PARTICIPATORY ACTION LEARNING (PAL):

A MANUAL AND A COMPILATION OF POND AND RICE FIELD FISH CULTURE PAL SESSION PLANS

Edited by:
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Naseem Aleem

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Acronyms

Danida	Danish International Development Agency
DFID	Department for International Development
DSAP	Development of Sustainable Aquaculture Project, Bangladesh
ELC	Experiential Learning Cycle
FAO	Food and Agriculture Organization of the United Nations
FSPS	Fisheries Sector Programme Support
IPM	Integrated pest management
NFEP	Northwest Fisheries Extension Project, Bangladesh
PAL	Participatory action learning
NGO	Non governmental organization
SUFA	Support to Freshwater Aquaculture, Vietnam
VND	Vietnamese Dong
WorldFish	The WorldFish Center (formerly known as ICLARM)

Support to Freshwater Aquaculture (SUFA) programme

SUFA is one of five components under the Danish International Development Agency (Danida) Fisheries Sector Programme Support (FSPS) which has the overall aim of: *Environmentally and socially sustainable economic growth in the fisheries sector in line with international standards.*

The immediate objective of the Support to Freshwater Aquaculture (SUFA) project in Vietnam is: *Increased consumption and income from sustainable freshwater aquaculture by rural communities.* SUFA is addressing this objective through three initiatives:

1. Establishment of three national broodstock centres;
2. Support to provincial aquaculture extension services in Nghe An, Ha Tinh and Bac Kan provinces (See Figure 1); and
3. Support for applied freshwater aquaculture research and development programmes in Vietnam.

Figure 1. Map showing Bac Kan, Nghe An and Ha Tinh provinces (descending from the north), where SUFA conducts extension and training activities.

Development of Sustainable Aquaculture Project (DSAP)

The Development of Sustainable Aquaculture Project (DSAP), which commenced in June 2000 in Bangladesh, is funded by USAID and implemented by WorldFish. The DSAP goal is: *To increase the smallholder farm household incomes and life circumstances of resource limited people who take advantage of improved ways to farm the extensive inland water resources of Bangladesh and to bring to market increased aquaculture products.*

DSAP objectives are to:

1. Disseminate improved technologies to a large number of smallholders through local NGOs and training of their extension staff;

2. Continue research on applied aquaculture technology innovation and refinement; monitor effectiveness of different dissemination methodologies and assess impact of the demonstrations; and

3. Provide training support to aquaculture-related small businesses (hatchery owners, managers).

Working with 35 partner NGOs and over 70 associate partner NGOs, DSAP has implement over 60 000 demonstrations to disseminate different aquaculture practice models. Assisting SUFA with the collaborative development of this manual addresses all three DSAP objectives listed above.

Figure 2. Map showing upazillas[1] where DSAP conducts its technology dissemination activities.

[1] Administrative unit in Bangladesh.

2. Manual Production Methodology

This publication was produced collaboratively by Support to Freshwater Aquaculture (SUFA) in Vietnam and the Development of Sustainable Aquaculture Project (DSAP) in Bangladesh.

The process began when SUFA funded a consultancy to strengthen the capacity of its extension workers to conduct participatory training for freshwater aquaculture farmers. Several development projects in Bangladesh, including CARE Bangladesh and the Northwest Fisheries Extension Project (NFEP) of the Department for International Development (DFID) generously provided some sample rice field fish system PAL session plans as the starting point for this manual.

A working group of key central, provincial and district level SUFA staff modified each rice-fish session plan, making them more appropriate for conditions in Bac Kan, Ha Tinh and Nghe An provinces of Vietnam where SUFA is conducting farmer extension and training. The working group then also produced first drafts of pond-fish system PAL session plans.

Each PAL session was then delivered by a member of the working group to farmers in the field, with a team of observers in attendance, and sessions recorded by digital video camera for later discussion and feedback. Following delivery, discussion and feedback from farmers and the observer group, each PAL session plan was modified, before going through a second round of delivery to farmers, discussion, feedback and further modification.

In addition, in order to amass a wider range of PAL session plans for pond and rice field fish culture systems, SUFA and DSAP jointly sponsored an international PAL competition with cash prizes.

This manual, which focuses on pond and rice field ecosystems, is in two parts. Part 1 (chapters 1 to 7) provides background information for trainers of farmers on using the theory of participatory action learning (PAL), provides a PAL session sheet format and gives recommendations for using PAL sessions. A selection of 14 pond and 4 rice field fish culture PAL session plans is contained in part 2 (chapters 8 and 9).

This PAL manual can be used to lead farmers through a series of PAL sessions, each building on the knowledge gained from the last, with each opening a new "window" on pond or rice field ecosystems. The PAL session plans begin with the importance of sunlight and fertilisers to plankton growth and end with the factors to be considered when deciding when to harvest fish.

This manual includes two types of PAL sessions: those which need facilitation only once, and those which farmers can use repeatedly as a diagnostic tool.

SUFA and DSAP wish to share the 18 PAL session plans contained in part 2 of this manual with other agencies and institutions in Vietnam, Bangladesh and elsewhere, which conduct farmer extension and training.

It is hoped that this manual will boost the confidence of the extension staff of the SUFA and DSAP, and others, to deliver more effective and relevant aquaculture training in a participatory manner to rural farmers. SUFA and DSAP also hope that this manual will stimulate other trainers and extension workers to develop other innovative, improved PAL session plans for both pond and rice field fish culture systems.

SUFA and DSAP request that readers please send feedback on the PAL session plans included at the end of this manual and submit ideas for other PAL session plans to:

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3. Constraints to Conventional Training of Farmers

Why the need for participatory action learning (PAL)?

Aquaculture lags behind agriculture in trying and testing the effectiveness of different available extension and training methods, of which there are many. Each method has advantages and disadvantages. Specific situations also differ, so that no single extension and training methodology is ideal or applicable in all cases.

Currently the training and visit system and the use of demonstration farmers are two of the most popular extension and training methodologies practised in Vietnam.

Against the background of limited manpower, budgets and resources, much aquaculture extension and training has been and is presently conducted in a **prescriptive** manner where farmers are 'spoon fed' or given facts which they must remember, and where 'foreign' or non-indigenous practices are promoted by development projects.

Formal education has conventionally been a passive learning process where the learner sits and is 'filled' with information, usually from books or lectures. Decisions on what is to be taught, learning goals and objectives, and learning methodologies are all made by trainers/teachers (Robinson, 1995).

In addition, in **pond and rice field fish culture systems everything happens beneath the water surface and the effects of changes are not easily seen.** It is therefore very difficult for farmers to observe and understand many of the complex interactions going on in ponds or rice fields and the fish themselves are often invisible in green or turbid water conditions. Some species may be observed at feeding times but it is still difficult to assess how many fish are present and what size they are. For a large part of the cycle, the farmer is essentially blind to the status of the fish in the pond at any given time. **At only two times do farmers know what the real status of their pond is: firstly when fish seed is stocked, and lastly if and when a pond is completely emptied of both fish and water.**

Extension workers are in an even worse position as they only see a particular pond occasionally and essentially the situation is one of "the blind leading the blind" (Gregory and Kamp, 1989).

Participatory action learning is an innovative extension approach which when used in combination with other extension approaches results in farmer focused development.

The participatory action learning (PAL) approach to farmer learning empowers farmers to make better decisions based on an improved understanding of how natural resource systems function.

Participatory action learning shifts training away from prescription, by enabling farmers to understand how pond and rice field ecosystems work. A practical understanding of the aquatic ecosystem by farmers is a pre-requisite of successful culture of fish in ponds and rice field systems.

4. What is Participatory Action Learning (PAL)?

The United Nations Food and Agriculture Organization (FAO) and the international non-government organisation CARE have successfully used PAL sessions 'delivered to farmers in field schools' to break rice field ecosystems down into small chunks for the extension of integrated pest management in Asia. The same approach can be used to deliver PAL sessions on pond and rice field culture systems at regular training meetings to groups of aquaculture farmers. PAL sessions enable farmers to visualise and to understand concealed interactions going on in ponds and rice fields.

What is a PAL session?

PAL is a more experiential approach to extension that improves farmer understanding of natural resource systems, enabling farmers to make improved rational decisions on the use of scant on-farm resources for, in the case of this manual, aquaculture.

Effective PAL sessions are designed to provide farmers/trainees with opportunities for self discovery of a phenomenon, an effect, a relationship or a concept through experiential approaches.

A trainer decides what concept is to be demonstrated and then designs a PAL session for that purpose. A PAL session might involve an experiment, a trial, a demonstration, role play, a game, modelling, reviewing videos or films, simulations, case studies, etc.

Building on the experiential learning cycle

PAL sessions encompass the experiential learning cycle (ELC) which has the following four steps:

- **Experiencing** - concrete experience
- **Processing** - observations and reflections
- **Generalizing** - formation of abstract concepts and generalizations
- **Applying** - testing implications and concepts in new situations

PAL sessions also integrate learning and living together in a single process.

In each PAL session, the facilitator/trainer guides participants through the four ELC steps, with the participants learning from a PAL experience and **not** from the trainer's knowledge.

The experience and knowledge the farmers/trainees bring to the session is respected and built upon during each PAL session. Equally important is that farmers and the PAL session facilitator are equals who learn from each other.

Each PAL session builds upon earlier sessions and provides opportunities for self-discovery and opening of new 'windows' for the farmers/trainees. This, in turn, raises further questions and provides **self-direction** for further training and new PAL sessions. Both the ELC and PAL are iterative (repeated) processes that encourage farmers/trainees to continue learning through experimentation and careful observation.

The five PAL steps

- **Step 1** - Introduce the training topic
- **Step 2** - Focus farmers' attention and validate their knowledge
- **Step 3** - Explain the experiment or observations that the farmers will conduct
- **Step 4** - Have the farmers discuss their observations during the experiment
- **Step 5** - Farmers summarize what they have learned and relate it to practical farming

In step 1 the topic is introduced without telling the farmers/trainees what conclusions they will draw from the session. In step 2 the facilitator/trainer checks what the participants already know about the topic, including what they may have learned in previous sessions and acquired from their own real life experiences.

Step 3 describes what the PAL session involves but not the results that will be discovered. In step 4 the facilitator encourages the farmers to discuss what they are doing, seeing and the implications, while they are conducting the PAL.

Through questioning in step 5 the facilitator encourages farmers to summarize what concepts they have learned and to relate them to their own fish pond, rice field or relevant farming practices.

The advantages of participatory action learning (PAL)

- PAL sessions are designed to provide farmers with maximum opportunity to make **discoveries for themselves**. Information thus gathered is retained longer and is more likely to be acted upon (Islam, 2002).

- PAL sessions break natural resource systems down into manageable pieces which enable farmers to better understand and to make more informed decisions on the use of scarce on- and off-farm resources.

- Decisions on training direction are made by the farmers and the facilitator as equals. With **self-discovery** and **self-direction** the process is **participatory**.

- Observations, reflections, and generalizations from PAL training sessions are applied by the farmers to their own real life situation.

- PAL training is an **iterative** process which encourages farmers to **continue learning** through a process of experimentation and careful observation, even **beyond the life of a development project and inputs from the trainer** (Islam, 2002).

A standardised PAL session plan format was developed and modified by SUFA over the consultancy period (see the standardised format below). Contributors to the international PAL competition were also asked to use the same session plan format to make judging easier.

Standardised PAL session plan format.

1. Training topic	
2. Objective(s)	At the end of the session farmers will be able to
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: Duration:
5. PAL summary	
6. Materials needed	-
7. Method	Step 1 – Introduce the training topic Step 2 – Focus farmers' attention and validate their knowledge Step 3 – Explain the experiment or observations that the farmers will conduct[2] Step 4 – Have the farmers discuss their observations during the experiment Step 5 – Have farmers summarize what they have learned and relate it to practical farming

To make using the above PAL session plan format easier, the following formatting system was used when drafting PAL sessions:

1. The shaded sections of the sheets are notes for the trainer and **NOT** for the farmers.

2. Sample questions to ask farmers are all in *italics.*

3. Possible answers which the farmers may give to questions are in brackets. E.g., (Characteristics of poor quality seed include dark colour, slow swimming speed, slow reaction time when the container side is knocked, etc.).

4. **Important points which trainers must remember are highlighted in bold in the text.**

[2] This step may include several separate trials.

6. Guidelines for Implementing PAL Session Plans. Dos and don'ts

- Prepare all materials (equipment and hand-outs) well in advance of any PAL session.

- Chose an appropriate venue to conduct the PAL session. Consider the availability of resources and materials required, ease of access for the trainer and farmers, group size and seating/sitting arrangements, shelter from rain and sun, and warmth in the winter.

- Create a sitting/seating arrangement that gives an unobstructed view of activities and which promotes the full participation of all group members. Sitting in a small circle on a mat, or arranging chairs in a "U" shape around a blackboard for PAL sessions is more informal than sitting in rows in a classroom. If working at a pond, the trainer should stand at one corner because this allows the farmers to observe from the two adjacent sides.

- The number of groups you divide farmers into will depend on the number of trainers available to assist. One trainer can handle at best two groups of 4 – 8 people. Consider splitting farmers into groups before the session, if you don't want farmers to be distracted part way through a session.

- Lead the farmers through a logical sequence of topics, with each building on the last through effective questioning. Effective questioning should avoid closed questions that will result in "yes" or "no" answers and leading questions that contain the desired answers. Effective PAL session facilitators demonstrate active listening, use paraphrasing to check that answers have been correctly understood, and reiterate correct answers given by farmers.

- If several example questions are listed in a PAL session plan, wait for the farmers to answer the first question before moving on to another.

- Don't give the possible answers that farmers may give to questions (which are given in brackets in the PAL session plans) to the farmers. The **trainer should not say these answers or mention the answers when phrasing questions**. The trainer should ask questions that will lead the farmers to the answers in brackets ( ). If the farmers give the right answers, **only then** should the trainer repeat the answer to emphasise a correct point.

- Direct questions to individuals by name to ensure that all the participants are involved and engaged in the learning process.

- If you are asked a particularly difficult question which is important to the session, ask the farmer group "*What do you think?*" This will give you time to think of an answer. When someone has answered the difficult question, to promote further discussion you can then ask the farmers, "*Do the rest of you agree with that answer?*"

- If you don't know the answer and you can not facilitate the group to come up with an acceptable answer, then be truthful and say "**Your question was very good. I'm not sure that I can answer that satisfactorily now. However I will go away and find an answer and will tell you what I have found in the next training session.**"

- The question "*What have you learned from today's session?*" is too broad for many farmers. It is probably better to ask a series of easier more focused questions to lead them to the same point. For example: *What activities have we done today? What happened when we did .....? Why do you think that happened? If this happened in your pond, what would it mean? How could you prevent this from happening in your pond?* Etc.

- Limit 'telling' in the PAL session to giving the topic of the session, the introduction and simple, clear instructions for the PAL activity. Thereafter the facilitator should encourage self-analysis, careful observation, and critical thinking through questioning, leading the farmers/trainees to discovery.

Only **TELL** farmers:

- Session topic
- Introduction and
- Instructions for the PAL activity

DO NOT TELL THE FARMERS ANYTHING ELSE. Everything else should be done by **QUESTIONING.**

ONLY WHEN A FARMER GIVES A CORRECT ANSWER, CAN THE TRAINER TELL OR REPEAT FOR EMPHASIS.

- Remember an effective PAL facilitator should be a catalyst and a helper, **not** a giver of information and facts.

- The PAL session sheets have been designed as a tool to **assist** trainers in the delivery of effective PAL sessions to farmers. However, the session sheets are **only a guide** and should be used **flexibly**. If, for example, the culture system or species in a particular PAL session sheet isn't appropriate in your area, allow the farmers to choose another culture system or fish species.

- Continually think of ways to modify and improve the session sheets and in particular of interesting, more relevant questions that can be used to stimulate farmer discussion and analysis of the experiments, trials or demonstrated effects.

- **Do not tell** the farmers about the PAL training methodology and how it works. It will only confuse and distract them from the session that you are facilitating.

7. Titles of Related Interest Cited

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8.1. Effects of sunlight, fertilisers and nutrients on plankton growth

1. Training topic	Effects of sunlight, fertilisers and nutrients on plankton growth[3]
2. Objective(s)	At the end of the session farmers will be able to describe what happens to plankton if sunlight is prevented from entering a pond or rice field, why fertilisers and nutrients are important for promoting plankton growth and how to increase the amount of plankton available as natural feed for fish in their ponds and rice fields through proper nutrient management.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: A shaded area near a green, plankton rich pond Duration: 1.5 hours. (One session of 60 minutes and a second session of 30 minutes after two weeks)
5. PAL summary	This PAL session is conducted in two parts and tests the effects of sunlight and various types of locally available fertilisers on plankton growth. Nutrient rich water is placed in three cans, one of which has a lid placed on it, one of which is left open, and one of which is left open but is covered with aquatic weeds. The three cans are placed in a partially shaded place for two weeks. In addition different types of fertilizers are added to clear, plastic bottles containing the same amount of well water and which are then seeded with a small amount of plankton. The bottles are then covered with clear plastic and left in a partially shaded area for two weeks. Two weeks later the water from each can is poured into a clear plastic bag, the difference in the water colour is observed and the effect of sunlight on plankton growth is discussed. The farmers also observe and discuss the condition and colour of the water in each bottle containing the different fertiliser treatments.
6. Materials needed	- 5 clear, plastic bottles, 2 litres - Urea, 25 g - Triple super phosphate (TSP), 10 g - Clear plastic sheet or large plastic bags

[3] Unless mentioned otherwise the PAL sessions are a collaborative effort between the SUFA and DSAP projects as described in chapter 2.

	- String - Paper tape - Permanent marker pen - Well water, 10 litres - Pig manure, 10 g (or 20 g of goat manure if pig manure is not available) - Cow manure, 20 g - Chicken manure, 10 g - Leguminous leaves, 20 g - Phytoplankton rich green water sample, 10 litres - Drinking glass - Teaspoon - Sharp knife (to chop the leaves, cut the plastic and string) - Film canister (for measuring the amount of manure) - 3 large tin cans with lids, (2 – 3 litres) - 3 large plastic bags or clear plastic containers - Duckweed, Azolla or other aquatic plants - Torchlight (to illuminate the plankton sample) - Leaflets, 1 per farmer on fertilisation recommendations
7. Method	**Step 1 – Introduce the training topic** After the farmers have all gathered, explain that in this session you want to give them an opportunity to increase their knowledge about the natural organisms that fish eat. By learning about this topic they can increase the quantity of natural food available for the fish that they culture in their ponds and rice fields. **Step 2 – Focus farmers' attention and validate their knowledge** Get farmers to look closely at a sample of green water collected from a pond by straining it through a fine woven cloth. Use a torch to illuminate the plankton sample. Begin the discussion by asking farmers questions such as: *Can you see anything swimming in the water?* Look very close! *Do fish eat the organisms swimming in the water?* *Have you noticed that some ponds are greener than others?* *What do you think causes this?* *Why are some ponds very green?* (They are receiving a lot of nutrients from fertilisers such as night soil from toilets, organic manures etc.). *What kinds of fertilisers do you put on your rice fields?* (Organic and inorganic like urea, TSP and potash).

What nutrients do the fertilisers contain? (N = nitrogen, P = phosphorus and K = potassium).

What things on your farm are green? (Plants).

What gives the water its green colour?

Which of you has the greenest pond?

Do your fish gasp first thing in the morning?

Who has the greenest pond without fish gasping in the morning?

What size is your pond and what types and quantities of fertilisers do you use and how frequent?

Explain that some of the organisms in the water, the ones that are swimming around, are tiny animals called zooplankton. Others organisms which are too small to see with the naked eye are actually very small green plants called phytoplankton and it is these plants which make the water green.

What would happen if you left a large black sheet of plastic or corrugated tin sheet on top of some grass for a long time? (The grass would go white and die).

Why does the grass die when covered? (Because plants need sunlight to live).

Does phytoplankton need sunlight too?

Let's do a trial to check if the microscopic plants in this green water need sunlight too.

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 1 - sunlight

Tell the farmers that you would like them to conduct a trial to see what happens when these tiny organisms get no sunlight for several days.

We have three tin cans, some green water and some aquatic weeds. Show the farmers the tin cans that you have brought.

Does anyone have any suggestions on how we should design the trial? (They can do this by keeping some green water in a tin can with a dark lid. They can compare this to green water that is allowed to receive sunlight).

Have one of the farmers fill up the tin cans to the same level with the green water and use the permanent marker pen to draw a line on the outside of the tin to indicate the water level.

For the first can, leave the can open without a lid.
For the second can, firmly place a dark lid onto the can.
For the third can, cover the water surface with a layer of the aquatic weeds and leave the can open, without a lid.

The cans should now be placed somewhere where there is partial shade (so that the water does not get too hot!).

Ask the owner of the house to **check the water levels in the tins every few days.** If the water levels get too low because of evaporation, ask him/her to **add some clean well water to increase the water level to the mark on the side of the tin.**

What do you think will happen to the colour of the water in each of the cans? Why?

After **two weeks**, gather the farmers together and have them pour the water into clear polythene bags or clear plastic bottles.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 - sunlight
Is there any colour difference? Which one is the greenest?

Is there anything moving in the water?

What caused the difference in colour?

What caused the difference in the number of organisms swimming in the water?

Do you think that the small plants which make the water green are food for the small organisms swimming in the water?

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 2 – fertilisers and nutrients
Tell the participants that in order to learn the effect of various types of nutrients on the growth of "green water", you would like them to conduct a trial.

Have the farmers fill the five bottles three-quarters full with clean well water and then add a glass full of plankton rich green water to each of the five bottles as 'seed' for the trial.

What types of nutrients and fertilizers do you normally use in your fish ponds and rice fields?

Tell them what nutrients you have brought with you today.

What kind (of those the trainer has brought or could be collected quickly from nearby) would you like to test in today's trial with green water?

Follow the participants' suggestions for trying various nutrients. In each bottle, try a different treatment. You may need to assist them in choosing the correct doses. For example for cow, goat, pig and chicken manure use 1, 1, 0.5 and 0.5 film cans full of manure, for urea use a half teaspoon and TSP a quarter teaspoon.

Do not add any nutrients to one bottle, the 'control'.

An example treatment set up is shown below:

Bottle 1 – ½ teaspoon of urea
Bottle 2 – ¼ teaspoon of TSP
Bottle 3 – ½ teaspoon of urea and ¼ teaspoon of TSP
Bottle 4 – ½ film can of chicken manure
Bottle 5 – no nutrient source or 'control'

However let the farmers choose the nutrient sources and design the trial themselves.

The farmers use the permanent marker pen to mark a line on the side of the bottle to indicate the water level, and write on paper tape what is in each bottle. Ask them to stick the paper tape on the bottom of the bottle. The farmers cover the top of each bottle with a piece of clear plastic and tie it with string.

When finished place the five bottles somewhere where there is partial shade (so that the water does not get too hot which would kill the plankton).

Ask the owner of the house to **check the water levels in the bottles every few days**. If the water levels get too low because of evaporation, ask him/her to **add some clean well water to increase the water level to the mark on the side of the bottle**.

What do you think we will find when we come back to the bottles in two weeks' time?

Why do you think that will happen?

Agree the time and date of a follow-up session with the farmers in about two weeks to compare the bottles.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 2 – fertilisers and nutrients
Is there any colour difference between the bottles?

Which one is the greenest? Which bottle is the least green?

What caused the difference in the colour of the water?

A glass containing tube well water with no natural feed (left) and a glass containing pond water rich in natural feed (right).
Photo: DSAP

Is there anything moving in the water?

What are the small micro-organisms called? (Zooplankton).

Do you think the zooplankton is good food for fish?

What caused the difference in the number of organisms swimming in the water?

What do you think the small organisms swimming in the water eat? (Very small plants which make the water green, but which cannot be seen by the naked eye).

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

Trial 1 - sunlight
Ask the farmers to think for a minute about the different ponds in their community.

Are there any ponds in the community which are completely covered with water hyacinth or other aquatic vegetation?

If a pond is covered with water hyacinth what effect will it have on natural food organisms in a pond or rice field?

How will the water hyacinth affect the "greenness" of the water?

If a farmer's pond is completely covered with water hyacinth how do you think this would affect the growth of her/his fish?

What could the farmer do to increase fish growth?

If your pond was completely surrounded by tall thick trees or bamboo, how do you think it would affect fish growth?

What would be better for fish growth, a rice field with some open areas where water gets sunlight or a rice field fully planted with closely spaced rice plants? Why? (Answer: If there are some areas of open water there will be greater plankton growth and more food for fish).

To conclude the session, confirm with the farmers that the more sunlight that enters the water, the greater the growth of plankton, and, therefore, the greater the growth of the fish that are stocked in the paddy.

Light is needed for optimum plankton growth. Phytoplankton growth stimulates zooplankton growth and in turn fish production. From an understanding of this concept, farmers will try to improve the penetration of light into the water, through weed removal and through altered rice spacing.

Trial 2 – fertilisers and nutrients

If you wanted to increase the amount of very small aquatic plants and zooplankton as a natural food for the fish in your pond or rice field how would you do it? (Add organic or inorganic fertilisers and remove shading around a pond or increase rice spacing in rice fields).

What is the effect of green water on fish growth?

Which fertiliser type was the most effective?

Is it difficult or expensive to obtain this type of fertiliser?

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.2 Natural fish feeds in ponds

1. Training topic	Natural fish feeds in ponds
2. Objective(s)	At the end of the session farmers will be able to list 3 different types of natural feed and will be able to explain how to examine benthos and plankton available for fish in their own ponds.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: Shaded area near a pond with **green water** Duration: 1 hour **(Tell the farmers in advance that two volunteers will be asked to get into the pond, so they should bring old clothes they don't mind getting wet and some clothes to change into afterwards).**
5. PAL summary	In this PAL session farmers will collect samples of benthic organisms from pond mud and plankton by filtering pond water. The natural feeds available in the pond will be put into water containing hungry fish and their reaction will be observed.
6. Materials needed	- Large bowl (plastic or metal) for holding the fish - 4 drinking glasses - Plastic or metal bucket, 5 litres - Well water (5 litres) - A piece of fine cloth (about the size of a towel) to filter a water sample - Another smaller piece of fine white cloth (about A4 size) - 1 wire mesh screen (approximately 2 mm mesh - to filter benthic organisms from mud samples) or a bamboo rice basket - 20 larvae, fry or fingerlings **(starve the fish in CLEAN well water for 2 – 3 days – select species which eat zooplankton or benthic organisms, e.g. common carp, mrigal, tilapia. DO EVERYTHING POSSIBLE TO KEEP THE FISH STRESS FREE UNTIL IT IS TIME FOR THEM TO BE FED IN THE TRIAL, BECAUSE EVEN HUNGRY FISH WILL NOT EAT IF STRESSED)** - Clear plastic containers, 2 litres, x 2 - A torch (to illuminate the plankton sample) - A sample of benthic organisms (Collected **earlier** from a rice field **in case you are unable to find any in the farmer's pond)**
7. Method	**Step 1 – Introduce the training topic** Today we will examine some natural feeds available in ponds but which are difficult to see with the naked eye. We'll also test if fish eat these small natural feeds.

Step 2 – Focus farmers' attention and validate their knowledge

Begin the discussion by asking farmers questions such as:

What kind of natural feeds, which we can see with the naked eye, are available in ponds? (Azolla, duckweed, water boatmen, insects etc.).

What kinds of food do fish eat in ponds?

Have you ever seen fish digging in the mud in ponds?

What do you think they are doing when burrowing in the mud?

Which species of fish like burrowing in pond mud? (Common carp, mud carp, mrigal).

Why do some ponds go green in colour?

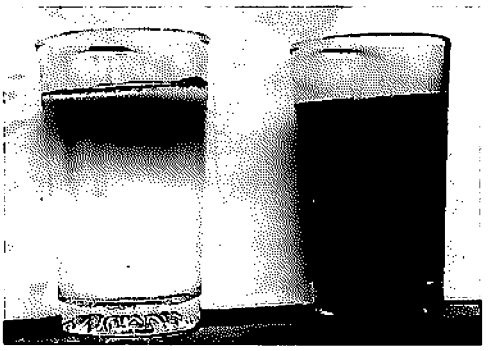
Is green pond water good for fish culture?

Step 3 – Explain the experiment or observations that the farmers will conduct

Before going to the pond side, explain **in detail** what you want the farmers to do when they get to the pond.

Trial 1 – glasses (pond side)
At the pond side, ask two farmers to take the fine cloth and with each holding two corners in the air stretch the fine cloth across a corner of the pond so that the middle is just touching the water. Ask another farmer to fill the plastic bucket (5 litres) with green water and ask him/her to pour the water into the middle of the cloth, while the two farmers continue to tightly hold the corners of the fine cloth in the air. Have the farmer collect and pour a total of five full buckets of green pond water into the middle of the cloth. (If the pond water is not very green then filter 10 or even 20 buckets of pond water through the cloth). Get the farmers holding the fine cloth to slowly lift the corners of the cloth to concentrate the water down until there is **only about 0.5 litres left** and have a third farmer scoop up the concentrated water in two drinking glasses.

Fill two other glasses with well water to the same water level as the concentrated pond water and split the farmers into two groups, each with one glass of well water and one glass of concentrated green pond water. Ask each group to gather around their pair of glasses and hold them up to the sun or against the light from the torch to compare the filtered green pond water and the well water.



A glass containing well water with no natural feed (left) and a glass containing pond water rich in natural feed (right).
Photo: DSAP

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – glasses (pond side)
Can you see anything moving in the well water sample?

Can you see anything moving in the concentrated pond water sample?

Does any one know what the moving organisms are called? (Zooplankton).

What other things on your farm are green? (Plants).

Does anyone know why the pond water is green coloured and what the green matter is called? (Very small plants which you cannot see with the naked eye, called phytoplankton).

What do you think the zooplankton eat?

Put one glass of well water and one glass of concentrated pond water somewhere safe where they won't be knocked over.

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 2 – small piece of fine cloth (pond side)
Have one farmer pour the second glass of tube well water through the small (A4 size) clean filter cloth and let the farmers examine the colour. Have another farmer pour the second glass of the concentrated pond water through the small piece of white filter cloth (or white tissue paper) and get all the farmers to look and discuss the colour.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 2 – small piece of fine cloth (pond side)
How does the small piece of fine cloth look after pouring the glass of well water through it? (It should be clean and clear of stains. If it is you can say that, "This well water is certainly good enough for drinking").

Does it look any different after pouring the glass of concentrated pond water through it? Why is it different?

If there was no plankton in your pond, what colour would the cloth be?

If there was a lot of plankton in the pond, what colour would the cloth be?

Do you think fish eat zoo- or phytoplankton? We'll do an experiment shortly to check.

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 3 – benthic organisms (pond side)
Get two farmers to collect some mud samples from the pond bottom and put them onto the wire mesh screen or the bamboo rice basket. **(Tell the farmer just to collect from the top 1 cm of the pond mud).** Use water to wash away the mud. **(Benthic organisms will be retained).**

Have the farmers gather around to observe and contrast the benthic sample collected from the pond with the rice field sample collected earlier.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 3 – benthic organisms (pond side)
What have you found in the mud samples? (Worms, snails etc.).

Do you think fish would eat these benthic organisms?

How does the sample collected from the pond compare with that collected earlier from the rice field?

Which has the most organisms? Why do you think that is? (There are many more fish in the pond than the rice field and they have may have eaten most of the benthic organisms).

Then take the benthic sample from the pond, the benthic sample collected earlier from a rice field, the remaining glass of well water and the remaining glass of concentrated pond water to a **shaded area where the farmers can sit on a mat on the floor in a circle or at the house.**

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 1 – glasses (in the shade or inside the farmer's house)
Get the farmers to fill the two large plastic containers with clean well water, three quarters full to the same level. Put half the fish into each container. Stand the containers on a bucket turned upside down, stools or chairs and have the farmers gather around so that they can all see.

Tell them that **in a moment** you want two farmers to pour, **at the same time,** the remaining glass of well water into one container of fish and the concentrated pond water into the other container of fish. **(It is important that the zooplankton is alive because this will provide additional stimulation for the fish to feed).**

What do you think will happen?

After they have answered then ask two farmers to pour, **at the same time,** the remaining glass of well water into one container of fish and the concentrated pond water into the other container of fish. The farmers should observe if anything happens.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – glasses (in the shade or inside the farmer's house)
After putting some plankton rich water in with the starved fish:

What are the fish doing in the container to which you've just added the concentrated pond water? (Feeding on the plankton).

What are the fish doing in the other container?

If the fish are very small, *Look at the belly of the fish, is it changing in any way?* (Colour and/or getting bigger).

What do you add to your rice fields to make the rice grow faster? (Organic manure and inorganic fertilisers).

Does anyone know how we could increase the amount of phytoplankton available in a pond? (Reduce shading by water hyacinth etc. and fertilise with either inorganic or organic fertilisers).

Trial 2 – is not continued in the shade

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 3 – benthic organisms (in the shade or inside the farmer's house)
Have the farmers add the benthic organisms to the container with 10 fish in the well water (**that have NOT been fed plankton**) and observe if anything happens.

Step 4 – Have the farmers discuss their observations during the experiment

After putting some benthic organisms in with the starved fish:

What are the fish doing now? (Feeding on the benthic organisms).

Which types of benthic organisms do the fish like the most?

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What did you do in today's PAL session?

What have you discovered? (That there are many natural feed sources available in ponds such as phytoplankton, zooplankton and benthic organisms).

How could you increase the amount of natural feed available for fish in your own pond? (Add animal manures, green manures, inorganic fertilisers and agricultural wastes, e.g., from wine or sugar production. Reduce shading from water plants and trees).

If there is very little natural feed in your pond or rice field and you had no manures of any kind (organic, inorganic or other agricultural wastes), what could you do to increase fish growth? (Feed the fish with on-farm feeds like rice bran).

How could you check to see if there are natural feeds available in your own pond? (Collect samples of plankton by pouring it through cloth to concentrate it and collecting samples of benthic organisms by washing pond or rice field bottom mud).

	How could you check how the quantity of plankton in your pond changes in response to different management practices? (Collect plankton samples once a month, in the same way each time, and see how the relative abundance of plankton changes). *Are there any additional topics you would like to learn about as a result of today's session?* Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.3 Common carp spawning

1. Training topic	Common carp spawning[4]
2. Objective(s)	At the end of the session farmers will be able to successfully induce common carp to spawn naturally and be able to produce fish seed cheaply for stocking in their ponds and rice fields.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: At a pond containing mature male and female common carp Duration: 3 hours in 6 or 7 short sessions **(Tell the farmers in advance that two volunteers will be asked to get into the pond, so they should bring old clothes they don't mind getting wet and some clothes to change into afterwards).**
5. PAL summary	In this session farmers clear a pond of all floating and emergent weeds and debris and put water hyacinth inside a fixed floating bamboo frame. After 2-4 days the farmers remove the water hyacinth and check it for common carp eggs. If present the egg covered water hyacinth is then either placed in a hapa for nursing or is placed directly into a prepared pond or rice field for hatching. The farmers compare the survival and growth rates from the two systems.
6. Materials needed	- Pond containing mature male and female common carp **(This session is usually best conducted when common carp are ready to spawn after the cold season or at the start of the rainy season. Spawning likelihood can be increased by pumping water into the pond to simulate rainfall and to raise the water level).** - Bamboo (several lengths) - Knife - String - Cloth or blue nylon hapa - Water hyacinth - Prepared nursing area in a rice field - Fine cloth - Hard boiled egg yolks
7. Method	**Step 1 – Introduce the training topic** Today we're going to show you how to set up a system to make common carp spawn naturally and then we'll hatch the eggs produced so that you can produce very cheap common carp seed for stocking into your pond or rice fields.

[4] This PAL session was developed from FAO material by staff of CARE Bangladesh.

Step 2 – Focus farmers' attention and validate their knowledge

Begin the discussion by asking farmers questions such as:

Which fish species will spawn naturally in ponds without hormone injections or other assistance? (Common carp, silver barb, tilapia, snakehead etc.).

How many times do you think common carp will spawn in a year? (Twice). *When do common carp normally spawn?* (After the cold season and at the start of the monsoon).

What do you think triggers them to start spawning? (Rising water temperature after a cold season, rising water level during the monsoon season, increased turbidity and the presence of vegetation on which to lay their eggs).

How do common carp spawn and what do they spawn on? (The eggs of common carp are sticky. They lay them on vegetation, sticks and roots in the water).

How long does is take eggs to hatch? (18 – 36 hours depending on the temperature. In warm water fish eggs hatch more quickly).

How long after they hatch can they be put in the rice field? (Either put the eggs directly into a pond or rice field to hatch, or hatch them in a hapa and stock the hatchlings into the pond or rice field after nursing).

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 1 – common carp spawning

Instruct the group to clear the pond of all emergent and floating vegetation. Use the bamboo, knife and string to construct a rectangular frame of about 2 metres by 1 metre.

Ask one person to float the bamboo rectangle on the pond surface about two metres from the pond edge and to anchor it into position with a bamboo pole.

Have the group members collect and wash the roots of a large amount of water hyacinth. While washing the water hyacinth ask the group members to carefully examine the roots. When clean ask the group to fill the floating bamboo frame completely with water hyacinth, with the roots pointing downwards.

Ask the pond owner to sit near the bamboo frame each night during darkness for about 30 minutes and to report back to the group if he hears or sees any signs of activity. If activity does occur at night the group should meet the following morning to discuss and discover what has happened.

Water hyacinth plants placed inside a bamboo frame serve as a substrate for sticky common carp eggs.
Photo: DSAP

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – common carp spawning
Ask the pond owner to describe anything he/she heard at night and what evidence he/she saw to suggest that the common carp had spawned. (Common carp splash a lot when spawning and will probably knock some of the water hyacinth out of the bamboo frame).

Have the farmers look closely at the water hyacinth to see if there are eggs on it.

Where are the eggs attached? (On the roots).

What colour are the eggs? (Pale yellow and clear if healthy and white if dead).

Get the farmers to try and pull some eggs off the water hyacinth roots.

Are they firmly attached? (The eggs are very sticky and are firmly attached to the roots).

What will happen if the eggs are kept out of the water for a long time? (They will die. **After examination put the egg covered water hyacinth back into the water**).

Would the carp have laid their eggs on the water hyacinth if there was other floating vegetation in the pond? (The common carp would probably have laid their eggs on other material, which is why it is important to remove all other material before putting in the water hyacinth).

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 2 – common carp nursing

Explain to the farmers that some eggs will be infertile and others will die before and after hatching. While mortality rates can be very high, it can be reduced by simple techniques.

At this stage there are three choices. The water hyacinth can either be stocked directly into a prepared nursery pond, a nursery area in a rice field or the water hyacinth can be placed into a cloth hapa for hatching, feeding and nursing.

Ask the farmers to attach the cloth hapa to four bamboo stakes in the pond, leaving about 20 cm of the hapa above the water level. Instruct them to tie the top and bottom of the hapa tightly to the bamboo stakes.

Divide the water hyacinth into two parts and have the farmers put half inside the cloth hapa and stock the other half into a pre-prepared nursery area in the corner of a rice field. This should only be very small, approximately 1 metre by 1 metre and 0.6 metres deep.

How can we transport the water hyacinth to the rice field without the eggs drying out? (Put the water hyacinth in buckets filled with water or in wet sacks).

Should we put shade over the water hyacinth? (If there is enough hyacinth it shouldn't be necessary, but the hatchings will need some shade if the air temperature is likely to be very hot).

Can you think of any other problems that might arise? (Flooding, predators etc.).

Two days after hatching get the farmers to begin feeding with hard boiled egg yolk which has been forced through fine cloth to make it dissolve into small pieces.

After about seven days the hatchlings can be moved and stocked into either a prepared pond or rice field.

Compare the survival and growth of the hatchlings nursed in the hapa with the egg covered water hyacinth stocked directly into the nursery area of the rice field.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 2 – common carp nursing
What do the hatchlings look like?

What's the sac under the hatchling for?

Why do you think the yolk sac is getting smaller as the days pass?

What happened when you put the crushed hard boiled egg yolk into the nursing hapa or nursery in the rice field?

Which system gave the best survival of hatchlings and why?

Which system had the bigger hatchings and why?

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What steps do we need to take to successfully make common carp spawn? (After the cold season or at the start of the monsoon season remove floating and emergent vegetation from a pond containing mature male and female common carp. Put water hyacinth inside a floating bamboo frame and leave for 2 – 4 days. Collect the water hyacinth and either stock directly into a prepared nursery area inside a rice field or nurse in a cloth hapa, feeding on boiled egg yolks).

Which system, hatching and nursing in a cloth hapa or direct stocking into a nursery area in a rice field, gives the best results and why? (Nursing in the cloth hapa gives the best results because there are less predatory insects, fish, frogs, snakes, etc.).

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.4 Preparation of grow-out ponds

1. Training topic	Preparation of grow-out ponds
2. Objective(s)	At the end of the session farmers will be able to describe at least one benefit of liming and at least three important steps to be taken when preparing grow-out ponds before stocking fingerlings.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: At a farmer's pond (ideally less than 600 m^2) that has just been drained. If no recently drained pond is available, a clay model should be used. Duration: 1.5 hours **(Tell the farmers in advance that they will be asked to get into the pond, so they should bring old clothes they don't mind getting wet and some clothes to change into afterwards).**
5. PAL summary	During a practical pond preparation session farmers will conduct a simple trial by liming half a drained pond and not liming the other half. They will observe and discuss what effects the lime has on fish and other organisms hiding in the pond bottom mud.
6. Materials needed	- Black plastic sheet (to be used as a blackboard) - Chalk pen - Tape (to fix black plastic sheet) - Lime, 10 kg - Scale (to weigh lime) - Table spoon - 3 sickles - 3 spades - Bucket - Metal plate to scoop the lime - 2 surgical masks - 4 plastic bowls - Harrow or wooden board on a handle to smooth the pond mud - 30 candies
7. Method	**Step 1 – Introduce the training topic** Today we will do some practical grow-out pond preparation.

Working on pond banks to ensure the correct slope.
Photo: DSAP

A completed pond after vegetation removal, and slope repair.
Photo: DSAP

Step 2 – Focus farmers' attention and validate their knowledge

Begin the discussion by asking farmers questions such as:

How many members of the group have grow-out fish ponds?

What type of pond preparation do you do before you stock fish?

Why are you doing that type of preparation?

What do you think would happen if you did no preparation at all?

Do the other members of the group agree with that answer?

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 1 – pond bottom

Before going to the pond side, explain in the shade somewhere, what will be done and divide the farmers into two equal sized groups.

At the pond, ask one farmer to draw a line in the pond bottom mud to divide the pond into two equal parts. (**If there is water in the pond, ask the farmers to separate each half with a mud embankment, so that there is the same amount of water on each side and fish cannot move from one area to the other area**).

Find out the size of the pond from the pond owner. Get the farmers to weigh out enough lime to cover half the pond using 10 kg per 100 m^2. Then ask two farmers to put on the surgical masks and rubber gloves and to spread the lime over one half of the pond bottom. (**No lime is to be added to the other half of the pond bottom**). Ask each group to guess how many fish they think will remain alive in the area which is limed.

Liming a pond to remove predatory air breathing fish, like snakehead and climbing perch. The farmer is wearing a mask to prevent inhalation of the powdered lime and rubber gloves to prevent burning of his skin. Foot protection would also be advisable.
Photo: SUFA

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – pond bottom

Can you see any fish or other organisms moving in either half of the pond bottom?

What is happening in the area without lime?

Are the same things happening in the area with and without lime?

Why are there differences?

After about 20 minutes have two farmers collect any dead/dying fish and other organisms in a bucket from the area that has been limed. Ask two other farmers to check if there are any dead/dying fish and organisms in the area that hasn't been limed.

What types of fish and other organisms have you been able to collect from the limed area?

What types of fish and other organisms have you been able to collect from the non-limed area?

Are there still any live fish and other organisms in the limed area?

If yes, *How much longer do you think you should wait until they are all dead?*

How many dead fish have you collected from the limed area?

Are there still any live fish and other organisms in the non-limed area?

What would happen if we filled the pond with water now and stocked fish in a few days' time? (The predatory fish remaining in the non-limed area would eat many of the stocked fish seed).

What can you do to stop this happening? (Lime the other half of the pond bottom).

What dose of lime should we use? (10 kg per 100m^2).

Get two farmers to lime the other half of the pond bottom and watch the effects again while weeding the repairing the pond banks.

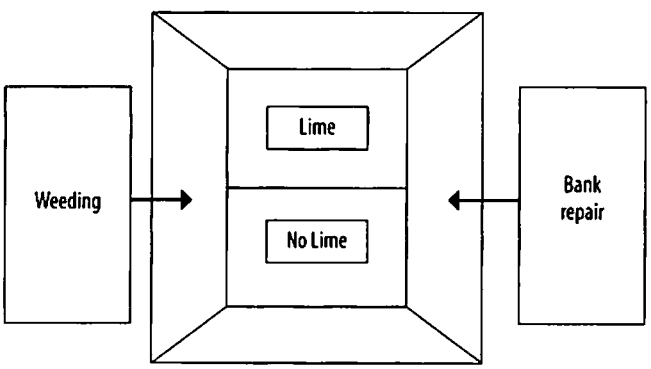
What happened when the pond mud was harrowed? (Harrowing helps to kill fish hiding in the mud and in footprints).

If the pond was half full of water would the lime kill the fish and other organisms as effectively? (No, less effectively).

What can we do therefore before liming a pond to make the lime more effective? (Drain and dry the pond bottom).

After the liming is complete and the fish have died get the farmers to level the rest of the pond bottom.

Check on the developments in the 2 halves of the pond and then have one of the groups cut the grass and weeds and remove overhanging vegetation from one pond bank and have the other group repair the embankment and fill in any holes on the opposite pond bank.



Make sure that while they are working they watch what is going on in both halves of the pond bottom, with and without lime.

After 30 minutes have two farmers harrow the pond mud in the half of the pond that has been limed to make the pond mud smooth and even and to mix the mud with the lime. Ask the farmers to watch for any fish moving in the mud when the harrowing is done.

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

When they have finished leveling the pond bottom. Gather the farmers in a group somewhere in the shade.

What have you learned today? (Liming pond bottom kills predatory fish and other organisms).

What other reasons are there for using lime? (Killing bacteria, reducing disease and controlling pH).

What else did you do today? (Weeding, bank repair and pond bottom levelling).

Why do you need to weed pond banks before stocking fish? (To reduce the hiding places for predators like frogs, snakes, rats and birds).

Why do you need to repair the pond banks and fill in holes before stocking fish? (To reduce the hiding places for predators like frogs, snakes, rats and birds. To prevent the bank from breaking and the fish escaping).

Why do you need to level the pond bottom? (To make draining and netting easier. To make sure there are no more remaining fish).

Next time you prepare your own pond what steps will you take?

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.5 Nursing small fish fry

1. Training topic	Nursing small fish fry [5] (This session is more appropriate to farmers with rice-fish plots and to areas where water is scarce and farmers do not want to drain their pond or where farmers are unable to drain a pond to remove predatory fish).
2. Objective(s)	At the end of the session farmers will be able to describe at least four reasons why nursing fish fry is important before releasing them into large ponds or rice-fish fields.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: In a group member's house or in a shaded area, preferably near a fish pond or a rice-fish plot Duration: 1.5 hours – if possible leave the trial overnight and come back the following day to see if there have been any developments
5. PAL summary	Farmers will stock fish fry (2-3 to 5-6 cm size) in different sized glass aquaria and observe their behaviour in relation to space, available food and the presence of predatory fish species.
6. Materials needed	- 3 plastic or glass aquaria (20 litre capacity) - 50 litre of clean well water - 2 clear plastic bottles - Small size plastic rectangular basket or tray with holes of less than 2 cm (This will be suspended in the aquaria representing a nursing hapa) - Stone - to hold the basket down - 2 sticks (longer than the width of the aquaria) - 30 cm of string - Small scoop nets - 3 aerators (battery operated) - 30 common carp or tilapia fry, 2 – 3 cm - 20 common carp or tilapia fry, 5 – 6 cm - 6 snakehead or other predatory fish species, about 100 g, **(live and starved for 3 days)** - Measuring jug - Nursing feed, 10 g (fine rice bran and fish meal mix) - Small baby doll
7. Method	**Step 1 – Introduce the training topic** Today we will conduct some simple trials to examine what happens to fish fry with and without nursing that are stocked into rice-fish fields or grow-out ponds containing predators.

[5] Submitted to the PAL competition by Arlene Nietes-Satapornvanit (arlene@ait.ac.th), Asian Institute of Technology, Bangkok, Thailand.

Step 2 – Focus farmers' attention and validate their knowledge

Begin the discussion by asking farmers questions such as:

When you buy fish fry, do you nurse them first or stock them directly into your rice fields or grow-out ponds?

If you nurse them, why and how do you nurse?

If not, why don't you nurse your fish before releasing them into a grow-out pond or your rice-fish field?

How many of you have children? In the first three months of the child's life what did you do for them? (Feed, shelter and protect them).

Why did you have to do that? (Because the infants were weak and unable to fend for themselves).

Pass around some 2 – 3 cm fry in a clear plastic bottle and the small baby doll.
Imagine that these fish fry are babies. What do babies and fish fry need during this stage of their lives? (Protection from harm, feeding, shelter from harsh environmental conditions).

How do you ensure that the babies survive and can develop?

What about these fry? Can they survive if they are immediately stocked into the grow-out ponds? If we were to stock these fish into this nearby pond now, what do you think would happen to them?

What wild fish species are most likely to enter fish ponds or rice-fields during heavy monsoon rain and flooding?

Pass around some of the 5-6 cm fry.
What about these ones? If we were to stock them immediately into the nearby pond or a rice field, what do you think would happen and why?

Why is it important to consider the number of fry that you stock into your pond or rice field?

How do you think the stocking density effects your fish production at harvest?

Step 3 – Explain the experiment or observations that the farmers will conduct

Split the farmers into three groups and give them to the following assignments:

Group 1: Aquarium with nursing basket, stone and 2 – 3 cm fry
Group 2: Aquarium without nursing basket, 2 – 3 cm fry
Group 3: Aquarium without nursing basket, 5 – 6 cm fingerlings

Explain that these aquaria represent large grow-out ponds, and that the basket is a nursing hapa. Ask each group to add 10 litres of water to their aquaria, stock two snakeheads and to set up a battery powered aerator.

Tell Group 1 to place the two sticks across the width of the aquaria and to use the string to suspend the nursing basket in the aquarium. Instruct them to place the stone in the middle of the basket so that it does not float up, and to adjust the string so that the top 1 cm of the nursing basket is sticking out above the water level.

What do you think will happen when you stock the fry into each aquaria/grow-out pond? What do you think the snakehead will do to the fry?

Instruct the groups to stock their fish seed. **Tell them it is important to count the exact number of fish.**
Group 1 – stock 10 fish fry (2 – 3 cm) into the nursing basket.
Group 2 – stock 20 fish fry directly into the aquaria.
Group 3 – stock 20 fingerlings (5 – 6 cm) directly into the aquaria.

Ask each group to add a small amount of nursing feed to their aquaria, to watch the fish in the three aquaria closely for 20 minutes and to record their observations.

If convenient leave the trial overnight. Ask the farmers to come back the following day at a specified time and to count how many fish remain in each system. **If the aquaria are left overnight, cover the aquaria to prevent the snakeheads from jumping out.**

Step 4 – Have the farmers discuss their observations during the experiment

What happened when the fish seed were stocked into the aquaria?

Were there any differences in the reaction of the fish between the three systems?

Were the fish seed in all three systems equally stressed?

What was the reaction of the fish when feed was added to the three systems?

In which system was it easier for the fish seed to find the feed? Why?

In which system would you expect the least amount of feed to be wasted?

Did the snakehead eat any of the fry or the fingerlings? Why or why not?

If we leave the tanks overnight or for one week, and check them tomorrow or every day, what do you think would happen?

Which system do you think offers the best protection for your fish seed and why?

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What trials did we set up today?

What are the main benefits of nursing fish fry in a small area, such as a nursing hapa? (It makes checking fish number, general health, and feeding them, easier. Less feed is wasted. Predatory fish are excluded and survival is higher so less seed can be purchased; this in turn results in more income for the household).

Why should you nurse fry in an enclosed area before stocking into a grow-out pond or rice field? (Fry nursed to fingerling size (5 – 6 cm or more) are stronger and more likely to escape from predators).

If you do not have a hapa to nurse the fry, what can you do instead? (Enclose a small area at the corner of a rice field or a grow-out pond by making a small dike. Alternatively find an old mosquito net or a piece of cloth and use it for nursing. Make sure there are no holes in the mosquito net or cloth however).

If you cannot ensure that your grow-out pond or rice field is free of snakeheads and other predators, what should you do to protect your fry? (Either nurse fish fry for 4 – 6 weeks until they are fingerling size or, if available, buy and stock fingerlings instead of fry).

What are the benefits of stocking fingerlings instead of fish fry? (Survival is higher so fewer fingerlings are needed, even though they are more expensive to buy initially. Fingerlings reach market size quicker so less labour, fertilizer, feed and other inputs are needed. Turn-over is faster, so the return on your money is quicker).

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.6 Tilapia seed production in hapas

1. Training topic	Tilapia seed production in hapas [6]
2. Objective(s)	At the end of the session farmers will be able to identify at least three characteristics of mature broodstock male and female tilapia and describe how to breed and nurse tilapia in hapas.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: Duration: 3 hours. 1 hour in the first session and 30 minute sessions every 15 days thereafter. **(Tell the participants that they will need to get into the pond at each session and should therefore bring suitable clothes for getting wet).**
5. PAL summary	Participants first observe the size, colour, fins, abdomen and genital papilla of mature male and female broodstock tilapia. A breeding hapa is set up and stocked with male and female tilapia. Fry are harvested after 15 days and nursed in a smaller nursing hapa. Fry are harvested every 15 days and nursed for 30 days.
6. Materials needed	- 6 mature male tilapia (75 – 100 g) - 12 mature female tilapia (75 – 100 g) - 2 plastic buckets - 2 scoop nets - 3 banana leaves - 1 nylon hapa (3 x 2 x 1 metres) - 2 nylon hapas (1.5 x 1 x 1 metres) - 18 bamboo poles - String - Sharp knife - Rice bran and fish meal (or other available protein source) (Broodstock should be fed with 85% rice bran and 15% fish meal at 3% body weight per day, while seed should be fed with 75% rice bran and 25% fish meal at 5% body weight per day) - Empty sardine tin - Bottle of blue or black ink - Pipette or a straw
7. Method	**Step 1 – Introduce the training topic** Today we are going to observe and decide how to differentiate between mature male and female broodstock tilapia. Then we are going to set up a hapa breeding system for tilapia in a pond. Later we will also set up a tilapia nursing system in the same pond.

[6] This PAL session was developed by Dr. Benoy Barman (bkbenoy@yahoo.com) who is presently working for WorldFish, Dhaka, Bangladesh. Dr. Barman's doctoral thesis was sponsored by the DFID funded Northwest Fisheries Extension Project (NFEP).

Step 2 – Focus farmers' attention and validate their knowledge

Begin the discussion by asking farmers questions such as:

What fish species do farmers commonly culture in your village?

Where do farmers usually culture tilapia? (Ponds and rice fields).

Where do farmers usually obtain tilapia seed?

At what age do tilapia begin to spawn? (Tilapia is an exotic fish. Female tilapia begin laying eggs when only 3 – 4 months old. Female broodstock tilapia, hold and incubate their eggs in their mouth).

How can you identify male and female tilapia broodstock?

Let's check and see if you are right?

Nile tilapia
(Oreochromis niloticus)
broodstock
Photo: SUFA

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 1 – identifying male and female tilapia
Have the farmers gather around buckets containing mature male and female tilapia (75 – 100 g). Ask them to use the scoop net to take out individual fish and lay them on the banana leaf. Get the farmers to carefully examine and note down the differences between the male and female tilapia.

Instruct the farmers to put one drop of ink onto the papilla of each tilapia and to stroke the ink covered papilla with a finger.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – identifying male and female tilapia

Do the fish all look the same (colour and shape)? If not, in what way do they differ? (Female tilapia generally have a swollen abdomen and are usually smaller than males. Females often have a pale body colour and are golden/yellowish below the mouth around the throat area. The female papilla located behind the anus is blunt with a pinkish colouration.

Males are usually larger, the abdomen is not swollen, and they may be bright reddish violet under the mouth around the throat area. The male papilla located behind the anus is pointed and blackish in colour).

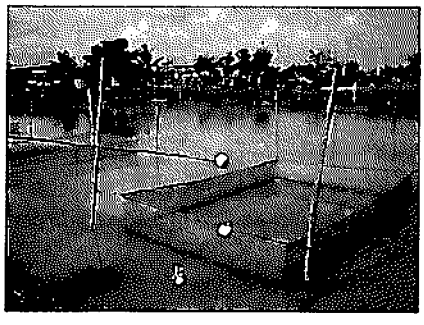
What does a female tilapia's papilla look like when ink is stroked across it? (It has a transverse line and a pore beneath the line).

What does the male tilapia papilla look like when ink is stroked across it? (Only a pore is visible for males).

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 2 – hapa breeding of tilapia

Get the farmers to separate all the male and female tilapia. Ask four people to set up the breeding hapa at a suitable location in the pond. Instruct them to tie the hapa to the bamboo poles carefully at both the top and bottom in the corners. Then instruct the farmers to stock 6 male and 12 female tilapia into the hapa. **(Stock breeding hapas with three fish per square metre with a ratio of two females for each male).** Ask the pond owner to feed the tilapia in the hapa each morning and evening and to observe what happens. **(Feed the broodstock a mixture of 85% rice bran and 15% fish meal at 3% total body weight daily divided equally in the morning and the evening. Use a sardine can to measure the feed ration needed).** Arrange a date and time, and meet the farmers at the pond after 15 days.



Blue nylon tilapia breeding hapas are securely tied, both at the top and at the bottom onto bamboo poles. A plastic scoop on a bamboo pole is used to feed the fish
Photo: Nam Sai Farms Co. Ltd. - www.tilapiathai.com

Step 4 – Have the farmers discuss their observations during the experiment

Trial 2 – hapa breeding of tilapia

What happened each morning when you fed the rice bran/trash fish feed?

What do you think has happened in the hapa in the last 15 days?

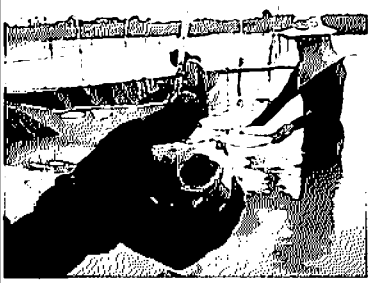
How can we check?

Ask two farmers to untie the strings at the bottom of the hapa at two corners on one end of the hapa and to slide a bamboo pole under the hapa. Gradually have them move the pole from one end of the hapa to the other, at just above the water level height, so that all the fish are eventually crowded together at the other end of the hapa.

Ask the farmers to all get in the water and to gather near where the fish are crowded at one end of the hapa. Using a scoop net get the farmers to carefully remove the tilapia broodstock one by one. Ask them to look inside the mouth of each fish and if it is empty to transfer the fish into a bucket containing pond water.

Is there anything inside the mouth of the fish? (Some females may hold eggs or small fry in their mouths). If they do, wash the eggs or fry out into a bowl containing clean water.

Why do the females have eggs (or fry) in their mouths?



A female broodstock tilapia incubating eggs in its mouth. Photo: Nam Sai Farms Co. Ltd. - www.tilapiathai.com

When all the broodstock have been transferred to the bucket, have the farmers carefully collect anything which remains in the end of the hapa.

What is there in the corner of the hapa? (Small tilapia fry). **(Typically this system will produce 9 swim-up fry per square metre per day, i.e., a 6 m² hapa will produce about 810 fish every 15 days).**

How could we nurse these fry using the equipment we have available? (In a nursing hapa).

When the fry have all been removed, ask the farmers to clean the breeding hapa and then to reset it and restock the broodstock tilapia back into it.

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 3 – hapa nursing of tilapia
Instruct the farmers to set up the nursing hapa in the pond and to carefully transfer the small fry into the nursing hapa. (500 fry can be nursed for one month in a 1.5 x 1.0 metre nursing hapa).

If the pond is green, feeding may not be necessary. But for less productive ponds, and to increase the tilapia fry growth rate, ask the pond owner to slowly feed the fry **with a mixture of 75% rice bran and 25% fish meal at a rate of 5% body weight per day, divided equally between the morning and afternoon.**

Arrange for the farmers to meet again in 15 days time.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 3 – hapa nursing of tilapia
What did the fry do when you fed in the morning and the evening?

Have the fry in the nursing hapa grown?

Instruct the farmers to set a second hapa for nursing and to catch and transfer the fry from the first nursing hapa into it. They should count the fish that they transfer. Have the farmers clean the first nursing hapa and reset it.

Have the farmers check the breeding hapa again for new fry and to clean and reset the hapa as before.

Are the new fry and the fry you've nursed for 15 days the same size?

Should the old and the new fry be nursed together? If not, why not?
(The large fry should be nursed separately otherwise they will take most of the food and possibly eat the smaller fry).

Ask the farmers to wash the first nursing hapa and the sides of the breeding hapa and to stock the new fry separately in the washed nursing hapa.

Repeat the process every 15 days, and sell the fry after nursing for 30 days.

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What characteristics can be used to identify male and female tilapia?

How do tilapia normally spawn? (Male and female tilapia spawn when 3 – 4 months old, by mating and laying eggs in a nest, made by the male, in the bottom of a pond or other water body. The female tilapia collects the eggs in her mouth, where she incubates them).

Using one large and two small hapas how can you set up breeding and nursing systems for tilapia in a pond?

If you had hapas but didn't have a pond could you still set up breeding and nursing systems for tilapia? (Yes, by setting the hapas in a friend's pond, a rice field, a water body or in a sheltered part of a river).

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

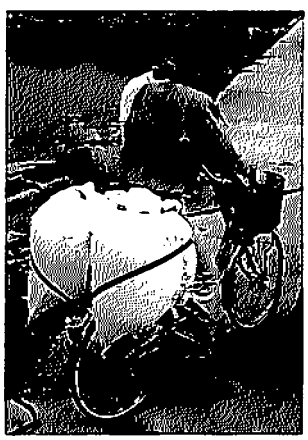
8.7 Fish conditioning for transportation

1. Training topic	Fish conditioning for transportation
2. Objective(s)	At the end of the session farmers will be able to state how and why fish should be conditioned before transportation.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: At a nursery farmer's fish pond with a shaded area Duration: 1.25 hours
5. PAL summary	Unconditioned fish caught shortly after feeding, and fish conditioned by holding them in clean water for 48 hours are packed separately in water and air in sealed plastic bags. The conditioned and unconditioned fish are then transported on the back of a bicycle for 10 minutes over rough ground. After transportation the farmers examine the fish, remove them and examine the water in a drinking glass. The effect of conditioning on water quality and fish stress is discussed.
6. Materials needed	- 50 conditioned fingerlings **(hold the fish in clean water for 48 hours – THIS IS VERY IMPORTANT)** **(Check the plastic bags for holes and tie the bamboo onto the bicycles before catching the unconditioned fish)** - 50 fish **caught 60 minutes after being fed rice bran** **(same size and species as the conditioned fingerlings – THIS IS ALSO VERY IMPORTANT)** **Each container should be the same size and surface area and contain the same number and size of fish.** **(If possible provide a battery operated air pump rather than splash the water by hand, since this will disturb the fish and affect the outcome of the PAL session)** - 8 large plastic bags - 40 large strong elastic bands - Battery air pump – for small aquarium - Bicycle pump - 2 bicycles - 2 plastic or metal bowls, large - 2 scoop nets - Well water, 8 litres - 2 measuring jugs, plastic, (or a 1 litre plastic bottle) - 4 drinking glasses - Bamboo, 1 metre long, 2 pieces (Split the **bamboo into two lengths and tie the two lengths in parallel across the back of each bicycle, so that they stick out equally on each side – see photo below)** - Rope - 2 permanent marker pens

7. Method	**Step 1 – Introduce the training topic** This morning we are going to conduct a simple trial to demonstrate how the treatment of fish before transporting them can affect water quality, fish stress, and survival. Treatment of fish before transportation is called **conditioning**. Conditioning is particularly important when fish are transported for longer periods, and today we will find out why. **Step 2 – Focus farmers' attention and validate their knowledge** Begin the discussion by asking farmers questions such as: *Where do you get the fry and fingerlings which you stock into your fish ponds and rice fields?* *How far away is the hatchery/nursery?* *How do you transport the fish to your pond?* *Do any of you buy fry or fingerlings from seed traders?* *How do the seed traders transport the fry and fingerlings?* Before transporting fry and fingerlings good seed traders **condition** their fish. This morning we will look at the impact of **conditioning**. **Step 3 – Explain the experiment or observations that the farmers will conduct** The trainer should explain that they have two groups of fish for use in the trial. The conditioned fish were caught 2 days earlier and have been held for 48 hours in clean water and have not been fed. The unconditioned fish were caught that morning, 60 minutes after feeding with rice bran. Divide the farmers into two groups (with different fish names e.g., grass carp and common carp) and get each group to nominate a secretary to note down the results of the test that they will conduct. Each group will take 4 plastic bags, check them for holes, rinse them out with clean water and double up the plastic bags (put one inside the other). Instruct the farmers to check for holes like checking a bicycle tire for a puncture. Also tell them to keep the bags off the floor, in case the rough ground punctures the bags. Use a permanent marker pen to label one double bag "conditioned" and the other double bag "unconditioned". They will then put elastic bands tightly on the bottom corners of the bags to round them off. (**This stops fish getting**

trapped and squashed in the corners of the bag). Use the measuring jug to add 2 litres of water to each bag.

Each group should then divide into two more groups. One half of the group should catch and put 25 conditioned fingerlings into one of the bags, use a bicycle pump to fill it with air **(count the number of pumps to fill the bag)** and then close the bag tightly with elastic bands. **At the same time** the other half and the group should pack 25 unconditioned fish in the same way **with exactly the same amount of water and number of air pumps – 100 pumps for a large plastic bag.** When both bags are ready have the group tie their unconditioned and conditioned fish bags one on either side of a strong piece of bamboo tied to the back of a bicycle. **(If there is only 1 trainer, then 1 group can be made responsible for conditioned fish transportation and the other for non-conditioned fish).**



Transporting fish in sealed plastic bags by bicycle
Photo: SUFA

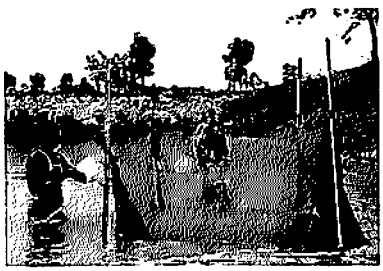
Ask for one volunteer from each group to ride the bikes around the village and then to return after 10 minutes. **The riders should go together and if possible ride over rough ground.**

The remaining members should have a cup of tea, while the trainer facilitates discussion on what they think will happen to the fish and to the water in the two bags.

While, the groups are waiting for the cyclists to return the trainer can explain how fry traders condition fish before transportation by both netting and crowding them.

Why do you think they do this? (To acclimatise the fish to handling and high densities).

Fry traders also hold fish without feeding in clean water.
Why do they do this? (To improve water quality during transportation).



Fry traders crowd fry in hapas and splash them with water to condition them before transportation
Photo: DSAP

The trainer should ask:
Do you think there will be any visible difference between the conditioned and unconditioned fish?

What effect will the unconditioned fish and the conditioned fish have on the quality of the water in the transport bags?

While the cyclists are away you can discuss the quantities of fish that farmers normally stock per litre of water when transporting fish.

Before opening the bag
When the riders return, each group should take the conditioned and the unconditioned fish bags off the bicycle and gather around and examine the fish to see and discuss if there is any visible difference.

After opening the bag
The groups should then open the bags and again look and discuss whether there is any visible difference between the fish in the conditioned and unconditioned bags.

Examining the water
Have two farmers from each group carefully remove the conditioned and unconditioned fish and to restock them in the nursing pond. Allow the water to settle for a minute and then ask two other farmers from each group to pour three quarters of the water away. Collect one glass full of water from the bottom of each bag.

Have the farmers gather around and closely examine the water collected from each bag. The trainer should facilitate discussion on visible differences (if any) in the quality of water samples taken from the conditioned and unconditioned transport bags.

Ask the farmers to smell both glasses of water.

Step 4 – Have the farmers discuss their observations during the experiment

When the cyclists have returned and the bags have been taken off the bikes the trainer should ask:

Before opening the bag
How do the fish look in the conditioned and unconditioned bags?

If there is any visible difference ask, *What do you think has caused this?*

After opening the bag
Can you see any visible difference between the fish in the conditioned and the unconditioned bags? (There probably won't be any difference in fish stress levels after only 10 minutes).

Examining the water
How does the water smell from the conditioned and non-conditioned bags?

How does the water look in the conditioned bag compared with that from the non-conditioned bag?

If you had to drink one of the 2 glasses of water which one would you prefer to drink?

Are there any fish faeces in the water?

How would the fish faeces affect the water quality in the unconditioned transport bag? (As the faeces dissolves it irritates the gills of the fish and it uses up dissolved oxygen from the water).

How does conditioning affect the amount of food in the stomach of the fish that are going to be transported? (By starving the fish before transportation there is less food in their stomachs and fewer faeces are released into the water).

We have only transported these fish for 10 minutes; how would the water quality differ, for the conditioned and unconditioned bags, if we had transported the fish for four hours? **(Over longer journeys poor water quality would result in fish stress, higher mortality in the bag and after stocking, a delay in feeding, and reduced fish growth).**

	Step 5 – Have farmers summarize what they have learned and relate it to practical farming *What have you learned from today's trial?* (That holding fish without food before transportation results in cleaner and better water quality in the transportation container. Poor water quality stresses fish and causes higher mortality following transportation, and slower growth after stocking). *What should you do before transporting fish for periods longer than one hour?* (Condition the fish first by holding them in clean water without food and then pack them, otherwise periodically stop and change the water in the bags for fresh water). *Are there any additional topics you would like to learn about as a result of today's session?* Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.8 Open fish transportation and stocking techniques

1. Training topic	Fish conditioning for transportation
2. Objective(s)	At the end of the session farmers will be able to detail one method of transporting fish which is appropriate for moving fish on short journeys of limited duration and for use in mountainous areas; and will also be able to explain why fish should be acclimatized before release into a pond.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: In a shaded area near a farmer's house Duration: 1 hour
5. PAL summary	Fish will be transported in open containers with and without splashing of the water. Following transportation, fish will be released with and without temperature acclimation. Farmers will observe, discuss and contrast the different treatments.
6. Materials needed	- 2 plastic buckets (10 litres each – **same size and shape**) - 2 plastic bowls, large - 1 plastic bowl, small - 1 plastic bottle (1 litre) – for measuring water volume - 2 pieces of netting - 1 weighing scale (5 kg) - 2 bamboo yokes (shoulder poles) - 2 pieces of rope - 2 strips of rubber inner tube, (0.5 m long) - 1 stick, 50 cm long - Piece of foam rubber 15 cm long, 2 cm thick (sole of a sandal) or polystyrene foam - 1 kg fingerlings 4 – 6 cm (**Conditioned by holding in clean water for 48 hours**) - 1 thermos flask of hot water - 1 thermometer - Prepared hand-out sheet on key points of the session, one per farmer - Battery or electric aquarium air pump - White/blackboard or flipchart paper - Chalk or marker pens
7. Method	**Step 1 – Introduce the training topic** Today we will look at transportation of fish in open containers and how fish should be released into a pond to reduce mortality after stocking. **Step 2 – Focus farmers' attention and validate their knowledge** Begin the discussion by asking farmers questions such as:

Where do you buy fingerlings?

How do you transport fish?

Do the fish die during transportation?

How do you release the fish into the pond when stocking?

Why are seed traders able to transport fish over long distances with very few fish dying?

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 1 – seed transportation with and without splashing

Have the farmers split into two groups. Each group should pour 5 litres of water and 0.5 kg of fingerlings into a bucket, cover the buckets with nets, tie the nets in place with the strips of rubber inner tube and shoulder-pole carry the fish for **about eight minutes around the house.**

How many fish would you normally transport in this quantity of water? (It depends largely on the time and the distance the fish will be moved).

Do you think a stocking density of 0.5 kg of fingerlings in 5 litres of water is appropriate?

Group 1 (professional fry traders) will transport their fish and will splash the water using a piece of foam rubber (from the bottom of a sandal) attached to the end of a stick. Group 2 (inexperienced fry traders) will transport their fish WITHOUT any splashing of the water.

The PAL trainer should stay with the group at the house to ask questions like *"What do you think will happen?"* etc., to keep the group from becoming bored. A second trainer should go with the seed traders to ensure that they get back to the house on time.

At the end of transportation put the two buckets together and get the farmers to compare and discuss the differences. Group 1 should CONTINUE TO SPLASH the water with the foam rubber.

Use the foam rubber to try to revive the second group's fish.

At the end of trial 1, keep some fish for trial 2, but release the remainder.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – seed transportation with and without splashing
How do the fish appear in group 1's bucket with the splashing?

What are the fish in group 2's bucket doing?

Which group's fish look the most stressed?

Why do you think this is? (Lack of dissolved oxygen).

If fish have been stressed during transportation, how do you think it affects their survival and growth in the pond?

Do you think group 2's fish will revive if we splash in their bucket? Let's see shall we?

When do you think is the best time of day to transport fish and why? (Midday is hot and the hot water temperature will cause additional stress to the fish).

If the fish from both buckets were stocked into a pond which fish do you think would survive and grow the best?

Do you think transporting 0.5 kg of fingerlings in 5 litres of water was an appropriate stocking density?

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 2 – with and without acclimation before stocking
This PAL is about transferring fish from cool to warm water with and without acclimatisation. In some areas the reverse situation, where fish are transferred from warm water into cool water with and without acclimatisation may be more appropriate. Use a temperature difference of about 12 to 14 degrees Celsius between the cool and warm water or between the warm and cool water. Either way test the water temperature in a practice session before doing the PAL session with farmers.

Mix hot and cold water in a bucket until you have 6 litres of water which is 12 - 14°C warmer (or cooler) than the water the fish are in. Divide the water into equal amounts in two large plastic bowls.

Ask the farmers to feel the temperature of the water in the large bowl and the temperature of the water in the container that holds the fish.

Group 1 should pour five fingerlings directly into their large bowl of warm (or cool) water. Groups 1 and 2 will observe how the fish react and discuss their observations.

Group 2 will put five fingerlings into a small plastic bowl with some water from the container of fish and will float the small plastic bowl of fish in the large bowl of warm (or cool) water. Ask one farmer to gently splash the water in the small plastic bowl so that the fish have enough oxygen.

After 5 – 8 minutes ask the farmers to feel the water temperature in the bowl and in the plastic bowl to see if they are the same.

When the temperatures are very similar, add water from the large plastic bowl into the small plastic bowl little by little and allow the fish to swim out. Both groups will observe and comment on the reaction of the fish.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 2 – with and without acclimation before stocking

Before stocking the fish – *Is the water temperature the same in the bowl as in the container with the fish?*

If not, which container has the warmest water?

If fish have been transported over a long distance and are stressed, what do you think may happen if they are suddenly thrown into water which is at a different temperature?

Let's check shall we?

After stocking the fish – *What happened when the fish were quickly poured into the warm water in the bowl by group 1?* (They may initially swim about very quickly, perhaps try to jump out of the container, before going into shock and some may die).

Did the fish look stressed by this activity?

What happened when group 2 released their fingerlings into the warm (cool) water in their bowl? (The fish swam out comfortably).

Did the fish look stressed?

What was the difference between the two treatments which caused the different fish reactions? (Group 2's fish were acclimatised to the change in water temperature slowly).

In the hot season if the water temperature at the surface of your pond was hot, but was cooler lower down what could you do to make the water temperature less hot at the surface? (Mix the water with your hand).

How would stressing the fish during transportation and release into the pond affect them later? (Some may die after stocking, feeding will be delayed and growth will be reduced).

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What can you do, using locally available materials, when transporting fish to increase the amount of dissolved oxygen available for the fish?

If the water temperature in the pond and in the transport container are different and you suddenly drop the fish into the pond what will happen?

How should the fish be released to increase survival after stocking?

What are the negative impacts of stressing fish during transportation and release into a pond?

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.9 The importance of correct stocking density

1. Training topic	The importance of correct stocking density [7]
2. Objective(s)	At the end of the session farmers will be able to explain the reasons for following recommended stocking densities and the effects of under- and over-stocking.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: In a shaded area or room Duration: 1.5 hours
5. PAL summary	Participants will first role play being fish fry stocked at different stocking densities in a pond. Thereafter they place fish fry (that have been starved for two days) at varying stocking densities in clear containers with equal amounts of water, and feed them. They will observe and discuss the behaviour of the fish and the water condition in each container and relate it to the stocking density of the fish.
6. Materials needed	- 3 plastic or glass containers (3 – 5 litre capacity) - 3 plastic holding bowls (2 litre capacity) - 6 litres of clean well water - Plastic measuring jug (1 – 2 litre) - 100 small fingerlings (2 – 3 cm) placed in **clean water** in a container with **aeration** and **starved for 2 days** - 1 piece of chalk or 6 pieces of flipchart paper (Used to mark a "pond" on the floor during the role play) - 3 small scoop nets - 5 small pieces of bread (or cake) - 3 nursing mix (duck feed concentrate and rice bran) packed in plastic bags, with each bag containing 2 g
7. Method	**Step 1 – Introduce the training topic** Today we will do a role play as well as some practical activity related to the stocking density of fish fry in a pond or rice field. **Step 2 – Focus farmers' attention and validate their knowledge** Begin the discussion by asking farmers questions such as: *What experience have you had with stocking fish fry at different densities in your fish ponds or rice fields?* *How many fish do you normally stock into your ponds and what size are your ponds?*

[7] Submitted to the PAL competition by Arlene Nietes-Satapornvanit (arlene@ait.ac.th), Asian Institute of Technology, Bangkok, Thailand.

How do you decide how many fish fry to stock in your pond or rice field?

Is it important to consider the number of fry that you stock into your pond or rice field? Why, or why not?

How do you think the stocking density effects your fish production at harvest?

Step 3 – Explain the experiment or observations that the farmers will conduct

Activity 1 – role play

Before beginning this activity use chalk to mark out three "ponds" of the same size (2 metres x 1 metre) on the floor. Alternatively the "ponds" can be marked out using two sheets of flipchart paper or two sheets of newspaper for each "pond".

Divide the farmers into three different sized groups, using a prepared list. For a group of 15 farmers divide them as follows:

Group A: 2 people – this represents under-stocking
Group B: 5 people – this represents a correct stocking density
Group C: 8 people – this represents over stocking

Call the groups one at a time and allocate each group a "pond" area where they should stand as a group. Tell them that each person in the group must imagine, and act, and move around in their "pond", as if they are fish fry.

How does each group feel in their "pond"?

Give five small pieces of bread (or cake) to each group. Tell them to divide the bread (or cake) among their own "pond" members so that each fish fry has a portion to eat.

How much did each person get? Did everyone within the group and between the groups get the same amount to eat? Which group got the most per person to eat and which group the least? Did the fish fry have to fight for some food and was there enough food for every single fry?

Can you see any other differences among the different groups?

Tell the farmers to keep the discussion issues in mind when they move on to the next activity.

Activity 2 – a mini-fish trial

Trial 1 – stocking densities

Now let's try to use the same concepts with real fish fry. What do you think will happen?

Ask two farmers to set up three plastic or glass jars on a table or on the floor where all the farmers can gather around to see. Tell the two farmers to add 2 litres of water to each container and to label the jars A, B and C. Explain that each jar is an example of a pond which is ready to be stocked with fish fry.

Using the same groupings as above assign one jar to each group. Write on the board the number of fish fry that each group has to take (see below) from the fish holding container and to stock into their "pond". Ask the farmers to observe their fry, and to compare them with the fry of the other groups.

Group 1: 5 fry
Group 2: 15 fry
Group 3: 80 fry

Trial 2 – feeding the fry

What do you think will happen if we feed the fry?

Give a plastic bag of feed to each group and ask the farmers to feed the fry the food little by little.

Encourage the farmers to move around and to observe the fry in all three "ponds". After the feeding is finished ask the farmers to observe the "ponds" for five minutes and to discuss and continue processing their observations.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – different stocking densities

What can you see inside the "ponds"? What do you think the fry are experiencing right now?

What do you think will happen to the fish fry in the pond?

Ask the farmers to compare and contrast the three different fry stocking densities. *Which "pond" do you think is the best of the three different fry stocking densities and why?*

Encourage one or two farmers who have had stocking density problems to share their experiences with the entire group.

Trial 2 – feeding the fry

What's happens in each "pond" when the feed is added? Are the fry feeding?

Do the fry in each "pond" have enough feed? Which "pond" finished their feed first?

If we continue feeding the three "ponds" with the same amount of food each day, what would you expect to happen to the fry and to the water in the "pond"?

Are there any other differences between the "ponds" after feeding? (Waste food in the "pond", amount of faeces in the water, oxygen levels, water colour).

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

In your role play and in the "ponds", how did the fish react and behave when stocked at different densities?

Which fish were the most stressed?

What happened, and what was the behaviour of the fish, when feed was added?

What have you learned today from these activities? (Stocking ponds or rice fields with the correct number of fish is important because it provides a suitable environment (enough food for each fish, good quality water, reduced stress), for fish growth. In addition pond inputs will not be wasted).

(Knowing the carrying capacity of a pond or rice field is important, so that farmers know how many fish they should stock. Ponds should not be over-stocked just because a lot of fish fry are available or because fry traders are selling them cheaply. Farmers should decide how many fry to stock before buying from hatcheries or fish fry traders. Basic information on stocking density (which depends on the production system being used) can be obtained from the Department of Fisheries or from extension literature).

How does under-stocking and over-stocking affect fish production? (Under-stocking wastes energy and space and results in a few larger sized fish. Water quality may also deteriorate if the pond or rice field becomes too green because natural food is not fully utilized. For mixed sex tilapia production, it can also lead to recruitment and, over time, over-stocking with fish of different ages and sizes).

	(Over-stocking will lead to lack of food, and poor water quality due to fish wastes and lower oxygen levels. This can lead to increased fish stress, disease and mortality, thereby reducing total yield. Also smaller-sized fish will be harvested. Fish may be stunted, or may not reach market size. Economically the farmers will lose out). *If you feel that your pond or rice field is overstocked, how can you remedy it?* (The fish should be thinned by removing some of the fish. The fish can be held in a hapa in the same pond, transferred to another pond, or sold). *Are there any additional topics you would like to learn about as a result of today's session?* Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.10 Fish seed selection for grow-out culture

1. Training topic	Fish seed selection for grow-out culture
2. Objective(s)	At the end of the session farmers will be able to describe at least four things that can be used to identify good quality fish seed.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: In a shaded area near a farmer's house Duration: 1.5 hours
5. PAL summary	A small number of good quality and weak poorer quality fingerlings will be placed in clean well water in two plastic bowls. The side of the bowls will be tapped with a stick and farmers will observe the reaction of the fingerlings. In two groups farmers will separate out inferior and good quality fingerlings and discuss and describe what physical characteristics they are using as each fish is selected and put into separate bowls, for poor quality, and good quality, fingerlings.
6. Materials needed	- Clean well water - Wooden stick - 4 plastic basins of 10 litre volume - 20 healthy mrigal (5 – 7 cm) - 20 weak mrigal (5 – 7 cm) - 20 healthy grass carp (8 – 12 cm) - 20 weak grass carp (8 – 12 cm) **(Use sizes and species of fish appropriate to your area. Before the session mix the weak and strong fish together and split them equally into two different bowls for each species)** - Electric or battery air pump - 4 soup/rice bowls for catching fish - Pens as prizes, 1 per person - A0 sheet listing characteristics of poor quality fish seed **(pre-prepare this before the session)** - Hand out sheet listing characteristics of poor and good quality fish seed, one for each group member **(pre-prepare this before the session)**
7. Method	**Step 1 – Introduce the training topic** Today we are going to try and develop a simple way to judge the quality of fish seed that you can use when buying fish for stocking. **Step 2 – Focus farmers' attention and validate their knowledge** Begin the discussion by asking farmers questions such as:

How much fish production did you get from your pond or rice field last year?

How many of you stock fingerlings for grow-out?

Where do you buy your fingerlings?

What species do you stock?

Are fingerlings of all species readily available?

Do any of you buy seed from fry traders?

If yes, *Is the quality of seed from nurseries and fry traders the same?* (If fry traders have transported fish long distances, the seed may be more stressed and of poorer quality).

Do you prepare your pond before stocking fingerlings and if yes, how?

How long before stocking do you prepare your pond?

Have you ever seen dead fingerlings after stocking?

If we stock fish of poor quality and a lot of them die after stocking, how does that affect your profit from pond grow-out of fish?

If fingerlings were offered for half the normal price but the quality was poor, would you buy them?

Today we are going to do a trial to help you judge the quality of fingerlings and how strong they are, when you are considering buying.

Step 3 – Explain the experiment or observations that the farmers will conduct

Divide the farmers into two groups. Bring out the two bowls of mixed grass carp and put them down on the floor in two positions where the farmers in each group can gather around their bowl and they can all see. Ask them to just stand and observe the fish very quietly (**no talking**) and not to make sudden movements or touch the bowl or water for two minutes.

After two minutes ask one member of each group to knock on the side of the bowl and ask the farmers to watch how the fish react and to observe if all the fish react in the same way and at the same speed.

Discuss this before moving on.

After hitting the bowl.

What happens when you hit the side of the bowl after a quiet period?

Do the fish all react in the same way and at the same speed?

Which fish react the slowest and which fish react the quickest?

Also ask one farmer to swirl a rice bowl around the bowl of fish three times to make a circular current and have the farmers observe and comment on how the fish react to the water current.

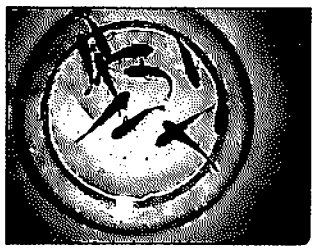
Do the strong and weak fish react in the same way to the circular current? (River fish normally turn to face a water current. The strong fish should turn and face into the current more quickly than the weaker fish, which are carried along by the current).

Now ask both groups to take two more large bowls each and to put the same amount of water in each bowl. Ask a farmer to write on a piece of A4 paper "poor quality fingerlings" and on another sheet "good quality fingerlings". Have the farmer place the A4 sheets next to each bowl.

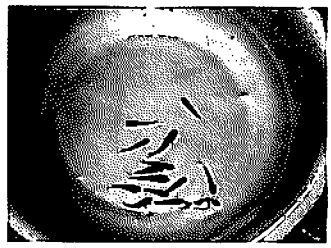
Ask one farmer in each group then to use the soup/rice bowls to select those fish that they think are poor fingerlings. **As each poor quality fish is selected, ask the farmer doing the selection to tell the group members why that particular fish has been identified as weak. Ask the farmers to pass the bowl around the group and get each person to confirm agreement with the criteria for poor quality fish** before transferring the fish into the bowl labelled "poor quality fingerlings". As this is being done, ask another group member to write down the different criteria used to identify the poor quality fish. Tell the two groups that the group with the most criteria approved by the judge (trainer) will receive a prize.

Continue to observe fish in the poor and good quality bowls and compare and contrast how good and poor quality fingerlings look.

Group A should go and 'visit' group B and check their bowls to see if they agree with the selection of poor and good quality seed. The trainer should facilitate the discussion, especially if there is any disagreement. Group B should then 'visit' group A to check their selections.



Strong, good quality fish fry
Photo: SUFA



Weak poor quality fish fry
Photo: SUFA

At the end, have each group read out its list of criteria for identifying poor quality seed and the trainer will judge and award prizes (pens or some other small useful item) to both the winners and losers.

Go through the same process for the mrigal (or another species).

Step 4 – Have the farmers discuss their observations during the experiment

When selecting poor quality fish:

What factors have you used to select poor quality fingerlings? (Some things the farmers may come up with include: Damaged fins, missing scales, dark colour, dull colour with no shine, curved spines, concave stomach, swimming on its side, swimming slowly, reacting slowly to knocking on the bowl, continually swimming near the surface, less endurance, swimming in a tight spiral, easy to catch, diseased fish or fish with parasites, and shape – big head and small thin body).

Do the rest of you agree with these criteria?

Does anyone know of any other factors which we can see by eye that we can use to identify poor quality fingerlings?

If a fry trader arrived at your pond with poor quality fish like those you've graded out today, would you buy them to stock in your pond?

If you did stock the poor quality fish, what kind of survival and production would you expect?

When selecting good quality fish ask:

What factors have you used to select good quality fingerlings? (Fins whole, no missing scales, light shiny colour, straight spines, swimming fast, reacting quickly to knocking on the bowl, quickly turning to swim against water current, jumping out of the bowl, difficult to catch).

Do the rest of you agree with these criteria?

Does anyone know of any other factors which we can see by eye that we can use to identify good quality fingerlings?

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What have we done and learned today?

Can you tell me at least four indicators which can we use to identify poor quality fish seed? (Damaged fins, missing scales, dark colour, dull colour with no shine, curved spines (back bone), concave stomach, swimming on its side, swimming slowly, reacting slowly to knocking on the bowl, continually swimming near the surface, less endurance, swimming in a tight spiral, easy to catch, diseased fish or fish with parasites, and shape – big head and small thin body).

Were the indicators the same for grass carp and mrigal?

When you next buy seed for stocking, what could you do to ensure that you are buying good quality fish seed? (Put the fish into a bowl with water and remove all the poor quality fry, as we did today).

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.11 Effects of different temperature and dissolved oxygen levels on fish cultured in ponds and rice fields

1. Training topic	Effects of different temperature and dissolved oxygen levels on fish cultured in ponds and rice fields. **(In areas where there is not much rice field culture, it may be better to discuss ponds only).**
2. Objective(s)	At the end of the session farmers will be able to explain how temperature and oxygen affect the behaviour of fish cultured in ponds and rice fields.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: In a household Duration: 1 hour
5. PAL summary	Farmers will examine and discuss the effect of different water temperatures and different dissolved oxygen levels on fish behaviour in plastic bottles containing water.
6. Materials needed	- 5 clear plastic containers (1 litre) - 1 thermometer, **(0 – 110° Celsius; NOT A HUMAN THERMOMETER because the range is too narrow)** - Ice, 0.5 kg - Flask of hot water - Well water, 10 litres - 20 fry, 4-6 cm – all one species - 2 marker pens, blue - A0 flipchart paper, 3 sheets - Tape - A4 paper, 10 sheets - Ball point pens - Plastic bowl for holding fish - Plastic bucket for holding well water - 2 small plastic bowls to catch fish from holding bowls - Post-it notes - Drinking glass to measure water into the plastic bottles
7. Method	**Step 1 – Introduce the training topic** Today we will look at two different water quality parameters, temperature and dissolved oxygen, and see how they affect fish behaviour. We will discuss how this behaviour might affect fish survival and growth, in ponds and rice fields. From this you will be able to draw comparisons with your own ponds and rice fields and assess if you are properly managing them for fish culture. **Step 2 – Focus farmers' attention and validate their knowledge** Begin the discussion by asking farmers questions like:

Do any people in this aquaculture group grow fish in rice fields?

What area is your rice field and how many fry or fingerlings did you stock?

What rice fish system do you use? (For example - One rice crop followed by one fish crop; two rice crops followed by one fish crop; rice and fish together).

What area are your ponds and how many fish did you stock?

Have you ever seen dead fish in your pond or rice field? Why do you think the fish died?

Have you ever had any fish die in your pond or rice field in the hot season?

Do fish eat more or less food when the air temperature is very hot?

Do fish eat more or less food when the air temperature is very cold?

If farmers reply that the fish eat less food, ask: *How do you think this affects the growth and survival rate of the fish?*

Have any of you had tilapia die in your pond or rice field in the cold season?

What is the minimum air temperature in the cold season in this province?

What is the maximum air temperature in the hot season in this province?

Have any of you seen fish gasping first thing in the morning at the water surface of your pond or rice field? How do you think water temperature and oxygen levels affect fish survival and growth?

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 1 – Temperature

First pass the thermometer around among the farmers and explain how to use it to measure temperature.

Ask a farmer to pour two glasses of well water into a 1 litre plastic container and measure the temperature. Write the temperature on a piece of paper with a marker pen and put it under the plastic container.

Ask another farmer to add two glasses of water to the two other 1 litre plastic containers. Get the farmer to place these two containers on either side of the container with the paper under it. Ask a farmer to add three fish into all three containers.

Get another farmer to gradually put small lumps of ice into the container on the left. As the ice melts, have the farmer measure the temperature. Add enough ice to **take the water temperature down to 8 – 10˚C**. Ask the farmer to measure the water temperature with the thermometer and write down the temperature on a piece of paper and put it under the second bottle. **(If any fish turn over, immediately get a farmer to remove any remaining ice).**

Ask another farmer to add boiling water **slowly** from a flask into the container on the right until the water temperature **is about 38˚C**. Write the temperature down on a piece of paper and put it under the third bottle.

Get the farmers to observe the fish and comment on and discuss what is happening in each bottle.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – Temperature
How are the fish reacting?

Which fish look the most stressed?

Which fish look the least stressed?

Get the farmers to use their hand to feel the water in the left (cold) and right (hot) containers – *How does the water temperature compare to pond water in the cold and hot season?*

If the fish become shocked and the farmers want to try to revive them, tell them to add warm water to the container with the fish in cold water; and cold water to the container with the fish in the warm water. This will almost miraculously revive the shocked fish **IF DONE QUICKLY.**

If you are stocking fish into your fish pond and there is a big temperature difference between the water in the pond and the water in the transport container, what should you do to prevent fish mortality? (Gradually mix the water from the pond into the transport container).

In the hot season, is water in a pond warmer or cooler than the air temperature?

How does the water temperature differ at the surface and deeper down in a pond in the hot season?

In the cold season, is water in a pond warmer or cooler than the air temperature?

Why do you think farmers dig refuge ditches in rice fields?

What can we do to ensure that the water temperature doesn't get too warm or too cold in our pond or rice field? (Put floating plants inside a bamboo frame to provide shade; dig a refuge ditch in the rice field; and harvest tilapia before the cold season months).

Now I want your assistance to do a simple trial to look at the affect of stocking density on oxygen levels in pond and rice field water.

Step 3 – Explain the experiment or observations that the farmers will conduct

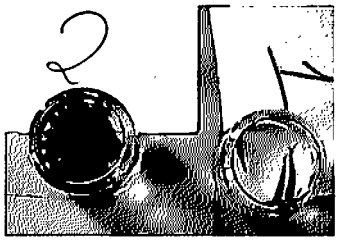
Trial 2 – Dissolved oxygen

Before beginning, explain that you want them to fill two bottles with exactly the same amount of water (2 glasses each) and then they will put three fish into one bottle and 20 fish (similar size and same species) into the other.

Ask *"What do you think will happen?"*

OK let's see. Please fill the two containers with water to the same level. Put three fish into the first container and 20 fish into the second container.

Ask them to observe and comment on how fast the fish are opening and closing their mouths. **Ask the same farmer to count how many times the fish open and close their mouths in 30 seconds in both containers, so that the same counting method is used.**



Testing the effect of high and low fish density on water oxygen levels
Photo: SUFA

Step 4 – Have the farmers discuss their observations during the experiment

Trial 2 – Dissolved oxygen

How many times are the three fish opening their mouths in 30 seconds?

How many times are the 20 fish opening and closing their mouths in 30 seconds?

Why do you think the 20 fish are opening and closing their mouths more often? (They are trying to get more oxygen).

What can we do to reduce the gasping? (Splashing and exchanging water).

After gasping has been seen and discussed.

Ask one farmer to pour out three-quarters of the water and then add more water so that the water level is the same as in the other bottle.

How are the fish now?

Wait a few moments and the fish will begin gasping again.

What else can we do to solve this problem? (Reduce the stocking density by partial harvesting).

Have the farmers pour out three-quarters of the water and remove 17 of the fish. Add more well water so that the water level is the same as in the other bottle.

How are the fish reacting now?

Do they look less stressed?

If the fish in your pond or rice field were gasping at the water surface like this, what could you do? (Splashing, exchange water, add additional fresh water or reduce stocking density by partial harvesting).

What stocking density is recommended for rice field systems?

What stocking density is recommended for fish ponds?

Why do you think lower stocking densities are recommended for rice fields? (So that fish have enough natural feed to eat, and so that there are no dissolved oxygen problems).

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What have you done in today's session?

What have you learned about the effect of high and low temperatures on fish?

What can you do to reduce the effects of very high and low temperatures on fish in your ponds and rice fields? (Dig deeper refuge areas and ditches in rice fields and provide shaded areas in ponds and rice fields to protect the fish from extremes of temperature. Don't stock tilapia in ponds or rice fields over winter).

What have you learned about the effect of fish density on dissolved oxygen levels in ponds and rice-fish fields?

If the fish are gasping in your pond or rice field what would it indicate? (High fish density, low dissolved oxygen and/or possibly pesticide poisoning).

What could you do to solve the problem? (Splashing the water, water exchange, adding fresh water and/or partial harvesting).

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.12 Clearing suspended clay using lime

1. Training topic	Clearing suspended clay using lime
2. Objective(s)	At the end of the session farmers will be able to explain how to clear suspended clay sediment from pond or rice field water using lime.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: In a household Duration: 40 minutes
5. PAL summary	Farmers will use lime to clear sediment from a water sample.
6. Materials needed	- Water sample with fine suspended clay, 2 litres - 2 clear plastic bottles (1 litre) - Quicklime powder, 1 teaspoon - 2 marker pens, blue - A4 paper, 10 sheets - Drinking glass to measure water into the plastic bottles - Handout leaflet on "Routine liming of ponds for disease prevention"
7. Method	**Step 1 – Introduce the training topic** Today we will conduct a simple trial to see how effective lime is at clearing sediment from pond or rice field water.
	Step 2 – Focus farmers' attention and validate their knowledge Begin the discussion by asking farmers questions such as: *Do any people in this aquaculture group grow fish in ponds or rice fields?* *What rice fish system do you use?* (For example - One rice crop followed by one fish crop; two rice crops followed by one fish crop; rice and fish together, etc.) *What water quality parameters do you think are important for good fish survival and growth?* *Do you add lime to your ponds or rice fields?* If they do, ask them, *Why do you add lime to your ponds or rice fields?* *After rain storms what happens to the colour of the water in your rice fields with fish, and your ponds?*

What happens if plants do not get sunlight? (Relate the trial to plants needing sunlight to grow, and phytoplankton also needing sunlight to grow).

If pond or rice field water contains large amounts of suspended solids or sediment, how will it affect fish health and growth? (Less sunlight will penetrate the pond and phytoplankton growth will be reduced. Sediment can cause eye and gill irritation, respiratory problems, etc., leading to fish stress, poor feeding and poor growth).

Today we will test if lime can be used to clear sediment from rice field or pond water after rainfall.

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 1 – sediment clearing with lime

Get a farmer to pour four glasses of muddy water into two plastic bottles.

Ask the farmer to use a marker pen to write the word "lime" on a piece of A4 paper and to put the paper under one plastic bottle. To the bottle on the "lime" paper have the farmer add one spoon of powdered lime and use a spoon to stir the water and lime exactly 10 times. **(After adding lime try not to move or shake either container, so as not to disturb the sediment).**

Ask the farmer to write the word "control" on another sheet of paper and put the sheet under the other bottle. Get another farmer to stir the "control" bottle exactly 10 times with the spoon like the first bottle, but **DO NOT ADD ANY LIME.**

Leave the bottles and check to see what is happening or has happened after five and 15 minutes..

Discuss with the farmers what has happened to the mud sediment in the two bottles.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – sediment clearing with lime
Has anything happened to the muddy water without lime?

What's happened to the muddy water to which we added the lime? (The sediment should have settled out to the bottom leaving the water clear).

A glass (left glass) containing pond water clouded by clay sediment; a few moments after adding lime the clay begins to flocculate (centre glass); the lime has sedimented out the clay to the bottom of the glass (right glass) Photo: DSAP

Tell the farmers that:
For this demonstration we have applied a large dose of lime powder directly to the water to demonstrate, in the time available for this training session, that lime can settle out fine sediment.

Normally we mix lime powder with water before applying it to a pond. The recommended liming rate is 1 kg of quick lime per 100 m^2 of pond area for routine liming every two weeks. It would normally take 24-48 hours for the sediment to settle out. This dose of lime would not increase the pH significantly and would not harm the fish. I will give you all a leaflet at the end of the session giving the correct doses of routine liming for the prevention of fish disease.

If we use lime to clear muddy ponds or rice fields will phytoplankton growth be more, or less? Why?

What other reasons are there for liming your ponds or rice fields regularly? (To maintain pH and reduce disease pathogens).

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

If the water in your rice field or your pond becomes very muddy, will phytoplankton growth increase or decrease?

What can you do to improve the water quality in your pond or rice field if the water becomes muddy after rain?

What other advantages are there of regularly liming your rice field or fish pond? (It helps to stabilise pH levels, reduces pathogens and prevents disease).

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.13 Selection of different plant materials as feed inputs for plant-eating fish in grow-out ponds

1. Training topic	Selection of different plant materials as feed inputs for plant-eating fish in grow-out ponds
2. Objective(s)	At the end of the session farmers will be able to describe a simple method that can be used to test which locally available plant materials are suitable as a fresh feed for fish in their grow-out pond.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: A farmer's grow-out pond with plant eating (herbivorous) fish species. **(Tell the pond owner not to feed his/her grass carp and not to fertilise the pond for two days before this PAL session)** Duration: 1.25 hours. (One session of 30 minutes and a second session one day later of 45 minutes).
5. PAL summary	This PAL provides farmers with a tool or method they can use to test if newly found plant species are suitable feeds for plant-eating fish. The PAL session is conducted in two parts. On the morning of the first day farmers collect a variety of locally available plant materials or vegetable leaves from nearby areas, which may be suitable as fresh feeds for herbivorous fish in grow-out fish ponds. Bundles of the different types of plant materials are tied by string at intervals (every metre or so) along a length of rope. The rope is tied across the pond with the bundles of plant material suspended in the water. The owner of the pond is asked to watch the rope in the afternoon to see if there is any activity. On the second day the farmers return in the morning and observe if there has been any activity along the rope. They then retrieve the rope from the pond, observe the bundles of different plant materials and discuss the suitability of the different plants as a food source for plant-eating fish.
6. Materials needed	- Rope (20 metres long) - Ball of twine or string - Sharp knife - 4 wooden or bamboo stakes with points on one end - Bundles of 5 or 6 different plant materials and vegetable leaves which are locally available **(Ask farmers to collect them and bring them on the way to the session – encourage farmers to bring some plants that they have never tried before and also both red and white cassava leaves)**

7. Method

Step 1 – Introduce the training topic

Today we are going to set up a simple trial which you can use later in your own ponds to test whether a variety of different locally available plant materials, including some new plants, are suitable as food for plant eating fish.

Step 2 – Focus farmers' attention and validate their knowledge

Begin the discussion by asking farmers questions such as:

How many of the group culture grass carp in grow-out ponds?

What do you feed the grass carp?

Do any of you have any other plant-eating fish in your ponds? (e.g. giant gourami, silver barb, tilapia).

If yes, *What species? What do you feed these fish?*

Other than the plants you now use, have you ever tried feeding any others?

If yes, *What types?*

Today you will set up a "feed rope" to test if other plant species, which you can collect locally for free, are any good as a feed for plant-eating fish species.

Step 3 – Explain the experiment or observations that the farmers will conduct

Split the farmers into two groups and ask each group to nominate a group leader. Give each group a 10 metre length of rope, two bamboo or wooden stakes, some string and a knife. Ask each group of farmers to tie separate bundles of each type of vegetable leaves or plant materials they have brought, tightly around the bottom with string. The bundles should then be tied at one metre intervals with another piece of string along the rope. **Ask the group leader to draw a diagram and to record what type of plant species is in what position on the rope. This is in case any plant materials are completely eaten or pulled off the feed rope.**

Have each group of farmers suspend their "feed rope" with the plant bundles on it across the pond at different places, if the pond is less than 10 metres wide. Fix the "feed rope" into position by tying the ends to a wooden or bamboo stake pushed into the ground on each side. If the pond is wider than 10 metres, have each group suspend their "feed rope" across opposite corners of the pond.

Farmers setting a feed rope across the corner of a pond to test which plants herbivorous fish prefer to eat
Photo: DSAP

Once the ropes are staked in position with the bundles suspended in the water, the farmers should observe them for a few minutes to see if there is any activity. (This normally takes some time).

Which feed types do group 1 think will be eaten the most and the least from your rope?

Which feed types do group 2 think will be eaten the most and the least on your rope?

The owner of the pond and the group leaders should be asked to observe the "feed rope" in the afternoon to see if there is any activity. The trainer should ask the farmers what time they would like to return again the following morning. The second session will only take about 45 minutes.

On the second day when the farmers meet again, ask the pond owner and the group leaders to tell the others if they saw any activity after the others left the previous day. Ask the farmers to retrieve the "feed ropes", and to observe and discuss what, if anything, has happened to the different bundles of plant or vegetable leaves. The leader of each group will give a brief presentation on what happened to their feed rope.

Step 4 – Have the farmers discuss their observations during the experiment

Ask the owner of the house, *Did you see any activity at all on the "feed rope" yesterday after the groups went home?*

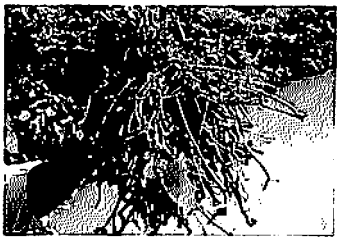
If yes, *What do you think was happening?*

Ask the entire group, *How can we check if he/she is right?*

Ask both groups to collect their "feed ropes" and to stretch them out on the floor somewhere in the shade out of the sun.

If you move back to a shaded area or a member's house to discuss the results, ask the farmers to take some plant samples with them.

What has happened to the bundles of plants or vegetable leaves since yesterday? (Some should have been eaten by plant-eating fish, especially red cassava, water spinach, banana leaves, green cassava and grass).



Sweet (red) cassava proves a popular feed item with grass carp when tested on a feed rope
Photo: SUFA

Are there any plant types that have not been eaten at all?

If yes, *Do you think that plant is suitable as a feed for plant eating fish?* (Maybe not).

When you've first stocked a pond, do the fish begin feeding straight away?

What can you do to train fish to eat? (Feed at the same time, place, with the same food type, and make the same noise when feeding each time).

Which plant types have been eaten the most? (The trainer should write up a league table on the board or on a flipchart of the different plants with the most eaten plant at the top and the least eaten at the bottom).

Which kind of cassava has been eaten the most? (Probably the red).

Why do you think this is? (The green cassava is bitter and the red is sweet).

Can these plant types be collected locally fairly easily?

When you feed plant materials to a grass carp what happens to the food? (It passes through the guts of the fish and comes out the other end as faeces).

How do the wastes from plant eating species affect the water quality in the pond? (If needed relate this question to the fertilizer PAL session. The wastes of plant eating fish species act as fertilizer which increases natural feeds. Feeding plants to herbivores therefore indirectly increases the production of other non herbivorous fish species).

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What have you learned from this simple trial?

If you wanted to find out if some new plants were suitable fish feeds for plant-eating fish in grow-out ponds, how would you do it?

What could you do to reduce the time spent collecting leaves for grass carp? (Grow plants near the pond to feed to the fish).

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

8.14 Identification of harvest time and fish harvest size

1. Training topic	Identification of harvest time and fish harvest size[8]
2. Objective(s)	At the end of the session farmers will be able to list and discuss at least five factors which should be considered when deciding when to harvest and sell their fish in order to achieve higher financial benefits.
3. Trainees	Aquaculture group members who are grow-out farmers
4. Date, venue and duration	Date: Venue: In a farmer's house or a meeting hall Duration: 1.5 hours
5. PAL summary	On a large sheet of flipchart paper marked with the 12 months of the year farmers will place pictures of different fish sizes commonly seen in the market at that time of year. Farmers will then put paper money on each month of the year representing fluctuating fish prices. The chart will be used to facilitate a discussion by farmers on the best time and size to harvest their fish and therefore when to stock.
6. Materials needed	- A0 paper, 6 sheets **(Prepare 3 of the sheets with 3 columns labeled "months","fish price per kg"and "fish size in kg" and 13 rows)** - 60 pictures of stylised or cartoon fish all the same size - Paper Vietnamese money **(VND 8 000, 9 000, 10 000, 11 000, 12 000, 13 000, 14 000, 15 000 notes – 24 of each)** - Calculator - Sellotape, paper tape or blue tack **(Put sellotape on the chart so that 12 fish pictures and 12 bank notes can be stuck on for the months of the year)** - 4 marker pens, blue - Pre-prepared table outlines, 4 on A0 flipchart paper **(see example at the end of the session sheet)**
7. Method	**Step 1 – Introduce the training topic** Today we're going to use a game to stimulate discussion about what should be considered when you are trying to decide when is the best time of year to harvest fish and at what size fish should be harvested to get higher financial benefit for group members. **Step 2 – Focus farmers' attention and validate their knowledge** Begin the discussion by asking farmers questions such as:

[8] This PAL session should be adapted to the specific conditions of each country/region

How do you normally harvest your fish?

How many months after stocking fingerlings do you normally harvest fish?

Is it the same for all species?

Which fish species do you normally harvest first?

What production did you get from your pond last year?

What is the major species which you sell? (Whatever species the group gives then use that species for the discussion game that follows).

What month do you normally harvest?

What things do you consider when trying to decide the best time to harvest?

What things do you consider when trying to decide the best size of fish to harvest?

Today we will do a simple activity to help you decide what factors to consider when deciding when, and at what size, to harvest your fish.

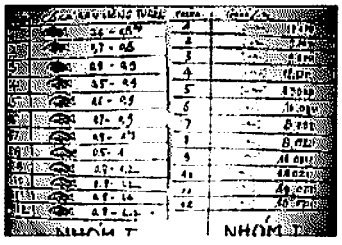
Step 3 – Explain the experiment or observations that the farmers will conduct

Before beginning this activity, ask the whole group which calendar (sun or moon) they would prefer for this exercise and then once agreed have all three groups agree to use it on their flipchart.

Divide the farmers into two or three groups (if there are enough women make a women's group). Give each group 20 fish pictures, eight of each denomination bank note, and one blue marker pen.

Tell them that you want each group to lay their flipchart somewhere flat and to all gather around. The group should first fill in the months (sun or moon calendar as agreed). Then each group should decide what is the average approximate price per kilogram of grass carp **(or what ever the group has decided is their most important species for selling)** in January. If they decide the average price is VND 8000/kg, they should stick a VND 8000 on the chart for January. **(The trainer should demonstrate on the board with the sample flipchart while giving the farmers these instructions, so that everyone understands clearly).** Each group should discuss and agree each monthly price and allocate prices for each month from January to December.

Then each group will discuss what size of grass carp are most commonly found in the market in January. If they think that 1 kg grass carp is the most common size grass carp in January, they should write 1 kg on a fish picture and then put the fish picture on January. Each group should discuss and agree on the monthly size of grass carp and stick fish, with weights written on them, for each month from January to December.



Farmers estimate fish size and market price when deciding when to harvest fish
Photo: SUFA

Tell each group to elect one group member who will be asked to present their price and size chart to the other two groups for discussion and comment, when all the groups have finished.

Step 4 – Have the farmers discuss their observations during the experiment

The charts produced by this exercise will almost certainly be different. The trainer should ask questions that help farmers to highlight the main seasonal trends and similarities.

Do the charts of the three groups show similar trends? If not, discuss the differences.

In which month are the largest fish available in the market?

In which month are the smallest fish found in the market?

What factors influence the size of fish in the market? (Time in the production cycle, culture techniques, level of farmer investment, environmental parameters such as rainfall and temperature, when the fish were stocked, etc.).

In which month are fish prices the highest? Why?

In which month are fish prices the lowest? Why?

What factors influence the rise and fall in the price of fish? (Weather e.g. monsoon rains and the dry season, quantity of sea fish landed, quantity of wild freshwater fish caught, market demand, Tet holiday, etc.).

Which month is best time to sell fish? Why? (Availability of fingerlings for restocking needs to be considered).

If you want to sell fish in that month when would you have to stock?

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

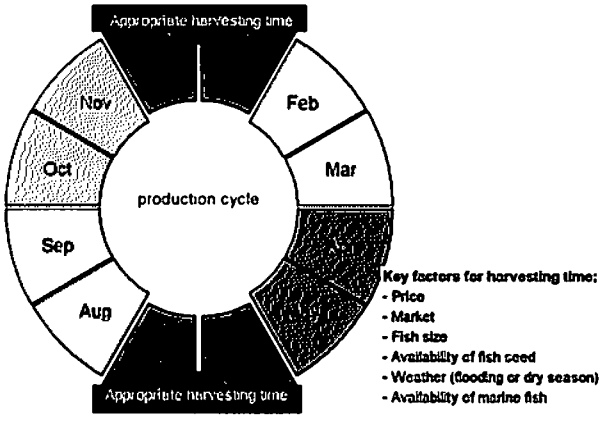
What factors most influence the price of fish in the market?

Is there a relationship between fish size and fish price per kilogram? (Small fish are lower priced).

What is the best size of fish and time of year to be selling fish in the market, and why?

What factors should you consider when deciding when to sell your fish and at what size? (Fish size, fish price, season, availability of water to fill ponds, availability of fingerlings for restocking, the amount of marine fish in the market, the amount of wild freshwater fish in the market, the amount of grass carp in the market etc., upcoming holidays and festivals).

If you could stock fingerlings at any time of the year, when would be the best time, and why? **Use the production calendar or 'clock' below for discussion in step 5, if the trainer thinks it will help.**



Today we have talked about the things which you should consider when you are deciding when to harvest your fish and at what size you should harvest, to try and increase your financial benefits. SUFA is **NOT** saying that you should only harvest in December/January and June/July, we are only suggesting the things that you should consider when trying to decide. **The final decision is always up to the individual farmer.**

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

Sample flipchart outline

Average price of fish in the market (VND per kg)	Lunar or calendar month	Average size of fish in the market (kg)
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	

9. A selection of rice-field fish culture PAL session plans

9.1 The dangers of pesticides to humans

1. Training topic	The dangers of pesticides to humans [9]
2. Objective(s)	At the end of the session, farmers will be able to state the symptoms of pesticide poisoning and which parts of the human body come into greatest contact with pesticides when spraying rice fields.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: At the edge of a rice field Duration: 1 hour
5. PAL summary	Farmers are given the opportunity to 'see' how much pesticide they come into contact with when they spray their fields. Group members wrap one volunteer farmer in white paper. Then, using a normal sprayer filled with water and red dye, the volunteer farmer sprays a nearby field for three minutes. The farmers then observe and discuss which parts of the body come into contact with the greatest quantities of sprayed chemicals.
6. Materials needed	- Red dye - White paper - String - Knife - Pesticide/herbicide sprayer
7. Method	**Step 1 – Introduce the training topic** Today we are going to do a trial to see which part of the body comes into contact with the greatest amount of chemical when you spray your fields with pesticides. **Step 2 – Focus farmers' attention and validate their knowledge** Begin the discussion by asking farmers questions such as: *How many of you have become sick after spraying or applying pesticides to your fields?* *What kind of symptoms have you had?* (Common symptoms include headaches, dizziness and an upset stomach).

[9] This PAL session was developed by staff of CARE Bangladesh.

When you are spraying your fields with pesticides where do you think are the main points that the chemical enters your body to make you sick (or even possibly kill you)? (Nose and mouth).

Besides your mouth and nose, where else do the chemicals enter your body to make you sick? (The skin absorbs significant amounts of pesticides).

Step 3 – Explain the experiment or observations that the farmers will conduct

Ask for one volunteer from the group. Tell the other group members to wrap white paper around his/her legs, arms, body and head (leave eye holes so that he/she can see). Use string to tie the paper in place.

Ask the volunteer to take the sprayer containing water and red dye to a nearby rice field and to spray the field as they would normally do with pesticide.

Which parts of the body do you think will get most of the pesticide?

After only three minutes tell the volunteer to come out of the field and ask the other group members to inspect him/her to see which parts of the body have come into greatest contact with the sprayed chemical.

Step 4 – Have the farmers discuss their observations during the experiment

Did he/she get any pesticide on him/herself? (The white paper will be covered in dye red where the chemical would normally come into contact with the body).

Which part of the body received the greatest amount of chemical? (Groin area and chest. Pesticides also enter the body through the skin of the chest, arms, wrists, armpits, back, face and eyes).

How long was he/she spraying?

How long would it take you to spray a 1 hectare field?

How much pesticide do you think would be on your body if you sprayed a field for an hour?

If large quantities of pesticide lands on your groin area is it dangerous? How do you think it may affect your body? (Some pesticides can make men sterile, and/or impotent, if they penetrate the skin of the groin and testes area. In extreme cases it can result in birth defects).

How can you reduce the amount of pesticide that lands on yourself when you spray? (Wear a mouth mask, gloves and a raincoat).

Correct protective clothing to be worn when spraying rice fields with pesticides or herbicides
Photo: DSAP

When you spray pesticides on your field what effect does it have on beneficial insects? On you? (The pesticide kills off the beneficial insects which prey on pest insects. Pesticides kill fish in the rice fields. Pesticides can also make humans sick, sterile, impotent and can cause birth defects and even death).

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

If you have to spray your field with pesticides, which parts of the body come into greatest contact with the sprayed chemical? (Groin, chest, arms and legs).

What are the main symptoms of pesticide poisoning? (Headaches, dizziness, nausea, sterility, impotence, birth defects and death).

What can you do to minimize the effects of pesticides on human health? (Wear appropriate protective clothing).

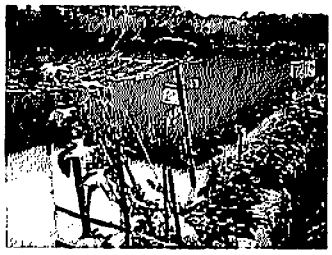
Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

9.2 Rice field design for fish culture

1. Training topic	Rice field design for fish culture **(This PAL session can be modified and used for any type of rice field fish culture system and to examine a variety of features such as refuge trench configuration, and water inlet and outlet system design under specific local conditions).**
2. Objective(s)	At the end of the session farmers will be able to describe the benefits of different outflow and spillway systems for rice fields stocked with fish.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: At a shaded location near a group member's house Duration: 1.5 hours
5. PAL summary	Farmers will make two model rice fields using clay, fill them with water and will stock them with small fish. They will observe what happens to the water level and the fish if light rain falls on the models if the field has 1) no outlet pipe or spillway and 2) an overflow pipe but no spillway. They will also observe what happens to the water level and the fish if heavy rain falls on a field with 3) an outlet pipe and no spillway and 4) an outlet pipe and a screened spillway.
6. Materials needed	- Clay (enough to make 2 model rice fields 50 x 50 cm) (Prepare 2 buckets of clay mixed with water) - 10 cm long piece of bamboo pipe (1 cm diameter), 2 pieces - 20 fry (common carp or other species), 2-3 cm - 2 plastic/metal buckets - Watering cans - 50 litres of well water - Banana leaf - 2 sharp knives - Scissors (to cut netting) - Nylon netting - String to tie the netting on the end of the pipe - 10 small bamboo sticks - Ruler **(To keep the scale appropriate, small pipe diameters 0.5 - 1.0 cm should be used and small fish should also be stocked, otherwise the proportions will be incorrect)**
7. Method	**Step 1 – Introduce the training topic** In today's training session we are going to talk about rice field design for culturing fish. Inappropriate rice field design can result in fish loss and financial

disaster due to rain storms. Today we will use clay to make two model rice fields and you will test how different outlets and spillways perform during light and heavy rain storms.



A real rice-fish system integrated with vegetable growing on the rice field embankments
Photo: DSAP

Using clay to model different rice field designs for rice-fish culture systems
Photo: SUFA

Step 2 – Focus farmers' attention and validate their knowledge

Begin the discussion by asking farmers questions such as:

How many people in this group have done rice fish culture before?

Who's been doing rice fish the longest?

What are the advantages of doing fish in rice fields? (Extra income, the dikes can be used to grow vegetables, the water can be used to irrigate vegetable crops, the water reduces mice, rat and chicken damage to the rice, no pesticides are used, etc.).

Have any of you ever lost fish during heavy rain through overspill or when field dikes broke?

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 1 – light rain storm and no overflow pipe
Divide the farmers into two groups and ask each group to take a bucket of prepared clay soil, a watering can, a knife and half a banana leaf each. Tell each group to select a leader to take notes and report back to the other group later in the session.

Tell each group to use the clay soil to create a 50 x 50 cm model of a rice field without an overflow pipe or a spillway on an area of ground or concrete, with a very slight slope. **The models should be far enough apart so that**

members of the group can all gather around their model, but can also see the other group's model. Have the farmers choose a site for the models with a slight slope. Using an earthen area allows farmers to dig down (refuge trenches) as well as building up the dikes.

Farmers can put a refuge canal in the model if they want to, for realism; though it is not necessary for the purpose of this training session. Ask each group to put the banana leaf on the bottom of the rice field and to pour in well water to fill the field to within 1 cm of the top. Each group should then remove the banana leaf and stock 10 small fry into their field.

Where do the buffalo enter the field to work?

Tell both groups to fill their watering can with well water and ask them to pour water steadily into the rice field to simulate a light rain storm. Everyone should closely observe what happens to the water level and the fish. Ask the team leader to record the results.

Collect any fish which escape quickly, because they will be reused in trials 2, 3 and 4.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 1 – light rain storm and no overflow pipe
What's happening to the water level in the rice field? (With only light rain, the field with no overflow pipe will flood and some fish may be lost).

What did the fish do when the water level rose?

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 2 – light rain storm and an overflow pipe
Ask the groups to modify their models by putting in an overflow pipe with netting on at the pond side end of the pipe. Tell the farmers to fill the watering cans and to pour the water steadily into the model to simulate a light storm. Ask the farmers again to observe what happens to the water level and the fish.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 2 – light rain storm and an overflow pipe
What happens to the water level when the model has an overflow pipe and there is a light rainstorm? (In light rain, an overflow pipe should be sufficient to stop the field from flooding and the fish from escaping).

What would happen to the fish if there was no net screen at the pond side end of the overflow pipe? (Fish would escape through the pipe).

What do you think would happen if the net screen on the pipe became blocked up with leaves? (The field would flood).

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 3 – heavy rain storm and an overflow pipe

Ask the farmers to fill both the bucket and the watering can and to pour it into the model rice field quickly to simulate a heavy rain storm. Everyone should closely observe what happens to the water level and the fish. Ask the group leader to record what happens.

A clay rice-fish field model with a refuge trench along one side
Photo: DSAP

Testing different outflow designs under different rainfall intensities
Photo: SUFA

Step 4 – Have the farmers discuss their observations during the experiment

Trial 3 – heavy rain storm and an overflow pipe

What happened to the water level in the rice field during the heavy storm? (The overflow pipe could not deal with the large quantity of floodwater and the water level rose and flooded the field dikes).

How did the fish react to the rising and falling water levels?

How could you modify the field so that it did not flood even in heavy rain? (Put in a screened spillway).

Step 3 – Explain the experiment or observations that the farmers will conduct

Trial 4 – heavy rain storm, overflow pipe and screened spillway
Ask the groups to modify their models by putting in a screened spillway as well as an overflow pipe with netting on it. Ask the farmers to fill both the bucket and the watering can and to pour it into the model rice field quickly to simulate a heavy rain storm. Tell the farmers to observe what happens to the water level and the fish.

Step 4 – Have the farmers discuss their observations during the experiment

Trial 4 – heavy rain storm, overflow pipe and screened spillway
What happened to the water level in the rice field during the heavy storm? (The overflow pipe and the screened spillway dealt with the amount of floodwater and the field was not flooded).

What do you think would have happened in the same storm if the spillways had no screens? (The fish would escape).

What do you think would happen if the spillway screen became clogged with leaves? (The water level would rise, the field would flood and the fish would escape).

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What have you learned today? (Different outflow and spillway systems can be used to reduce flooding and fish loss from rice fish fields).

How have you learned this? (Get the farmers to describe the simple trial they've done with the models).

If you had a rice field which didn't get heavy flooding what type of outlet system could you use? (The overflow pipe system with a net at the front to prevent the fish from escaping).

What kind of modification could you make to reduce the risk of losing your fish from rice fields which sometimes flood in heavy rain? (Add a screened spillway as well as an overflow pipe as the former can deal with larger amounts of rainwater).

What should determine the level of investment a farmer makes in installing overflow pipes and spillways? (How flood prone their field is).

	Besides installing the correct outlet system and net screens, what else should you do regularly to prevent fish loss? (Clean and unblock net screens of any leaves and check rice field dikes for holes). *Are there any additional topics you would like to learn about as a result of today's session?* Thanks for your cooperation. I'll see you after two weeks for the next training session.

9.3 Factors to consider when deciding what size of common carp fingerlings to stock in third-crop rice fields

1. Training topic	Factors to consider when deciding what size of common carp fingerlings to stock in third-crop rice fields[10]
2. Objective(s)	At the end of the session farmers will be able to list at least five factors to consider when deciding what size fingerlings will give the greatest profit when stocked in third-crop rice fields.
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: In a group member's house or on the floor in a shaded area Duration: 1 hour
5. PAL summary	Farmers will be given the opportunity to calculate the profitability of stocking different sized common carp fingerlings in third-crop rice fields. While observing real common carp fingerlings of various sizes in plastic bottles (or pictures of appropriate sizes), local prices will be agreed upon for the various sizes of fish seed, and of harvested fingerlings and fish. Mortality rates and survival will be estimated. From this, the farmers will calculate expected profit.
6. Materials needed	- Flipchart paper A0, 4 sheets **(Pre-prepare four sheets with four columns as shown in the example at the end of this session plan)** - Marker pens, 3 red and 3 blue - Common carp fingerlings 100 g, 50 g and 33 g, 5 of each - 3 plastic containers, with well water (If fingerlings of the correct size are not available, then use common carp fingerling pictures of the correct size) - Pictures of different fish sizes (rear side is coloured red or has a big cross (X) on the back) 100 g fish, 30 pictures 50 g fish, 30 pictures 33 g fish, 30 pictures - Pictures/photocopies of a range of fish sizes from 200 – 900 g (200, 300, 400, 500, 600, 700, 800, 900 g, 1 of each size) - 3 calculators

[10] In Vietnam, third-crop fish in rice fields describes fish culture in fallow rice fields between rice crops. The culture system and fingerling sizes used in this PAL may be inappropriate for some regions. However the methodology used in this PAL can be applied by either using a culture system, fish species and seed stocking size that is appropriate to your particular area or by asking farmers to follow an imaginary scenario.

7. Method

Step 1 – Introduce the training topic

After all the farmers have gathered, explain that today they will discuss and decide what factors to consider when deciding what size of common carp fingerlings to stock in their third-crop rice fields, and which fingerling size will give them the best financial return based on local prices.

Step 2 – Focus farmers' attention and validate their knowledge

Begin the discussion by asking farmers questions such as:

How many people in this aquaculture group have previously practiced fish culture as the third-crop in their rice field?

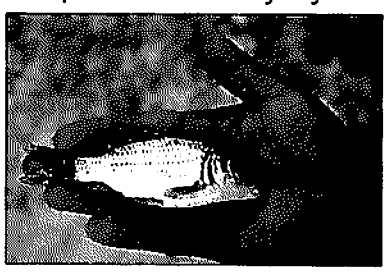
How many people in this group are thinking of practicing fish culture as the third-crop in their rice field this coming season?

What are the benefits of growing fish in a rice field as a third-crop? (Source of income from fallow land, reduces weeding costs, etc.).

What fish species is the main species usually stocked in third-crop rice field in this area? (Common carp). **If there is no third-crop rice-fish in your area another fish species and/or production system can be substituted that is appropriate to the particular area.**

Show them the 3 bowls of different sized fingerlings or the pictures of different sized fingerlings.

What species of fish are these fingerlings?



A common carp fingerling used during the fingerling stocking size PAL session

Photo: DSAP

How many fish would you stock in a 500 m² rice-fish field? [11]

[11] SUFA recommends stocking 22 – 30 fish per 500 m² of third-crop rice field. In Vietnam, 500 m² is a land area called a 'sao'. In northern areas of Vietnam however, like Bac Kan province, a 'sao' is 360 m², so it is better to use an area such as 500 m² for ease of calculation for this PAL session.

What sizes of common carp fingerlings did you stock in last year's third rice field crop? (10, 20 and 30 fish per kilogram, i.e., fish of 100, 50 and 33 g respectively).

There are three different sizes of common carp fingerling in the bowls. *Which size do you think would be the cheapest to stock in your rice field?*

Which size do you think would give you the highest profit if you stocked them in your field?

Does everyone agree with that answer or do some of you have a different opinions?

When different sizes of fingerlings are available for stocking, what factors do you take into account when deciding what size is best to stock? (Price of different size fingerlings, stocking density, survival or mortality of different sized fingerlings, the harvest size the different size of fingerlings stocked will reach and the price of different sizes of harvested fish).

Get farmers to shout out the factors to be considered and the trainer writes them on the flipchart paper – this is called brainstorming.

Today we'll consider all of the above suggestions and try to calculate which stocking size of fingerling common carp in third-crop rice fields will give the greatest profit.

Before beginning, divide the farmers into three groups and allocate each group a different fingerling size. Then tell each group to imagine they have a 500 m^2 rice field and they must discuss and agree:

1) How many of each of the three different sizes of fingerlings should be stocked in the 500 m^2 rice field.

2) The price of the different sizes of stocked fish, and

3) How many months the different sized fingerlings would be cultured.

The trainer should write the agreed stocking densities, the prices of different sizes of stocked fish and the culture period of the different sized fish on the board.

Step 3 – Explain the experiment or observations that the farmers will conduct

Explain that each group will calculate the cost of stocking a 500 m^2 third-crop rice field with their size of fish, i.e., group 1, 100 g fish (10 fish per kg); group 2, 50 g fish (20 fish per kg); and group 3, 33 g fish (30 fish per kg). They will then decide :

how many of the stocked fish survive, decide what size the fish will reach after the agreed culture period, and the sale price. Finally they will calculate the net profit made from their 500 m² rice field.

Give each group a bowl of common carp fingerlings of their size. **Use the correct size pictures of common carp fingerlings if there are no fingerlings available for the session.** Ask the three groups to go to different areas of the room or to three different shaded areas outside with their bowl of fish, their flipchart and a marker pen.

Have the three groups gather around their flipchart near their bowl of fingerlings. Put the flipchart either on a table or on the floor so that all the group members can gather around and participate.

The information for each group will be written-up on a piece of flipchart paper and the leader of each group will present their findings at the end to the other groups for comments. **Each group should only fill in one column on the flipchart for their size of fish.**

Step 4 – Have the farmers discuss their observations during the experiment

What is the approximate local price of this size of fingerling? **This was agreed earlier.** Have the group leader write it on the chart. **Each group should only fill in one column for their fish size.**

How many of this size of fingerling did we agree you should stock in your 500 m² rice field? **This number was also agreed earlier. Write the number on the chart.**

How much would it cost to stock a 500 m² rice field with this size of fingerlings?[12]

What else will affect the amount of profit that you will make from third-crop fish in your rice field? (Mortality/survival).

Ask the farmers to imagine that the flipchart is a 500 m² rice field and get them to 'stock' the rice field with the number previously agreed of pictures of their size common carp fingerlings putting them in three rows.

How many of this size of fingerling will die before harvest?

Ask the farmers to turn upside down the number of fish that they think would die. **Be sure that the bottoms of the fish cards have a cross on or are coloured red so that the live and dead fish can be easily distinguished.**

[12] Common carp prices of 33, 50 and 100 g fish are about VND 800, 1 000 and 1 600 respectively and 1 US$ = VND 15 780.

What causes some fingerlings to die? (Birds, snakes, frogs, natural death, extremes of temperature, etc.).

If you stock this size of common carp fingerlings in your third-crop rice field how big will they be at harvest after three months? Hold up pictures of different sized fish (200 – 900g) and have the farmers agree the approximate weight the fish will reach after three months.[13]

What price would this size common carp sell for at harvest?[14]

How much income would you get from a 500 m² rice field if you stocked this size of common carp fingerling?

Review with the farmers what they now know: the price of their size of common carp fingerling, stocking density and how much it would cost to stock a 500 m² rice field; how many fish would die before harvesting after three months; what size the common carp fingerlings stocked would be at harvest; and the sale price of different sized common carp at harvest time.

The farmers now have all the information they need to calculate financial return. Get the farmers to make the calculations on their flipchart. **The trainer can lead them through the process, but let them make the calculations, themselves.**

How would you calculate the net profit made? (Total income minus total cost of fingerlings stocked).

What is the net profit from a 500 m² third crop rice field if we stocked this size of fingerling?

When each group has calculated its net profit, put the three flipchart papers on the wall and ask each group leader to give a short presentation of their findings. Check if there are any disagreements and amend as needed with group agreement.

Then discuss the findings of the three groups.

Which fingerling size is the cheapest to stock?

Which fingerling size has the best survival?

Overall which stocking size gives the most profit?

[13] In Nghe An province of Vietnam, 33, 50 and 100 g common carp typically reach 250, 350 and 700 g in 3 months.

[14] In Nghe An of Vietnam common carp of 250, 350 and 700 g sell for about VND 10 000, 10 000 and 12 000 respectively.

How does the profit compare to the profit made from alternative crops such as maize or cassava?

What factors have you considered when calculating which size of fingerling is the most profitable to stock? (Price of different size fingerlings, stocking density, survival or mortality of different sized fingerlings, the harvest size the different size of fingerlings stocked will reach, and the price of different sizes of harvested fish).

Put up a fourth pre-prepared flipchart and ask *What happens if all farmers suddenly started only to stock 10 fish per kilogram fingerling common carp and the suppliers doubled the price of this fingerling size?*

Ask a different farmer to fill each line of the chart and get the others to shout out the answers to assist him or her.

How has the change in fingerling price affected the profit?

Which fingerling stocking size in now the most profitable?

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

When trying to decide what size of common carp fingerlings to stock in third crop rice fields what five things have we considered? (Costs of the various sizes of fingerlings, stocking density, the size they will reach at harvest, the price for different sized fish at harvest, and how many fish will survive).

If you are going to stock common carp fingerlings into your rice field as a third-crop this year, at present prices what size fish would you select and why?

We aren't recommending that farmers only stock large-size fingerlings. The object of today's session was to make you understand which factors you should consider when deciding. The final choice is ALWAYS up to the farmer.

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.

	30 fish per kg (33 g fish)	20 fish per kg (50 g fish)	10 fish per kg (100 g fish)
1) Fingerling price each (VND)			
2) Number of fingerlings stocked per 500 m^2			
3) Total price of fingerlings per 500 m^2 (VND)			
4) Percentage of fish surviving			
5) Number that survive per 500 m^2			
6) Size of each fish at harvest (g)			
7) Quantity of fish produced per 500 m^2 (kg)			
8) Sale price of each fish (VND/kg)			
9) Total income per 500 m^2 (VND)			
10) Net profit = 9) – 3) (VND)			

9.4 Tilapia seed production in rice fields

1. Training topic	Tilapia seed production in rice fields[15]
2. Objective(s)	At the end of the session farmers will be able to identify at least three characteristics of mature broodstock male and female tilapia and describe how to breed and nurse tilapia in rice fields. (If the 'tilapia seed production in hapas' session has already been conducted, then the sexing part of this PAL session can be used to quickly review).
3. Trainees	Aquaculture group farmers
4. Date, venue and duration	Date: Venue: Duration: 2 hours. One hour in the first session, and two 30 minute sessions one month after stocking and at final harvest. **(Tell the participants that they will need to get into the rice field at each session and should therefore bring suitable clothes for getting wet).**
5. PAL summary	Participants first observe size, colour, fins, abdomen and genital papilla of mature male and female broodstock tilapia. Male and female broodstock tilapia are then stocked into a pre-prepared rice field. The farmers meet again after 30 days and using a hapa or cast net, sample the tilapia in the rice field breeding system. The sampling is repeated at final harvest.
6. Materials needed	- 25 mature male tilapia (75 – 100 g) - 50 mature female tilapia (75 – 100 g) - 2 plastic buckets - Scoop net - 3 banana leaves - Nylon hapa - Cast net - Rice bran - Empty sardine tin - Bottle of blue or black ink - Pipette or a straw
7. Method	**Step 1 – Introduce the training topic** Today we are going to observe and decide how to differentiate between mature male and female broodstock tilapia and then set up a rice field breeding and nursing system for tilapia.

[15] This PAL session was developed by Dr. Benoy Barman (bkbenoy@yahoo.com), WorldFish Center, Dhaka, Bangladesh. Dr. Barman's doctoral thesis was sponsored by the DFID funded Northwest Fisheries Extension Project (NFEP).

Step 2 – Focus farmers' attention and validate their knowledge

Begin the discussion by asking farmers questions such as:

What fish species do farmers commonly culture in your village?

Where do farmers usually culture tilapia? (Ponds and rice fields).

Where do farmers usually obtain tilapia seed?

At what age do male and female tilapia begin to spawn? (Tilapia is an exotic fish. Female tilapia begin laying eggs when only 3 – 4 months old. Female broodstock tilapia hold and incubate their eggs in their mouth).

How can you identify male and female tilapia broodstock? Let's check and see if you are right.

Step 3 – Explain the experiment or observations that the farmers will conduct

Activity 1 – identifying male and female tilapia
Have the farmers gather around buckets containing mature male and female tilapia. Ask them to use the scoop nets to take out individual fish and lay them on the banana leaf. Get the farmers to carefully examine and note down the differences between male and female tilapia.

Instruct the farmers to put one drop of ink onto the papilla of each tilapia and to stroke the ink covered papilla with a finger.

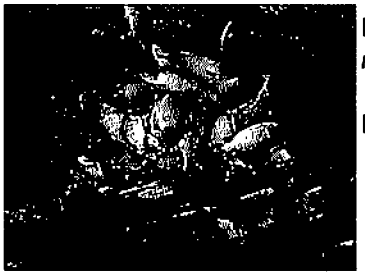
Step 4 – Have the farmers discuss their observations during the experiment

Activity 1 – identifying male and female tilapia
Do the fish all look the same (colour and shape)? If not, in what way do they differ? (Female tilapia, generally have a swollen abdomen and are usually smaller than males. Females often have a pale body colour and are golden/yellowish below the mouth around the throat area. The female papilla located behind the anus is blunt with a pinkish colouration.

Males are usually larger, the abdomen is not swollen, and they may be bright reddish violet under the mouth around the throat area. The male papilla located behind the anus is pointed and blackish in colour).

What does a female tilapia's papilla look like when ink is stroked across it? (It has a transverse line and a pore beneath the line).

What does the male tilapia papilla look like when ink is stroked across it? (Only a pore is visible for males).



Nile tilapia (*Oreochromis niloticus*) broodstock

Photo: SUFA

Step 3 – Explain the experiment or observations that the farmers will conduct

Activity 2 – tilapia breeding in rice fields
Get the farmers to separate all the male and female tilapia.

How has the rice field owner prepared his/her rice field ready for stocking with tilapia? **Rice fields are prepared in the normal way, except a deeper refuge ditch about 75 cm deep, usually ranging from 5 – 20% of the total rice field area is dug for the fish. Fish can be stocked 15 days after the rice has been transplanted.**

Have the farmers carefully stock the male and female tilapia into the prepared rice field. **75 tilapia should be stocked per 1000 m² of rice field, with 2 females for every male; i.e., 50 females and 25 males in 1000 m² of rice field. Six-month old tilapia weighing about 120 g are the best brood fish. They will lay eggs 3-4 times in a year, with April to October being the peak season.**

Ask the rice field owner to feed the tilapia each morning and late afternoon at the same spot in the rice field and to observe what happens. **Feed the fish rice bran at 5% total body weight daily divided 50% in the morning and 50% in the evening. Use a sardine can to measure the feed ration needed.**

Arrange a date and time and meet the farmers at the rice field in 30 days.

Step 4 – Have the farmers discuss their observations during the experiment

Activity 2 – tilapia breeding in rice fields
What happened each morning when you fed the rice bran?

What do you think has happened in the rice field in the last 30 days?

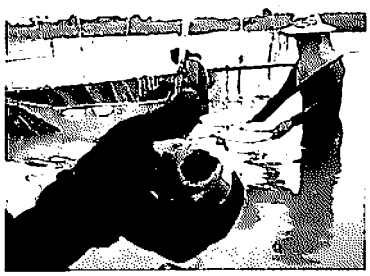
How can we check?

After feeding some rice bran in the usual feeding spot ask two farmers to get in the rice field ditch and to use the hapa or the cast net to catch a sample of tilapia.

Ask them to look inside the mouth of each broodstock fish.

Is there anything inside the mouth of the fish? (Some females may hold eggs or small fry in their mouths). If they do, wash the eggs or fry out into a bowl containing clean water.

Do the females have eggs (or fry) in their mouths?



A female broodstock tilapia incubating eggs in its mouth.

Photo: Nam Sai Farms Co. Ltd. - www.tilapiathai.com

How many tilapia did we originally stock in the rice field?

How many do you think there are now?

Are all the fry the same size?

What will the large fry do if they are left with the smaller swim-up fry? (The large fry will take most of the food and possibly eat the smaller fry).

How can this be prevented? (Nurse the larger fry separately in a pond, another rice field or a nursing hapa; or sell them to other farmers).

Thereafter the refuge ditch should be netted about every 20 days and the larger tilapia fry should be removed and sold. This will allow the smaller tilapia to survive and grow.

Have the farmers meet again when the rice field is finally harvested to discuss the results.

Step 5 – Have farmers summarize what they have learned and relate it to practical farming

What characteristics can be used to identify male and female tilapia?

How do tilapia normally spawn? (Male and female tilapia spawn when 3 – 4 months old, by mating and laying eggs in a nest made by the males in the bottom of a pond or other water body. The female tilapia collects the eggs in her mouth, where she incubates them).

If you do not have a pond or any hapas, how can you set up a tilapia breeding system?

How many male and female broodstock tilapia would you stock in a 1,000m² rice field? (25 males and 50 females).

Why do you need a deeper refuge ditch in the rice field for the fish? (So that the fish can escape predators, and avoid extremes of heat and cold).

Are there any additional topics you would like to learn about as a result of today's session?

Thanks for your cooperation. I'll see you after two weeks for the next training session.