end of the farmers' field school season the farmers will have an idea of which culture system he will adopt.

Time requirements:

One crop season or during the entire FFS period.

Resources Needed:

a pond and rice-fish plot, two happa nets of same size, fingerlings of *Hassar* and tilapia, fish feeds, gram scale, scoop net, lift net, ruler, pen and paper.

Procedure:

i. Install two happa nets in a prepared pond. Assign one happa net for monoculture of tilapia, while the other happa net should be used for polyculture of tilapia and Hassar.
ii. Stock tilapia fingerlings at 2 fish/m^2 into the monoculture net; stock tilapia and *Hassar* fingerlings together into the polyculture net at 2 fish/m^2.
iii. Feed the fish daily with same amount of feed.
iv. Sample the fishes in the two nets every month and adjust the amount of feeds to be given at 5% of fish biomass, based on the latest fish sampling conducted.
v. Sample the fish at harvest day and compare the result. Discuss results with the farmers.

Questions:

i. Which type of fish culture gave the higher profit? Why?
ii. How will these types of fish culture be scaled up to other farming communities?

WEEK 10- FISH STOCKING DENSITY

Background:

The growth of fish depends on the number of fish stocked and the number of fishes present in the pond or rice field. This is due to several factors that include density and competition.

Fish stocking density is one of several factors that affect fish growth. At low stocking density, the amount of natural food in the pond is higher for each individual fish and the excess food is not utilized. However, at higher stocking density the growth of fish will be slow because the capacity of the natural food to support the fish population will be limited to a certain extent. The maximum physiological growth of tilapia is attained at low stocking density.

Objectives:

i. To know the factors that influence the selection of the correct stocking density in the pond and rice field.
ii. To compare the growth difference of fishes stocked at two different densities using happa nets.

Time:

Three months culture period.

Resources Needed:

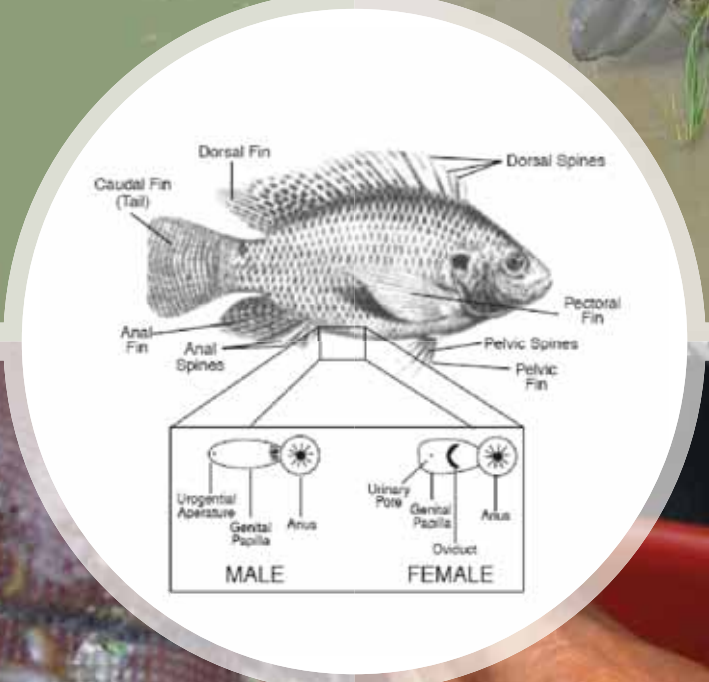
A fishpond, 2 happa nets (measuring 1 m x 1m x 1 m), gram scale, ruler, 6 tilapia fingerlings of the same size, fish feeds (on-farm and compound formulated feeds)

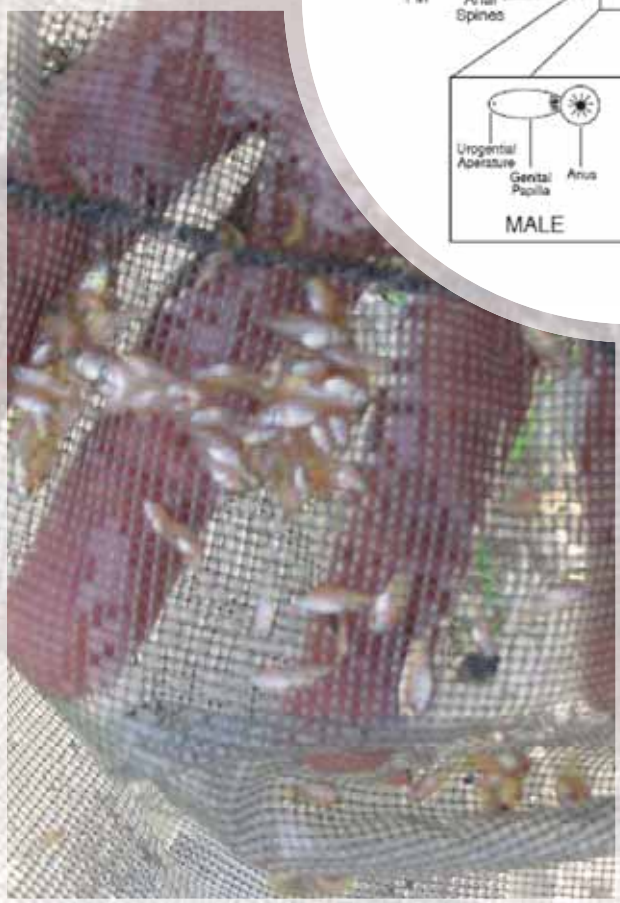
Procedures:

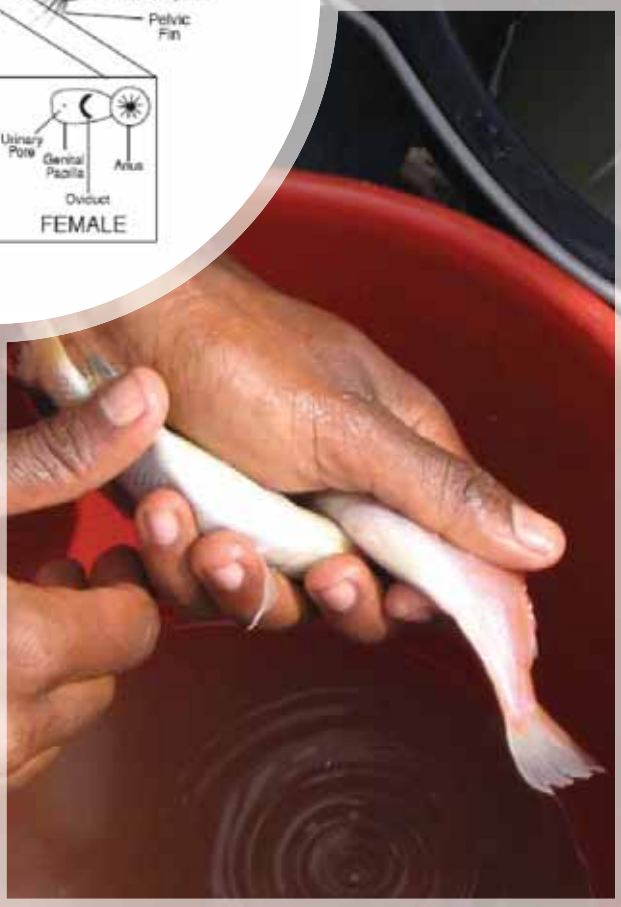
i. Install 2 happa nets in the pond.
ii. Get the individual initial weights of the 6 tilapia fingerlings,
iii. Stock 2 tilapia fingerlings in the first happa net and the remaining 4 tilapia fingerlings into the second happa net.
iv. Feed the fishes in the two happa nets with same amount of feeds at 5% of their total body weight, to be adjusted accordingly based on result of the samplings to be conducted monthly.
v. After three months of culture weigh individual fishes from separate happa nets upon harvest and compare the results.

Discussion:

Which stocking density gave better result over the other? Why? Discuss further other factors that affect growth rate of the fishes stocked at two different densities.


Dorsal Fin
Dorsal Spines
Caudal Fin (Tail)
Pectoral Fin
Anal Fin
Anal Spines
Pelvic Spines
Pelvic Fin
Urogenital Aperature
Genital Papilla
Anus
Urinary Pore
Genital Papilla
Anus
Oviduct
MALE
FEMALE





WEEK 11- PRODUCTION OF TILAPIA FRY AND FINGERLINGS

Background:

Tilapia is a very prolific fish species. The female starts reproducing in the third month after hatching and will continue spawning every four to six weeks thereafter. During spawning, the female tilapia enters the nest built by the male and lays the eggs. The eggs are fertilized by the male. The female then collects and incubates the eggs in her mouth. Because they are mouth brooders, they do not feed during incubation or in brooding period.

Objectives:

i. To be able to identify the sex difference between male and female tilapia.
ii. To know the spawning characteristics of tilapia.
iii. To know the number of eggs a female tilapia can produce.

Time:

One session for lecture, discussions and actual field demonstration.

Resources Needed:

Fishpond, tilapia broodstock, lift net, scoop net, feeds.

Activities to be undertaken:

i. Difference between male and female: Using a lift and scoop net, catch mature tilapia broodstock and identify male from female tilapia using the following identification: male has two openings just in front of the anal fin. The large opening is the anus and the smaller opening at the tip is the urogenital pore; the female has three openings- the anus, the genital pore, and the urinary pore. The genital papilla is usually smaller in the female.
ii. Spawning characteristics of tilapia: The male establishes a territory and builds a round nest at the pond bottom. Usually the diameter of a nest is 30 to 60 centimeters. The size of the nest is correlated to the size of the male. The female enters the nest and lays the eggs. The eggs are fertilized by the male. The female then collects and incubates the eggs in her mouth. The eggs are yellow in color. Eggs hatch in about five to seven days. After hatching the fry remain in the mouth of the female for another four to seven days. The fry begin to swim freely in schools, but may return to the mouth of the mother when threatened.
iii. Number of Eggs Produced: The number of eggs per spawning is related to the size of the female. A female of about 100 grams may produce approximately 100 eggs per spawning while a female weighing 100 to 600 grams can produce 1 000 to 1 500 or more eggs per spawning.

WEEK 12- FRY NURSING

Background:

Shortly after the fry have been hatched, it is wise to separate them from their mother fish and transfer them to a nursery area to prevent higher mortality caused by several factors, mostly by predation. There are many forms of nurseries which can be used to successfully rear fish fry. The decision as to which nursery system to use depends upon the species of fish, materials available and the amount of money that farmers can invest.

Objectives:

i. To know the different types of nursery facilities to use for nursing fry.
ii. To know the activities to be done for ensuring success in fry nursing.
iii. To know the difference in growth and survival rate of fry nursing using earthen pond and happa net cage.

Time:

15 minutes lecture and discussions; one and a half months actual fry nursing duration.

Resources Needed:

Earthen pond, happa net cage, one week old tilapia fry, fine mesh lift net, fine mesh scoop net, formulated fish feed or chicken starter feeds.

Activities to be done:

i. For fry nursing in earthen nursery pond:
   Good nursery pond preparation requires the following steps to be observed:
   - Empty the water out of the pond (drain or use a pump) and dry the pond.
   - If water can not de drained, predators in the pond can be killed by the addition of rotenone (derris powder) at a rate of 1.5 grams per cubic meter of pond water. If derris is difficult to obtain, draining and drying the pond is the most effective method of eliminating predators.
   - Add lime at a rate of 1 kg for every 25 m^2 of pond area. Lime can usually be purchased from building supplies shops. Lime assists soil fertility and reduces the amount of fertilizer required to produce green water in the nursery pond.
   - Add fertilizer to the pond at the rate of 1.5 kilos per 10 m^2. This is equivalent to one full bucket per 20 m^2 of pond area. Fertilizers that can be used include buffalo, cow, chicken, goat, sheep, and pig manure. After the manure is applied the pond can be filled to a depth of 5 to 10 centimeters to allow the breakdown of the manure. After 3 to 5 days, the pond should be filled to a depth of 30 to 50 centimeters, and it is then ready for stocking.
   - Fry are stocked into the nursery pond at a rate of 125 - 500 individuals per m^2.
   - After stocking the fry into the pond (usually done in the early evening), the water level is maintained for one week. One week after stocking the water level is then increased to 80 centimeters.
ii. For nursing of fry in happa net cage
   Once fry are large enough not to escape through blue netting (about 2 to 3 weeks

after hatching), they can be cultured in cages made of this material. The advantage of fry culture in cages is that they do not suffer from predation from larger fish, frogs or large water insects. The fish need to be fed more than if they were cultured in the pond, but the high survival will compensate for the extra cost of the feed.

If water can be supplied to the cage this will increase aeration and remove waste products. This will allow higher densities of fry to be cultured than is otherwise possible without water flow.

- Blue net cage (4 x 5 m) without water supply - stock 2 000 fry (>2 weeks old).
- Blue net cage (4 x 5 m) with water supply - stock 5 000 to 10 000 fry (>2 weeks old).

The fish should be fed with pig or chicken starter feed mixed with soft rice bran to ensure they obtain sufficient food and grow well.

iii. After the fry nursing period is completed, compare the growth performance and survival rate between the two fry nursing systems. Which one is better? Discuss results with the farmers.

WEEK 13- POND /RICE-FISH FIELD MAINTENANCE

Background:

To be able to do effective maintenance of a rice-fish farm, it is a must for a farmer to regularly visit his farm site. By having the farmer's regular presence in his farm he can immediately take remedial actions to whatever problems he could see, before the problem gets serious.

Objective:

To be able to maintain operation of a pond and /or rice-fish culture farm.

Time frame:

Lecture and discussions - 15 minutes; actual field activity - whole fish cropping season.

Resources Needed:

A fish pond connected to a rice field through a center trench.

Activities to be done:

i. Among the major maintenance and operational activities to be done by farmers are the following:
ii. Always maintain the desired water depth of the pond/rice field and make sure both ends of water inlet/outlet pipes (if any) are properly screened. Maintain the desired greenness of pond water. Change the pond water when it is smelling bad, or when fishes are seen gulping at the water surface due to a lack of oxygen.
iii. Feed fish daily at 5% of the total body weight. Adjust daily feeding ration monthly, based on the latest sampling of the fish stock conducted after every thirty days.
iv. To maintain the growth of plankton and other natural food for the fish present in the water, apply fertilization into the pond at a rate of 50 kg of animal manure per 100 m² every two weeks, or 0.6 kg of inorganic fertilizer per 100 m² per week.
v. Remove floating and submerged weeds growing inside the pond, as they compete with the stocked fish for space and nutrients necessary for production of natural food in the water.
vi. To prevent poaching of cultured fish, stakes or barbed wires can be installed underwater inside the pond.
vii. Grow and maintain crawling grass on top and slope of the dikes to help in maintaining compaction and preventing soil erosion.
viii. Always repair any damaged to the dike, such as leakages or seepages, before it becomes big and causes serious damage to the pond.
ix. Check for any foreign objects in the screens of the pond pipes and clean regularly to avoid screens from becoming clogged.

WEEK 14- FISH HARVESTING

Background:

Fish stocks are ready for harvest as soon as they reach marketable sizes. Usually fishes are harvested after six to eight months, if cultured in a pond. In rice-fish culture, fishes are harvested about one month to one week ahead of rice harvest. If they have not yet attained marketable size at this time, they can then be cultured further inside the pond adjacent to the rice field. Harvesting of fish cultured in the rice-fish plot is effected by gradually draining out water in the rice-fish field, allowing the fish to find their way back into the pond through the trench constructed at the center.

Objective:

To know the different methods of harvesting cultured fish.

Time:

Lecture and discussions - 15 minutes; actual field fish harvesting activity - half day.

Resources Needed:

A fishpond stocked with marketable size of fish, cast net, seine, scoop nets, buckets, and happa net

Activities to be done for fish harvesting:

i. In partial or selective harvesting, partially drain the water and use nets to catch the desired amount of fish needed.
ii. In total harvesting, drain the pond water totally by pumping out water (if the pond is not drainable by gravity). Collect the market size fish by using scoop net, and put into fish container or bucket. Collect undersize fish produced and put inside a happa net to be restocked back into the just harvested pond later after its pond preparation.

WEEK 15- POST HARVEST TECHNOLOGY

Background:

Fish spoilage begins as soon as the fish dies, and results from a series of deteriorative changes which are broadly classified into: autolysis, bacterial and chemical. Because the price of fish depends largely on its quality, it is important to handle it properly to be able to deliver or sell high quality fish, which can command a high price and at the same time, satisfy the consumers.

Objectives:

i. To know why fish spoils.
ii. To be able to differentiate fresh from spoiled fish.
iii. To know how to handle or process fish right after harvest to prevent its early spoilage.

Time:

30 minutes demonstration including discussion.

Resources Needed:

Knife, cutting board, bucket, fresh fish, spoiled or stale fish, ice.

Procedures in determining spoiled fish:

i. Secure two fishes: one fresh and another spoiled.
ii. Dissect the two fishes applying the same method of cutting, starting from the back part down to the belly part.
iii. Compare the flesh appearance: fresh flesh is reddish with traces of fresh blood while spoiled fish looks pale with blood starting to clot.

Other characteristics used to determine fresh from spoiled fish are the following:

	Fresh fish	Spoiled fish
Eyes	• bright, bulging • Pupil, velvet black; • Cornea, transparent	• dull, wrinkled, sunken; • pupil, dull black; • cornea, opaque
Gills	• bright red, covered with Slime; • odor under gill covers fresh	• dull brown or gray; slime cloudy; • odor under gill covers sour and offensive
Flesh	• firm; body is stiff; impression made by fingers does not remain • Slime present is clear	• soft and flabby; impression made by fingers remains
Body	• stiff	• limp
Belly walls	• intact	• often ruptured, with viscera protruding
Muscle tissue	• whitish	• pinkish, especially around backbone
Vent	• pink not protruding	• brown, protruding
Odor	• fresh, fishy odor	• stale, sour or putrid
Color	• bright	• faded

The three important ways of preventing fish from spoiling too quickly are: care, cleanliness and cooling.

Care in handling is essential because unnecessary damage can provide access, through cuts and wounds, for the spoiling bacteria, thus hastening their effect on the flesh
All surfaces with which the fish may come into contact should be scrubbed clean and kept as free as possible from bacteria-laden materials. Natural sources of bacteria can be removed soon after the fish is captured / harvested by taking out the guts and washing off the slime from the surface of the fish.

The higher the temperature, the faster the bacteria multiply, and the lower the temperature, the slower the bacterial and enzymatic activities. Therefore, the most important step to slow down these activities is to lower the temperature of the fish as quickly as possible.

WEEK 16- COST AND RETURN ANALYSIS OF RICE-FISH CULTURE

Background:

The primary purpose of culturing fish with rice is to get additional income derived from fish, as secondary crop, in addition to rice, which is the main crop. However, in order for fish to live in harmony with the rice, there needs to be an additional input for the construction of ponds with higher and stronger dikes to keep fish at certain period of time, before they are released into the rice field, and for heightening of the rice field perimeter dikes. With all the expenses entailed in developing the rice-fish culture site, coupled with operating and maintenance expenses, it is important to analyze its cost of production and return of investment after one year operation to be able to know whether the rice-fish farming venture is giving the farmer his desired profit or not.

Objectives:

i. To be able to know how much has been spent to produce both rice and fish in a given cropping season per year.
ii. To be able to know the production and income of rice and fish in a given cropping season per year.
iii. To be able to know the return of investment in rice and fish culture.

Time needed:

Recording of expenses start from pond and rice field construction until selling of harvested fish.

Cost and return analysis presentation with farmers - about 15 minutes.

Resources Needed:

Record book, calculator.

Procedure:

i. List all items under fixed assets investment and their corresponding total costs.
ii. List all items under operating expenses and their corresponding total costs. Add 10% as contingencies to the total cost.
iii. Get the total of annual depreciation costs of all fixed assets listed above.
iv. Compute the Gross Sales by multiplying harvest volume x price / kg x number of crops in a year. Subtract Gross Sales by the operating expenses to get Gross Income. Subtract marketing cost (5% of gross sales) and depreciation expenses from the Gross Income to get the Net Income.
v. Financial analysis. Compute the Return of Investment by dividing the Net Income by Operating Expenses plus Depreciation Expenses per Year and multiply its result by 100%.

PART III

ACTIVITY MATRICES

THE FOLLOWING TABLE DESCRIBES DISCREET STEPS AND BEHAVIOR THAT AN OBSERVER SHOULD BE ABLE TO SEE WHEN THE AGRO ECOSYSTEM ANALYSIS PROCESS, A SPECIAL TOPIC, OR A GROUP DYNAMICS EXERCISE, ARE BEING CONDUCTED. WHILE THESE ARE PRIMARILY OUTLINES, THE "INDICATORS" COLUMN PRESENTS THE OBSERVABLE STEPS THAT ARE FUNDAMENTAL TO THE PROCESS. NOTE THAT FOR ANY OF THE ACTIVITIES, THE ROLE OF THE FACILITATOR IS TO HELP PARTICIPANTS LEARN, NOT TO TEACH THEM

AGRO-ECOSYSTEM ANALYSIS

1. Agro ecosystem Activity Matrix

Agro ecosystem Activity

Activity	Critical Steps	Notes	Indicators
AESA Primary FFS activity develops good IPM habits • Observation • Analysis • Decision making Farmers become IPM experts	Observation & Drawing of Agro ecosystem	Participants need to understand process of observation and its purpose or objective. Participants in field observing, taking notes, collecting specimens. Purpose of drawing is to summarize observation, focus of analysis.	1. Before activity participant told a. Goal of activity and b. Process to be followed in activity 2. Participants all in the field 3. Process of observation includes the whole plant 4. Observation written down 5. Specimen collected 6. Drawing summarizes observations
	Presentation & Analysis	Result of analysis presented to large group by one member of each small group. Problems posed, questions asked. Purpose: to discuss field conditions & solve "what if" scenarios. Objective: to improve decision making & analytical skills based on ecosystem observation. Facilitator helps group achieve objective by asking probing questions to help analytical process	1. Presentation made by member of each small group 2. Participants ask presenter questions 3. Facilitator asks questions appropriate to analysis 4. Group discusses field conditions & agro ecosystem relationships 5. "What if" scenarios discussed 6. Previous weeks' agro ecosystem drawing used for comparisons 7. Field management decisions critically examined by group 8. Other factors in addition to economic thresholds are analyzed e.g. Plant stage, natural enemies 9. Facilitator uses leading questions to help participants analyze what was learned during activity

SPECIAL TOPICS

Special topics activities are discovered learning activities. They depend upon the facilitator's ability to pose questions that will help participants to critically analyze what they have observed during the activity.

2. Special Topics Activity Matrix

Special Topics Activity

Activity	Critical Steps	Notes	Indicators
Special Topics focus on topics such as ecology, biology etc.	Statement of Goal	Participants must know purpose of activity and what they will learn	1. Before activity begins participants told goal process of activity
	Small group process	Participants clear about what they must do and why. All materials at hand	1. All participants active and involved in the activity 2. No small group dominated by one person to the point that others are totally excluded
	Presentation	Activity analyzed by participants. Facilitator asks leading questions so that participants know what happened during activity and why. Special topics provide opportunity to learn of topics important to IPM.	1. Participants present results of their work during the activity, summarizing what has happened and why. 2. Leader asks leading questions to help participants examine steps in process of activity and apply learning to "real life."

GROUP DYNAMICS

Many of the group dynamics exercises are physical and active; others are more on the order of 'brain teaser'. The role of the facilitator is to help participants analyse what they have experience so that they reach a greater understanding of how people tend to behave in various situations.

3. Group Dynamics Activity Matrix

Group Dynamics Activity

Activity	Critical Points	Notes	Indications
Group Dynamics (Enhance team work & problem solving skills)	Process	Participant informed about objectives and process before activities begin. Materials for activities, if needed, are on hand before activity begins. Time allowed for activity is sufficient to achieve objective	1. Before activity begins participants tell goal and activity. 2. All participants involved/ active, no single individual dominates activity.
	Synthesis	Leaders take time to: review objective of activity; lead discussion concerning what happened during the activity; point out issues arising during the activity; help participant to make conclusions based on their experience during activity.	Leader: 1. Reviews goal and process of activity 2. Helps participant identify key learning points based on activity 3. Asks questions which help participants learn from their experience.

Part IV

SUGGESTED AQUACULTURE HANDOUTS FOR TOT/FFS

THE FOLLOWING HANDOUTS HAVE BEEN DEVELOPED FOR TOT/FFS BY THE PROJECT FAO/TCP/RLA/3003 (D) "INTRODUCTION OF AQUACULTURE AND OTHER INTEGRATED PRODUCTION MANAGEMENT PRACTICES TO RICE FARMERS IN GUYANA AND SURINAME".

1st Week Session

INTRODUCTION

Fish culture in rice paddies has long been practiced worldwide, particularly in the irrigated rice producing areas in tropical countries. In South-East Asia, varying methods of rice-fish culture are being practiced, applying different approaches to the technical problems encountered, with the aim of ensuring economic benefits derived from the system. Although rice-fish culture is known to have existed in many countries centuries ago, not much has been known about it in Guyana and Suriname.

Rice in combination with fish forms an ideal food for both the Guyanese and Surinamese people. While rice is the main dietary source of carbohydrates, the fish supplements protein, since it is an important source of cheap and easily digestible animal protein.

Rice-fish culture is one component of aquaculture which has great potential for development in Guyana and Suriname, due to the vast areas of irrigated rice fields present in both countries. If properly implemented, it could increase the rice farmer's production and income, since two crops, rice and fish, will be grown. Adoption of proper techniques in rice-fish culture is expected to help improve food security in the Caribbean Region and increase the profit of rice farmers in Guyana and Suriname.

It is envisioned that close cooperation between farmers and government technicians will remove the present constraints for the introduction of rice-fish culture and the production of both commodities would be enhanced considerably. Improved techniques developed in one area could be extended into another with similar physical and environmental conditions.

1. Rice-fish culture practices in Asia

Rice-fish culture is the simultaneous or alternate production of fish in a rice field. It consists of stocking the rice fields with fish of selected size and species to obtain a fish crop, in addition to rice, which is the main crop.

a. Two types of rice-fish culture

i. Simultaneous rice-fish culture: Rice and fish are concurrently cultured in the same field, rice being the main crop and fish as the secondary crop. Since rice is the primary crop, the fish culture activities have to be adapted to the requirements of the rice farming activities.
ii. Alternate or rotation of rice and fish: Rice and fish are cultured, one after the other. This is known as rotational cropping of rice and fish.

b. Advantages of simultaneous rice-fish culture

i. Grain output of rice is increased in the presence of fish;
ii. Fishes help in controlling the weeds;
iii. Fishes help in the control of insect pests;
iv. Fishes help in the biological control of mosquitoes, the carriers of many human diseases, particularly malaria;
v. Fishes help in the control of snails, which are harmful to rice plants and also act as

a secondary host for many diseases of human beings;
vi. Rice field tillering caused by the grazing of fish results in higher yields of rice;
vii. Fish excreta also fertilizes the rice fields;
viii. Farmers usually pay more attention in the raising double crop, and chances of better returns are increased;
ix. Fish is also a source of animal protein and gives an additional income to the farmers;
x. Concurrent culture of rice and fish achieves increased economical utilization of land.

c. Advantages of rotational/alternate rice-fish culture

i. It allows better care and better cultural techniques for both rice and fish (for both can be undertaken without any detrimental effect on each other);
ii. Pesticides can be used in this system, for a higher yield of rice;
iii. The system permits greater water depth for fish production, since fishes are cultured after harvesting of rice. The higher water level will give better survival and growth of fishes.
iv. The digging of trenches and canals is not essential;
v. Better control of insect pests is possible, because their life cycles are disrupted;
vi. The residues from fish culture can act as fertilizer for rice plants
vii. Rice stubbles/stalks rot after being submerged and promote growth of fish food organisms.

d. Basic considerations

i. Site Selection:
   a. Good soil type: Must contain high percentage of clay to be able to hold water for a long time.
   b. Good Water Supply: Must be clean, free from pollution and poisonous substances, wild fish and excess silt. Must be capable of supplying the recommended depth at all times.
   c. Must be free from floods.
ii. Design and Size of Plots: Each plot should be capable of being filled or drained independently of any other plot, for easier water manipulation, and to prevent the spread of insects or diseases. The recommended size of rice-fish plot is from 500 square meters to 2,500 square meters, for easy management.
iii. Construction of Trenches: Trenches are dug to provide a retreat for fish during periods of temperature extremes, or when fertilizers and selected pesticides are being applied. They also serves as a refuge in case of unexpected drop in water level, as passageways for easy movement of the fish around the plot, as a regular site for fish feeding, and as catch basins during harvest time. Trenches should not occupy more than 10% of the total paddy area.
iv. Construction of Dikes/Meres: Dikes of plots intended for rice-fish culture must be larger than those used for rice culture alone. They must be sturdy enough to hold more water for a longer period of time.

v. Installation of Water Inlets/Outlets and Screens: All water inlets and outlets should be equipped with fine mesh screen to prevent entrance of unwanted fish and/or escape of cultured fish. During the rice-fish culture period, screens should be cleaned regularly to prevent clogging and the resulting poor water flow.

e. General considerations for management

i. Selection of Fish Stock: The species of fish to be used in rice-fish culture should be able to withstand rice paddy conditions, such as shallow water, high and variable water temperature, low dissolved oxygen content and a high degree of turbidity. They should be fast growing as well.

ii. Fish Stocking Rate:
   a. Simultaneous rice-fish culture: 5,000 to 10,000 fingerlings per hectare, to be stocked two weeks after rice transplanting or three weeks after sowing.
   b. Alternate rice-fish culture: 10,000 to 20,000 fingerlings per hectare for paddy fields having a water depth of 20 centimeters, or 20,000 to 30,000 fingerlings per hectare if water is more than 50 centimeters deep.

iii. Rice Variety: The rice varieties should be locally available, high yielding, tolerant to high water depth and resistant to insects and diseases.

iv. Insect Pest Control: Pesticides are toxic to fish and their use to control rice pests can adversely affect rice-fish culture. Pesticide applications should be avoided as much as possible in rice-fish culture. Application of IPM technology is the best option for controlling pests harmful to the rice.

v. Fertilization: Part of the fertilizer applied to the rice plants goes to the production of planktons and other organisms which are the natural food of the fish.

vi. Water Management: The plot should be flooded deeper, if possible at all times, to make it more conducive to fish growth. In simultaneous rice-fish culture, the water should be kept to the maximum depth which rice can tolerate.

vii. Supplemental Feeding: This is required to maintain the normal growth rate of stocked fish until harvest.

viii. Harvesting: In simultaneous rice-fish culture, the fish are harvested 5-7 days ahead of the rice. In alternate rice-fish culture, fishes are harvested by totally draining the plot after four or more months of culture, depending on the availability of water or the onset of the next rice cropping season.

2nd Week Session

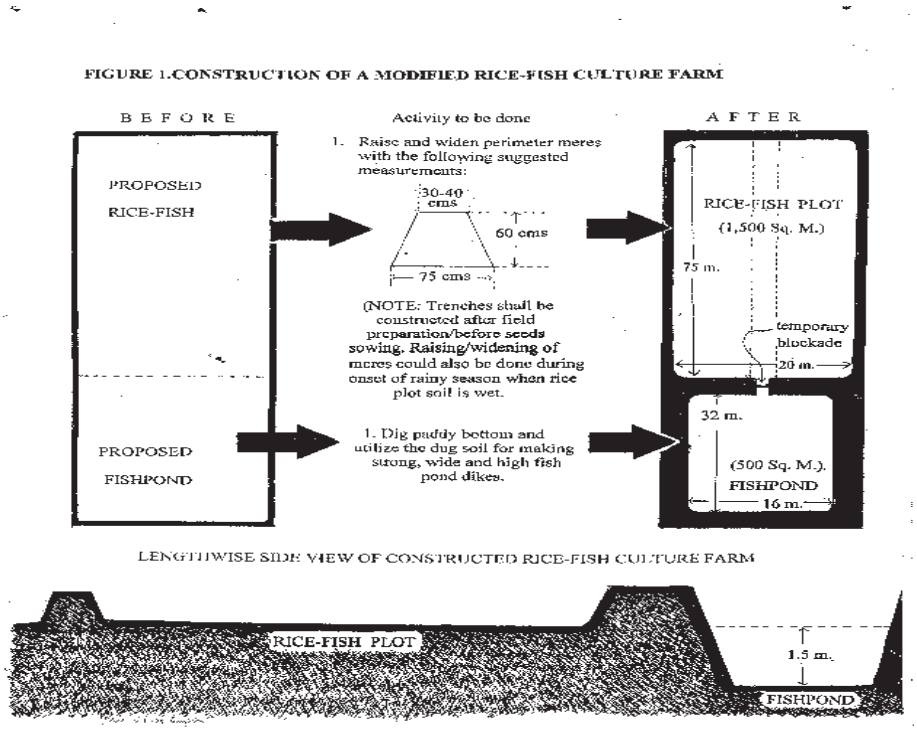
2. Modified rice-fish culture for Guyana and Suriname

Conventional rice-fish farming systems successfully practiced in Asia may not do well in either the Guyana or Suriname situation, unless the existing physical rice field conditions in both countries is modified, taking into consideration the constraints raised by farmers, especially their dependence on chemicals for rice production. For the purpose of trial and demonstration, the Project utilizes small areas from whole rice field plots belonging to collaborating farmers. The area utilized is 2,000 square meters (less than half of an acre) for easy management, where one-fourth of it is developed into a fish pond. The fish pond is located at the lowest part of the rice plot.

A rice field comprising ¾ of the total plot area is modified by raising and widening the bunds to hold enough water during the culture period of the fish. A center trench is constructed lengthwise in the rice field, with one end connecting directly into the opening in-between the rice field and the pond. The trench does not occupy more than 10% of the total rice field area.

a. Advantages of this modified system are as followings:

i. Fish can be held in the pond when there is a compelling need for the farmer to apply chemicals in his rice.
ii. Undersize fish can be grown longer in the pond if the culture period of fish in the rice field is too short.
iii. Fingerlings produced inside the rice field could be kept in the pond for further growing, while waiting to be released back into the rice field come next rice cropping season.
iv. Fish can seek refuge in the pond if water in the rice field trench suddenly drops to an unsuitable level.
v. The system will give farmers optimum fish production as a dual system of fish farming in the rice plot and pond is applicable.
vi. Fish seed production is continuous even after the rice harvest, which helps solve a problem of fingerlings supply for the next rice-fish cropping season.
vii. Selective harvesting of fish is possible inside the pond, especially during the peak of the dry season, where draining of pond water is not possible.



b. Fishpond Management

Poor yields in fish culture are usually attributed to poor management. Good pond management includes the application of the right amount of fertilizer, use of appropriate fish stocking density, elimination and control of aquatic weeds, prevention of entry and control of predatory animals and competitors of fish, proper water management, use of supplemental feeds and correct harvesting technique.

c. Pond/Rice Field Preparation

Pond Preparation: For an old fish pond, dry the pond bottom by exposing it to sunlight, to kill fish predators and organisms that may cause fish diseases. In a new pond, apply lime to pond bottom and dikes, at a rate of 5 kg/100 m². This will neutralize the soil, making it suitable for the production of natural food for the fish, and kill bacteria harmful to the fish.

Apply animal manure to the pond at the rate of 50 kg/100 m². Let water in gradually to allow production of natural food for the fish until desired water level is attained.

Cropping calendar of activities for modified rice-fish culture farm

	ACTIVITES TO BE UNDERTAKEN	
Farming Day	RICEFIELD	FISHPOND
Pre-Sowing Activites	• Rice field preparation (harrowing/chipping/ raking/hengering)	• Fish pond construction for new pond • Pond preparation for old/constructed pond (sun-drying for 1 week, liming if available at 5 kg/100 m²; application of animal manure at 50 kg/100 m²) • Block opening in-between rice field and pond to prevent chemicals applied in the rice field from contaminating the prepared pond. • Gradually let in water into the pond and maintain at level with the rice field bed.
0	• Sowing of pre-germinated rice seeds	• Irrigate water into the pond at 3" higher than the water level in the rice field.
14 to 20	• Irrigate water and maintain at 3" to 4" level	• Maintain pond water level at 3" higher than the water in the rice field.
21	• Maintain water level at 3" to 4"level • Fertilize rice	• Stock fish fingerlings into the pond at a rate of 2 fish per square meter.
25	• Remove blockade in-between the rice field and the pond. Allow fishes inside the pond to enter the rice field through the center trench.	
45	• Raise water level 5" to 8" deep	• Pond water rises at same level with the rice field • Feed fishes regularly
48	• Fertilize rice	• Continue regular feeding of fishes • Check & repair any leaks found around meres/ bunds/dikes
60	• Raise water level from 8" to 12" deep	• Pond water rises to same level with the rice field • Continue regular feeding of fish
80 to 85	• Drain water gradually and let fishes from the rice field find their way back into the fishpond through the center trench • Close the blockade in-between rice field and fishpond	
95	• Service equipment	• Continue regular feeding of fish inside the fishpond
96	• Check empty sacks • Find rice buyers	
110	• Harvest rice	
		• Harvest large size of fish and allow small sizes to grow in the pond

NOTE: THIS CROPPING CALENDAR OF ACTIVITIES WILL VARY DEPENDING ON THE RICE VARIETY TO BE PLANTED AND ON THE AGRO-CLIMATIC CONDITIONS PREVAILING IN THE LOCALITY.

3rd Week Session

3. Transporting and stocking of live fish

The transport of live fish from the hatchery to any unit of water plays an important role in aquaculture management. Transporting fish involves the hauling of a large number of fish in a small quantity of water. Unless this is done properly, the length of time involved can quickly deteriorate the water quality, which can cause fish mortality.

There are many ways of transporting live fish. Some farmers use boats, others use the suspension net method, oil barrels, plastic tub method, and the plastic bag with oxygen method. Another method uses a hauling box with aerators. The objective of having a good transport system for live fish is to minimize stress to the fish and ensure a high rate of survival.

a. Handling Prior to Transport

Most hatcheries consist of numerous earthen ponds where fish are collected through combined seining and draining. These methods of capture cause stress to the fish. Proper techniques in harvesting should be applied to lessen stress and mortality during the hauling operation. Improper handling may result in immediate or delayed mortality.

b. Holding Process

Fish captured from ponds should be held in happa nets or aerated tanks for about three days prior to transporting. This process is called "conditioning". Conditioning allows the fish to recover from handling stress after capture. During conditioning, fingerlings should be fed, except for the last 24 hours prior to transporting. The holding net should not be overcrowded with fish during conditioning. If fish are held in tanks, sufficient aeration should be supplied. If fish are seen at the surface gasping for air, increase aeration or decrease the holding rate.

The holding happa net should be tied to poles in the pond to keep it from being blown by the wind. Fine meshed nylon screen happa nets are preferred. Happa nets with large mesh are used for bigger fishes. Tanks used for holding fish should be clean, leak-proof, glazed or painted with epoxy paint to cover rough surfaces. Smooth surfaces will reduce physical injuries to fish.

Overcrowding should be avoided in holding happa nets or tanks especially in the early morning, when the dissolved oxygen (DO) level is low. Well-aerated water can hold more fish than less-aerated water. Approximately 4.4 kilograms of fish could be held in one cubic meter pond water, or 30 kilograms of fish in a happa net measuring 3 meters by 3 meters by 0.75 meters.

c. Transporting Fish Fingerlings by the Plastic Bag Method

This method uses plastic bags of various sizes. But the most common size which can hold a large quantity is 20" x 30" of a 0.003 gauge thickness. Standard size woven bags are used to support the plastic bags. Each woven bag has an approximate capacity of eight liters of water and 1.5 liters of pure oxygen. Four hundred grams of fish can be transported for 24 hours for more than 6 hours; 1,500 grams of fish for not more than 6 hours, for short

distances. The loading capacity per bag depends largely on the transport time involved, distance covered and handling techniques used. Likewise, the rate of survival is affected by the water temperature in the bag. The temperature should be maintained at 28°C to 30°C. To reduce fish mortality and stress during the trip, about 500 grams of cracked ice should be placed in between the two plastic bags. This technique increases the survival rate of the fish. Although this method requires a lot of space, it facilitates the transport of fish from one place to another.

The following are some pointers to be followed in using plastic bags for fish transport:

i. One set should consist of one woven bag (pandan bag) and two plastic bags.
ii. Carefully check the plastic bags for punctures; put one bag inside the other.
iii. Place eight liters of water inside the plastic bag.
iv. Water temperature in the holding happa net or tank should be the same as that of the bag.
v. For small deliveries, count fish individually.
vi. For big deliveries, use the average weight method.
vii. Use the recommended loading capacity to reduce mortality due to overcrowding.
viii. Fill the remainder of the bag with oxygen immediately after the fingerlings are placed inside it.
ix. Tie the oxygenated bag with rubber bands immediately to avoid oxygen leakage.
x. Icing is advisable only when transporting fish for more than six hours and if the water temperature is 30°C.

d. Handling after Transport

Stocking the delivered fish seems easy, but it is one of the difficult tasks in fish handling. Before the fish are released into the stocking pond, the water temperature should be checked first to prevent shock to the fish. Abrupt changes in temperature will cause thermal shock to the fish. This should be considered when fish are unloaded at the stocking or delivery sites.

e. Causes and Preventions of Stress

Fish stress may be caused by one or a combination of the following:

i. Harvesting by seining;
ii. Scooping the fish from the seine net to graders, from graders to holding happa nets, from happa nets to hauling units;
iii. Grading fish according to size;
iv. Hauling or transporting.

Fish handling is one of the inevitable aspects of fish culture. Fish stress can be minimized by proper handling and hauling procedures. Stress from handling during hauling in a distribution tank may be severe and can result in immediate or delayed mortality.

Aeration during transport provides oxygen which supplies at least half of the requirement of the fish; it reduces the concentration of carbon dioxide to a satisfactorily low level. In transporting tilapia, the fish have ample oxygen as long as they do not gasp at the water surface. However, if the carbon dioxide level increases, more oxygen is required by the fish. Loading the fish in tanks causes stress; overloading the scoop net also causes stress.

Water temperature in the hauling unit should not differ by more than 5 degrees centigrade from that of the holding water. A difference of 5 degrees centigrade or more requires acclimation. Acclimatization is also needed when stocking fish from freshwater to water with higher salinity. The water temperature should not go beyond 30 degrees centigrade, if hauling units are to be loaded to the maximum, to avoid severe stress. Knowing the loading capacity of the hauling unit will help much in the handling of fish. Undoubtedly, many improperly handled fish are stocked in ponds and eventually die unnoticed.

4th Week Session

4. Construction of nets for use in rice-fish culture

Nets are among the basic gears and equipment in fish culture, and are indispensable in rice-fish culture operations. For ease of use, without harming the fish, it is important for a fish farmer to have knowledge on how to make the right net and its proper use. The types of nets most commonly used in rice fish culture are: happa net, lift net, and scoop nets.

A happa net, which looks like an inverted mosquito net, is used to nurse fry until fingerling size (fine mesh happa net) or used to hold or keep large sized fish alive before stocking or marketing (larger mesh size happa net).

A lift net is an assembly consisting of a plain net cut in a square shape measuring 2 meters by 2 meters seamed with a rope along the edges of its four sides. It is made ready for lift netting operation by stretching it, through the use of two bamboo splits measuring 3 cm width by 8 meters long, tied at the net's opposing corners forming a crossed arc position. It is very effective in catching fishes with no injuries sustained.

A scoop net is a device made of a fine netting material with all openings at the sides and bottom stitched together forming a purse and the upper opening stitched into a round or square shaped iron rod.

5th Week

5. Fish feeds and feeding

a. Supplemental Feeds

Supplemental feeds are prepared diets formulated to provide protein and other nutrients, besides those obtained from natural food organisms in the water. As the fish grow, the natural food in the pond will not be sufficient to sustain the growth of the fish population. Hence, the growth rate will be less than the maximum potential. As the food deficit increases, growth rate decreases.

It is difficult to recommend nutrients for supplemental rations because the nutrient contribution of pond organisms can not be predicted with accuracy. In practice, however, it is unnecessary and uneconomical to balance the supplemental diet for fish ponds according to the absolute nutrient requirements of the fish.

Aside from formulated feeds found in the market, which are costly, there are some natural supplementary feeds good for the cultured fish which are available locally.

6th Week Session

6. Water management

Availability of good quality water is a basic and very important consideration in culturing fish. The water should be free from toxic chemical contamination and of unwanted predatory or wild fishes, and must be available when needed. Oftentimes, however, such ideal conditions are rare, if not absent in most fishpond and rice-fish culture operations.

a. Source

Sources of water for freshwater fishponds and rice-fish farms are deep wells, irrigation canals, free-flowing wells, springs, rivers, dams, rainwater, and streams.

Precautionary measures should be employed when using water from rivers, streams and communal irrigation systems. A simple bioassay can be done using two simple techniques: two or three fish are placed in a bucket full of water from the source to be tested and observed for at least one-half day; or a happa or scoop net with three to five fish situated 25 to 50 meters upstream of the water source, can be used as well. The water is safe for use when the fish remain alive after the test period. Just looking at, or smelling the water, to determine the presence of toxic substances is generally ineffective.

b. Depth

The definite water depth for any specific culture unit or species of fish is not well defined. Nevertheless, deeper water impedes high fluctuation levels of water temperature. Breeding of tilapia is enhanced when water temperature highly fluctuates as in the case of rice-fish fields where tilapia are observed to breed earlier. Tilapia nests are built at an average depth of about 45 centimeters.

To help discourage reproduction and in order to increase the growth of tilapia, water depth in a grow-out pond is maintained at a depth of about 80 to 100 centimeters as much as possible. Sufficient water volume will enhance the production of plankton. In fish paddies where dikes are relatively smaller, a water depth of 50 centimeters was found to be sufficient to grow fish to marketable size when properly fertilized.

Some management modifications are employed when water supply is seasonal. When using rainwater or irrigation water with limited flow, it is necessary to increase the pond volume by increasing water depth. Enough water should be accommodated in the pond during rainy days, if possible.

In rice-fish culture, the paddy field should be flooded deeper, at all times if possible, to make it conducive to fish growth. In simultaneous rice and fish cropping, the water should be kept to the maximum depth which rice can tolerate. When the rice plants are still young, the water is kept at 5 to 8 centimeters deep. As the rice grow taller, the water depth is gradually increased to about 20 centimeters or more, depending on the rice variety planted.

Wind action increases the water evaporation rate in rice-fish fields while high organic content in its dyking materials likewise aggravates water leakage. Water change or leakage causes loss of fertility and fish food organisms.

7th Week Session

7. Pond and rice field fertilization

Fertilizers stimulate the growth of plankton, which is the natural food of the fish. Hence, fertilizers can increase fish yields three to four times. Pond fertilization may be appropriate if the following indicators are observed: measurement indicates low levels of nitrates and phosphates; water is transparent and may contain abundant growth of submerged plants; water is turbid with suspended soil particles or stained with humic substances. However, fertilization may not be recommended in soils containing high levels of nutrients sufficient to support plankton bloom.

a. Use of Organic Fertilizer

In Israel, Tilapia responds better with the application of animal manure than with artificial feeds. The nutrients and organic matter content of manure increase the water-holding capacity of soil, decrease the rate of evaporation and increase enzymatic activity, all of which increase fertility and crop yield. Animal manures contain the major inorganic nutrient components: nitrogen (N): 72% to 79%; phosphorous (P): 87%; potassium (K): 82 to 92%, in addition to such trace elements as calcium (Ca), copper (Cu), iron (Fe) and magnesium (Mg). Urine which comprises about 40% by weight of the total daily excreta has higher nitrogen and potassium levels than feces.

The chemical composition of manure also varies depending upon the animal species, age and condition of animals, nature and amount of manure, and the handling and storage of the manure before use.

b. Inorganic or Chemical Fertilizer

Chemical fertilizers are readily soluble and have high nutrient contents. The problem, however, arises when too much dependence is placed on them, neglecting the soil's organic matter. Likewise, the price of chemical fertilizers may become prohibitive in view of the cost required in processing.

8th Week Session

8. Fish predators and other pests

Fish production in ponds and rice fields is commonly affected by some pests and predators. Predators are organisms which prey on the fish being cultured; the animals that compete for food or space are called competitors.

a. Birds

Herons, kingfishers and other birds should be discouraged from frequenting the ponds. They devour fish and fingerlings. Birds are also carriers of parasites. They are kept away by shooting or trapping. Ponds and rice-fish plots constructed without a shallow area are not attractive to birds.

b. Snakes

Snakes prey on small fish. But, they are not a serious problem. Slopes and top of dikes must be kept clean to prevent harbouring snakes near the ponds/rice-fish plots.

c. Frogs

Fry and fingerlings are eaten by frogs. Tadpoles also compete with the fish for space. Frogs are seldom found in well-fertilized and well stocked ponds/rice-fish plots. Their presence can be controlled by removing their egg sacks from the water.

d. Piscivorous or Predatory Fish and Other Competitors

Huri, Perai, Silver Fish, Sunfish and other species may enter tilapia ponds and rice-fish plots during floods or by accidental stocking with the cultured fish. These predators devour fry and fingerlings during or after stocking. To avoid them, the pond should be drained totally after harvest or before stocking. Huri, which tends to burrow into the mud, can be totally eliminated by sun-drying. If possible, only clean water should be used. Water inlets and outlets should be equipped with the finest screen available. Fingerlings should be properly checked for possible contamination by predatory fish prior to stocking them.

Oftentimes, competitors are associated with predators. They enter the ponds and rice-fish plots the same way predatory fishes do. Silver Fish, Patwa and other species can compete with the stocked fish for space and food.

e. Poachers

Poaching is rampant in most grow-out ponds. There is always the danger of losing fish to thieves. Poaching may be prevented by employing a watchman in the area. Only trustworthy workers should be hired. In addition, access to the pond area should be restricted. Small areas can be fenced and/or lighted. Dogs are excellent guards. They create noise when unusual activities occur.

Dikes should be cleaned of unnecessary vegetation, bushes or trees. Un-kept dikes are excellent covers for poachers and other types of predators. Poaching of stocked fish by netting is greatly prevented by installing stakes or barbed wire underwater.

9th Week Session

9. Pond/rice field fish culture systems

a. Monoculture

The very common and widely adopted culture practice in the production of food fish is monoculture. It is the rearing of a single species of fish in a pond or rice field.

The most economical stocking rate in monoculture is not necessarily that which results in the highest growth rate of per fish per day, but rather that which results in the highest yield per unit area. Performance of the selected strains of tilapia for monoculture should also be considered. Some strains of T. nilotica were found to be inferior. The inferior strains do not respond well to fertilization, reproduce prolifically and cease to grow earlier.

In many tilapia ponds, wild spawning may reduce fish yields to uneconomical levels. The competition by the great number of small fry and fingerlings can result in stunted fish population and growth. The great number of fish below the desired market size reduces the profit of the producer.

b. Polyculture

Polyculture is the rearing of two or more non-competitive species in the same pond. In combining two species, it is ensured that the production of the target species will remain the same or be enhanced by the system. Furthermore, the stocking density of the target species in a polyculture operation must be generally similar to the density of the fish in monoculture. The species of fish to be used in a polyculture system must have different feeding habits and occupy different niches in the pond.

Non-availability of fingerlings recommended for polyculture hinders the wide adoption of polyculture.

10th Week Session

10. Fish stocking density

The growth of fish depends on the number of fish stocked and the number of fishes present in the pond or rice field. This is due to several factors that include density and competition.

Fish stocking ratio is one of several factors that affect fish growth. At a low stocking density, the amount of natural food in the pond is higher for each individual fish and the excess food is not utilized. As long as other factors are not limiting, the daily growth of fish will be better. However, the growth of fish will be slow at a higher stocking density because the capacity of the natural food to support the fish population will be limited to a certain extent. The maximum physiological growth of tilapia is attained at low stocking density.

a. Factors that Influence the Selection of Stocking Densities in Ponds

A common mistake in grow-out production of tilapia in ponds is the selection of proper stocking densities. The failure to select the most appropriate stocking density will result in poor growth and low market value of the fish produced. To insure profit, the stocking densities in ponds must be selected based on the following factors:

i. Market Demand

Market size preferences vary, depending on the place. In some rural areas, smaller fish (less than 100 grams) are highly saleable. Nevertheless, in commercial fishpond operations that require middlemen in the marketing of the produce, large fish command higher prices than small ones.

ii. Productivity of the Pond

The productivity of a pond may be related to its age. Generally, old ponds are more fertile than newly constructed ones. The mud present in old ponds contain organic nutrients that may readily initiate the growth and support the population of plankton that will serve as the natural food of the fish. On the other hand, because of the absence of mud, it will take longer time before plankton growth is initiated in new ponds.

Even with the use of organic and/or inorganic fertilizers in both old and new ponds, old ponds will still be more productive than new ones because of the organic nutrient and plankton seeds contained in the former.

Generally, old ponds can accommodate higher stocking densities than new ponds.

iii. Quality and Quantity of Feeds Used

The stocking density of a pond or rice field can be increased beyond what has been recommended when supplementary feeds are given to the fish. The extent of increase must be based upon the quality and quantity of feeds to be given. A supplementary diet with high protein content is best to use in ponds with a very high fish population. For example, rice bran when mixed with fish meal will produce a better feed than rice bran alone. This is because fish meal has a high protein content. However, the price of fish meal may not warrant its intensive use.

A supplementary diet must be given to the fish at a sufficient level to be more effective. The quantity of feeds to be given to the fish must, however, be complementary to its quality. Feeding the fish at the rate of three to five percent of its body weight is appropriate. The feeds given in excess of this rate may not be consumed and will just adversely affect the water quality of the pond.

iv. Quality and Quantity of Fertilizer and Method of Application

Animal manures with higher phosphorous and nitrogen content are the best for intensive fish farming. Chicken dropping is the most widely used manure by fish farmers in Asia. Its use insures much higher yield than when cow of buffalo manure is used. The capacity of the pond to accommodate fish can be further escalated when inorganic fertilizer like 16-20-0 is added with the manure into the pond.

Fertilizers are more effective in supporting higher fish population when they are applied in short and regular intervals, i.e., daily or weekly application.

v. Fish Farmer's Resources

Low-density stocking may be recommended for the fish farmers belonging to the low-income group. The high production inputs required in higher stocking density may prohibit its adoption by the farmer. The recommended stocking ratio must conform with the ability of the fish farmer to supply the needed inputs.

11th Week Session

11. Production of tilapia fry and fingerlings

a. Sex Identification

Sex identification of tilapia is relatively simple. The male has two openings just in front of the anal fin. The large opening is the anus and the smaller opening at the tip is the urogenital pore. The female has three openings: the anus, the genital pore, and the urinary pore. The genital papilla is usually smaller in the female. Tilapia can be sexed when it has attained the weight of 15 grams. Application of ink or dyes to the papillae may increase the accuracy of sexing and may allow sexing of smaller fish.

b. Spawning

The Nile tilapia is a mouth-brooder. The male establishes a territory and builds a round nest at the bottom of the pond. Usually the diameter of a nest is 30 to 60 centimeters. The size of the nest is correlated to the size of the male. The female enters the nest and lays the eggs. The eggs are fertilized by the male. The female then collects and incubates the eggs in her mouth. The eggs are yellow in color. Eggs hatch in about five to seven days. After hatching the fry remain in the mouth of the female for another four to seven days. The fry begin to swim freely in schools, but may return to the mouth of the mother when threatened. Females do not feed during incubation or the brooding period. Females spawn every four to six weeks, but may spawn sooner if the eggs are removed. The number of eggs per spawning is related to the size of the female. A female of about 100 grams may produce approximately 100 eggs per spawning while a female weighing 100 to 600 grams can produce 1 000 to 1 500 or more eggs per spawning.

The male may mate with more than one female.

12th Week Session

12. Fry nursing

After the fry have hatched they are transferred to a nursery area. There are many forms of nursery used to successfully rear fish fry. The decision which nursery system to use depends upon the species of fish, materials available and the amount of money that can be invested.

a. Earth pond nursery

Earthen pond nurseries are effective for the production of many species of fish. The natural feed that occurs in a well-prepared nursery pond assists survival and compensates for poor quality supplemental feed. Growth rates are high in earth ponds, but survival rates can vary greatly. This is due to problems of controlling earth ponds because they are difficult to feed and predators of the fish enter easily. One of the principal problems in earthen ponds is the entry of predatory dragon fly larvae nymphs, tadpoles and carnivorous fish. These prey on the larval fish and can reduce the survival greatly. Correct preparation of the earth pond is essential for good survival of the fish fry. This is often poorly done due to difficulty in draining ponds, lack of fertilizers or rainfall to fill ponds at the required time. Good preparation requires the following steps to be observed:

i. Empty the water out of the pond (drain or use a pump) and dry the pond.
ii. If water can not de drained, predators in the pond can be killed by the addition of rotenone (derris powder) at a rate of 1.5 grams per cubic meter of pond water. If derris is difficult to obtain, draining and drying the pond is the most effective method of eliminating predators.
iii. Add lime at a rate of 1 kg for every 25 meter of pond area. Lime can usually be purchased from building supplies shops. Lime assists soil fertility and reduces the amount of fertilizer required to produce green water in the nursery pond.
iv. Add fertilizer to the pond at the rate of 1.5 kilos per 10 square meters. This is equivalent to one full bucket per 20 square meters of pond area. Fertilizers that can be used include buffalo, cow, chicken, goat, sheep and pig manures. After the manure is applied the pond can be filled to a depth of 5 to 10 centimeters to allow the breakdown of the manure. After 3 to 5 days, the pond should be filled to a depth of 30 to 50 centimeters and is then ready for stocking.
v. Fry are stocked to the nursery pond at a rate of 125 to 500 individuals per m^2.
vi. After stocking the fry to the pond (usually done in the early evening) the water level is maintained for one week. One week after stocking the water level is then increased to 80 centimeters.

b. Net cages

Once fry are large enough not to escape through blue netting (about 2 to 3 weeks after hatching), they can be cultured in cages made of this material. The advantage of fry culture in cages is that they do not suffer from predation from larger fish, frogs or large water insects. The fish need to be fed more than if they were cultured in the pond, but the high survival will compensate for the extra cost of the feed.

If water can be supplied to the cage this will increase aeration and remove waste products. This will allow higher densities of fry to be cultured than is otherwise possible without water flow.

- Blue net cage (4 x 5 m) without water supply – stock 2 000 fry (>2 weeks old)
- Blue net cage (4 x 5 m) with water supply – stock 5 000 to 10 000 fry (>2 weeks old)

The fish should be fed with pig or chicken starter feed mixed with soft rice bran to ensure they obtain sufficient food and grow well.

13th Week Session

13. Pond / rice-fish field maintenance

To be able to do effective maintenance of a rice-fish farm, it is a must for a farmer to regularly visit his farm site. By having the farmer's regular presence in his farm he can immediately take remedial actions to whatever problems he could see, before the problem gets serious.

Among the major maintenance and operation activities to be done by farmers are the following:

a. Daily feeding of fish at 5% of its total body weight. Adjust daily feeding ration monthly to be based on the latest sampling of the fish stock, conducted after every thirty days.
b. To maintain the growth of planktons and other natural food of the fish present in the water, apply fertilization into the pond at a rate of 0.5 kg of animal manure per square meter every two weeks, or 0.6 kg of inorganic fertilizer per 100 m^2 per week.
c. To prevent poaching of cultured fish, stakes or barbed wire can be installed underwater inside the pond.
d. Grow and maintain crawling grass on top and slope of the dikes to help in maintaining compaction and preventing soil erosion.
e. Always repair any damaged dike, leakages or seepages seen before it becomes big and causes serious damage to the pond.
f. Check for any foreign objects in the screens of the pond pipes and clean regularly to avoid clogging and the resultant restriction of water flow.
g. Remove floating and submerged weeds growing inside the pond, as they compete with the stocked fish for space and nutrients necessary for production of natural food in the water.

14th Week Session

14. Fish harvesting

For better regulation of fish density in ponds, harvesting methods that efficiently remove most of the fish should be employed. A small number of fish left in the pond after harvest will probably be caught during the following harvest. However, if they are too numerous, the growth rate of the fish stocked in the following production cycle may be affected.

a. Thinning

Partial harvest can begin in the latter part of the growing season. Wild spawning normally occurs in this part of the culture period when the fish reach sexual maturity. The population should be thinned out to allow further growth of the remaining fish. Either fingerlings or marketable size fish are partially removed. If thinning is done for marketing only, a net with a mesh size that can catch the desired size of fish should be used. This will allow small fish to escape and grow bigger, faster.

The principle of thinning or selective harvesting should not be abused. In tilapia culture thinning is effective only if done once. Total harvest of tilapia must be done one to two months after thinning.

b. Seining

Although seining is often recommended in harvesting fish in pond, it is not an effective method to insure total harvesting of the stock. tilapia often burrow into the mud to escape from the net.

c. Draining

After seining, which is the fastest method of harvesting, the pond should be drained so as to eliminate all the predatory species, competitors and fish which may have escaped from the net.

If needed, the pond should be poisoned to insure the total elimination of any species left in the pond. Draining is necessary as exposure of the pond bottom to sunlight will increase its fertility.

15th Week Session

15. Post harvest technology

a. Why Fish Spoils?

Spoilage of fish begins as soon as the fish dies. It is the result of a series of deteriorative changes which are broadly classified into: autolytic, bacterial and chemical.

i. Autolysis or self-digestion

This is the breakdown of tissues caused by enzymes. Enzymes are chemical substances naturally present in fish muscles which are primarily responsible for the digestion of food. They act as biological catalysts in chemically breaking down the food taken in by the fish and are very powerful in their action. In the live tissues, their action is controlled. As soon as the fish dies, however, the control is lost but the enzymes remain active. Instead of acting on the food, the enzymes now act on the fish muscles resulting in the softening of fish flesh. In addition to the naturally occurring enzymes in fish, bacteria which are introduced into the fish muscles, and those present in the gills and intestines secrete enzymes which also act on the fish flesh.

ii. Bacterial decomposition.

While autolysis is in progress, bacterial decomposition sets in. Bacteria are not present in the flesh of living fish. However, shortly after capture they enter the flesh by way of the gills, kidney (which usually remains after gutting), the blood vessels, and eventually through the skin. Soon after death, the body's defense mechanism against this invasion ceases to operate, and bacterial activity is enhanced. Two important characteristics of bacterial activity are enhanced: they grow rapidly and increase in number so fast that, unless checked, they continue to their spoiling action. They have been found to be the most active spoilers of fish. Since spoilage starts from the surface, we can prevent contamination of fish muscles by proper washing, gutting and chilling.

iii. Chemical change

In addition to bacterial and enzymatic action, chemical changes involving oxygen from the air and the fat in the flesh of fish can produce rancid odors and flavors. These changes overlap with enzymatic and bacterial activities. Rancidity develops more in fatty species than in lean ones.

b. Characteristics of Fresh and Spoiled Fish

	Fresh fish	Spoiled fish
Eyes	• bright, bulging • Pupil, velvet black; • Cornea, transparent	• dull, wrinkled, sunken; • pupil, dull black; • cornea, opaque
Gills	• bright red, covered with Slime; • odor under gill covers fresh	• dull brown or gray; slime cloudy; • odor under gill covers sour and offensive
Flesh	• firm; body is stiff; impression made by fingers does not remain • Slime present is clear	• soft and flabby; impression made by fingers remains
Body	• stiff	• limp
Belly walls	• intact	• often ruptured, with viscera protruding
Muscle tissue	• whitish	• pinkish, especially around backbone
Vent	• pink not protruding	• brown, protruding
Odor	• fresh, fishy odor	• stale, sour or putrid
Color	• bright	• faded

c. Handling of Fish

The three important ways of preventing fish from spoiling too quickly are: care, cleanliness and cooling.

Care in handling is essential because unnecessary damage can provide access, through cuts and wounds, for the spoiling bacteria, thus hastening their effect on the flesh. Fish is soft and fragile and is easily bruised or torn by rough handling. Therefore, prompt and proper care of the fish must be taken from the time it is caught until it reaches the consumer. It should always be remembered that fish is food and should therefore be handled as such.

Cleanliness should be observed throughout the fish handling chain. All surfaces with which the fish may come into contact should be scrubbed clean and kept as free as possible from bacteria-laden materials. Fish will keep longer in a fresh condition if they are kept as free as possible from contamination with bacteria. Natural sources of bacteria can be removed soon after the fish is captured/harvested by taking out the guts and washing off the slime from the surface of the fish.

Temperature is the most important factor in controlling the speed at which fish spoils. The higher the temperature, the faster the bacteria multiply; the lower the temperature, the slower the bacterial and enzymatic activities. Therefore, the most important step to slow down these activities is to lower the temperature of the fish as quickly as possible.

d. Transporting Fish from Source to Market

The prime objective in the transport of fish is to take the fish from one place to another in a manner that will ensure as little change in its quality as possible. Fish have to be moved through great distances until they eventually reach the consumers. This is done because most consumers are far from where the fish are caught or harvested.

One of the greatest problems encountered in the transport of fish is how to preserve

its freshness until it reaches the consumer. Since fish spoilage is controlled largely by temperature, enzymatic and bacterial activity, the control of temperature during transport, through icing or chilling, must always be observed.

e. Forms of Fish Sold in the Markets

Fish are generally sold in the market in the whole or round form. Other forms of marketing fish are the following:

1. whole or round	• fish is sold just as it comes from the water and must be dressed before cooking;
2. drawn	• fish have had their entrails removed to slow down spoilage process and be kept longer
3. headed and gutted	• head, tail fins, and viscera removed before sale;
4. dressed or "pan ready"	• fish are completely cleaned and ready to cook when purchased;
5. steaks	• these are larger sizes of cross-sections pf dressed fish where edible portion is about 86 to 92 %;
6. fillets	• sides of the fish cut away from the backbone; ready for cooking and 100% edible without any waste;
7. chunks	• these are cross-sections of large dressed fish, having a cross-section of the backbone;
8. fish sticks	• these are pieces of fish flesh cut into uniform width and length, and usually breaded before cooking;
9. fish portions	• larger than fish sticks but uniform in size and weight, usually, one portion is enough for a single serving;
10. deboned fish	• the whole fish is split, butterfly-fillet style, and all spines are removed with the use of a forceps.

16th Week

16. Cost and return analysis of rice-fish culture

a. Assumptions

Area of pond:	.....	m²
Stocking Density in pond:	.....	fish/m²
Area of rice field:	.....	m²
Stocking density in rice field:	.....	fish/m²
Total # of stocks:	.....	fingerlings
Quantity of rice seeds:	.....	lbs.
Average Body weight at Harvest:	.....	grams
Survival Rate:	.....	%
Harvest Volume:	..... kg. (fish)	..... kg (rice)
Price/kg:	..... G$ (fish)	..... G$ (rice)
No. of Croppings/year:	..... croppings for fish	..... croppings for rice

b. Fixed Asset Investment

Qty	Unit	Item Description	Unit Cost	Total Cost
...	Square meters	Pond construction	G$	G$ .....
...	Square meters	Rice field construction	G$	G$ .....
...	.....	.....	G$	G$ .....
				G$ .....

c. Operating Expenses

Qty	Unit	Item Description	Unit Cost	Total Cost
...	Pcs	Fingerlings	G$	G$ .....
...	lbs	Rice seeds	G$	G$ .....
		Land preparation (field and pond)	G$	G$ .....
...	Kgs.	Fertilizer (cow manure)	G$	G$ .....
...	Kgs	Feeds (artificial/local feeds)	G$	G$ .....
...	Pc.	Spade	G$	G$ .....
2	Pcs.	Buckets	G$	G$ .....
5	meters	Fine mesh twine net	G$	G$ .....
...	meters	Barbed wire	G$	G$ .....
1	pc	#3 PVC elbow	G$	G$ .....
5	feet	# 3 PVC pipe	G$	G$ .....
Add: contingencies (10%)				G$ .....
TOTAL				G$ .....

d. Depreciation Expenses

Item Description	Life years	Total Cost	Annual Cost
Pond	10	G$	G$ .....
Rice field	15 years	G$	G$ .....
.....	.....	G$	G$ .....
TOTAL DEPRECIATION EXPENSE			G$ .....

e. Income

GROSS SALES (harvest volume x price / kg x 2 croppings) :	G$ .....
Less: Operating Expenses	– G$ .....
GROSS INCOME:	G$ .....
Less: Marketing Cost (5% of Gross Sales)	– G$ .....
Less: Depreciation Expenses	– G$ .....
NET INCOME	G$ .....

f. Financial Analysis

$$\text{ROI} = \frac{\text{Net Income}}{\text{Operating Expenses + Depreciation Expense / Year}} \times 100\%$$

$$= \frac{\text{.....}}{\text{..... + ...}} \times 100\%$$

$$= \frac{\text{.....}}{\text{.....}} \%$$

$$\text{Payback Period} = \frac{\text{Operating Expenses + Depreciation Expense / Year}}{\text{Net Income}}$$

$$= \frac{\text{..... + ...}}{\text{.....}}$$

$$= \text{..... years}$$

NOTE: tilapia fry and fingerlings produced during the culture period is not included here

About this document:

The manuscript was prepared by the trainees of a season-long training of trainers conducted at the Rice Research Station in Lesbeholden Village, Black Bush Polder, Corentyne, East Berbice, Guyana as part of the activities in an FAO Technical Cooperation Project for Guyana and Suriname. The process was guided by FFS facilitators Mr. Godardo Juanich, Aquaculture Specialist, and Mr. Wahyu Sutisna, IPM/FFS Specialist. Final inputs and revisions were provided by the editors M. Halwart and W. Settle.

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