A Final Report on
Fish Production in Homestead Ponds by Women: A New Dimension of Adopting Fish Culture in Bangladesh

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Disclaimer

These are the views and expressions of the author, and do not necessarily represent the view of the Netherlands Embassy in Dhaka or the Blue Gold program.

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Executive Summary

Fish culture in Bangladesh has grown rapidly through recent technological advancements. This is due to higher profit, nutritional benefit and employment opportunities. Growth has been concentrated in large ponds, where women are excluded because of social and cultural barriers. However, women have access to backyard ponds which are largely overlooked for their potential to culture fish. This offers women an opportunity to increase the productivity of ponds. The participatory action research looks at the potential for women to undertake fish culture in small homestead ponds and therefore, enhance household nutrition.

Sixty households with small homestead ponds were selected in Khulna, southern Bangladesh. Women from the households participated in establishing eight habitat types in their small homestead using coconut leaves, bamboo branches, vegetable cages, water hyacinth rings, rope cages, mat cages and concrete rings. Baseline fish production in ponds was estimated. Ponds were stocked with carp, tilapia, climbing perch, catfish, snakehead, and various small fish. Learning Centers were established within communities and allowed women to participate in hands-on learning sessions about fish production management practices. The sessions were also important social learning amongst women. Data on fish production and use was recorded by farmers. Over one year, most women achieved up to six-fold increase in fish productivity. The highest production was 2263±542kg.ha^{-1} from ponds with rope cage, vegetable cage, coconut leaves and bamboo tubes as habitat. The productivity of ponds without additional habitat was the lowest 840±310 kg.ha^{-1}.A new dimension of fish culture evolved in which women became knowledgeable about the science of fish production technologies, thus building confidence and capacity to produce various fish species through managing small homestead ponds habitat

The Ecopond Project implemented from April 2014 to June 2015. The project extended until September 2015 as no cost extension and continued up to December 2015 with support from the Aquatic Agricultural (AAS) Program of WorldFish. The purposes of the extension of the Ecopond Project after its completion are (a) to measure the empowerment of women using Women Empowerment Agricultural Index (WEAI) with focus on fish production activities by women and (b) the learn about the continuation of the activities by women involved together with those who involved as new adopters. The results of WEAI showed that women in communities involved in fish production using Ecopond Approach are significantly empowered with respect to five domains and criteria of empowerment used. This showed that the approach of the Ecopond of lots of importance for uses in other communities by women for scaling-out and the methods of WEAI used showed a solid basis for measuring the level of empowerment of women.

The outcome of the follow up studies carried out after the project intervention in the four communities showed that the approach have been continued by all the women involved in the project with their own initiatives and own investments. The major factors they like to be useful from the institutions is the continuation of their Learning Centers wherefrom they get the facilitation support on technologies and approaches about management of their small homestead ponds for science based management to higher fish production for improve household consumption and income. It came out that although it was only 60 women involved in four communities for fish production in ponds in following year's total 165 women with 265 ponds involved with their own initiatives in fish production in their small homestead ponds. The final report of the project thus is the combination of the 1st report and the 2nd report. The Appendixes of the two reports are included at the end the 2nd report with specific indication. The contents of the 1st and 2nd report are included at the beginning together with page on list of abbreviations used.

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1st Report

Fish Production in Homestead Ponds by Women: A New Dimension of Adopting Fish Culture in Bangladesh

Small Pond Fish Productivity, Diversity and Resilience 'ECOPOND" Project

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List of Abbreviations

AAS – Aquatic Agricultural System

AVC – Aquatic Vegetation Cage

CL – Coconut Leaves

BB – Bamboo Branches

BMC – Bamboo Mat Cage

BWDB – Bangladesh Water Development Board

BT – Bamboo Tubes

CRS – Concrete Ring Set

DAE – Department of Agricultural Extension

DLS – Department of Livestock Services

DoF - Department of Fisheries

DWA – Department of Women Affairs

GPI – Gender Parity Index

LC – Learning Centers

PAR – Participatory Action Research

PAL – Participatory Action Research

RC – Rope Cage

WEAI – Women Empowerment Agricultural Index

WHC – Water Hyacinth Ring

Fish Production in Homestead Ponds by Women: A New Dimension of Adopting Fish Culture in Bangladesh

I Introduction

Fish culture in Bangladesh has grown rapidly through recent technological advancements. This is due to higher profit, nutritional benefit and employment opportunities. Growth has been concentrated in large ponds, where women are excluded because of social and cultural barriers. However, women have access to small backyard ponds which are largely overlooked for their potential to culture fish. This offers women an opportunity to increase the productivity of small ponds. These ponds are seasonal completely dried up or perennial hold water throughout the year. During wet-months all the ponds hold water and sometimes natural fish enter during flooding. Some of these ponds are used for fish culture using extensive management with very low productivity (≤500 kg/ha).

Most cases these small ponds are covered with shade, received leaves of trees and organic matters from homestead areas having aquatic weeds, bushes, holes and roots of trees. The presence of natural habitats such as; branches of tress, roots of tress, aquatic vegetation are considered as good shelter and sources for production of natural food useful for growth and reproduction of fish (**Photos 1, 2 & 3**). Taking the ideas on management of the habitats and pond ecosystem a research has been carried out to look at the use of these small homestead ponds for fish culture by women to increase productivity for increase household consumption of fish.

Photos (1) Small homestead pond full with aquatic weeds (2) Small pond with high content of organic matters and (3) Pond with shade, organic matters and leaves of trees

In Bangladesh, women are largely responsible for household food preparation and taking care of children. Women and children of poor households often suffer due to malnutrition. Fish is the major source of animal protein and many of the small fish such as; mola, darkina are rich with micronutrients such as; vitamin A, iron and calcium. Involvement of women in fish culture in small homestead ponds can increase fish production and reduce malnutrition through increased fish consumption.

Fish culture is normally within the domain of men in Bangladesh; women are constrained from fish culture due to social-cultural barriers and lack of knowledge on fish culture technologies. In order to involve actively in fish culture women need to improve their knowledge and skills in fish culture. Since 1995 Beijing Declaration and Platform for Action that increased attention on women empowerment and it is considered as key to promote development around the world (UN, 1995; UN Women, 2014). It is important to look at how involvements of women in homestead ponds are useful to bring positive changes in gender relations and empowerment of women. Women agricultural empowerment index (WEAI) and gender parity index (GPI) can be used for measuring the empowerment of women involved in fish production.

II Research Approach

Habitat Restoration Approach to Small Pond Fish Productivity, Diversity and Resilience briefly called **'**Ecopond**'** is an action research project of WorldFish implemented in collaboration with BRAC with support from Blue Gold Program. The main focus of the project is to increase productivity of small homestead ponds for fish production managed by women for regular household consumption. To maintain diversity of natural and commonly culture fish in these small pond ecosystems useful for regular harvest and household fish consumption. This approach is an important initiative for conservation and restoration of freshwater aquatic habitats to prevent further biodiversity loss and to get increase in fish production and fish consumption of poor households in the southern coastal region of Bangladesh. Importance is given to provide technical knowledge on habitats and ecosystem management to increase fish production based on production of natural feeds. The project builds up capacity of women necessary for their active involvement in fish culture.

It is done using participatory action research (PAR) approach with hands-on learning sessions and use of tools through establishment of a Learning Center (LC) in each community. The LC is the place where women participate weekly or fortnightly for learning and sharing with facilitation from the technical experts of the project. The ponds of the households located close to the LCs are used as the fields for the practical sessions. A Participatory Action Research (PAR) approach with hands-on sessions and tools like; magnifying glass, aquarium, microscopes are used for effective learning of women about science on fish culture technologies. There is an important gender dimension on involvement of women in fish culture using this PAR approach. When women achieve knowledge about the science on fish culture technologies, develop their knowledge, skills and build up linkages with the support providers it is expected that there could be improvement in gender relations through their active participation in the activities, increased role in decision-making and development of self-confidence. It could improve their positioning in the households, families and in the communities.

This research developed based on a review of natural pond habitats located in areas in the Khulna district in southern Bangladesh conducted in 2013. It showed that the small homestead ponds having floating vegetation, holes, bushes, aquatic plants, branches, roots of plants are the habitats of different fish species. The review documented the diversity of small homestead pond habitats and the fish species in ponds and surrounding areas in southwestern Bangladesh. This review is used as the part of the Master Degree Program of a student of Oxford University (**Heidi Ma, 2014 and Heidi et al., 2015**). The lessons learned from the research on challenge pond which showed great potential on use of the small homestead shaded ponds for fish production using suitable species of fish have also be used as evidence (**Kabir et al., 2015**).

2.1 Purpose and Objectives

The purpose of this research is to increase fish production in small homestead ponds involving women keeping the existing habitats and providing habitats useful to make the pond environment suitable for fish to grow and reproduce using natural feeds. To improve nutrition of the household members and bring positive changes in gender relations through direct involvement of women in fish production in their small homestead ponds. The specific objectives of the research are:

- To assess the effectiveness in use of different habitat structures useful to increase fish production and household consumption from small homestead ponds by women
- To assess the improvement in knowledge about the science on fish culture technologies by women
- To assess the changes in sell-confidence, participation and decision-making roles of women in fish culture and the changes in their position in the households and communities
- To develop strategies for continuation, fine-tuning and scaling-out of the fish culture technologies in small homestead ponds by women in a sustainable way

III Research Methodology

3.1 Selection of Research Sites

The sites of the research include four communities located in Batiaghata and Dumuria Upazila (sub-district) in Khulna District, Southern Bangladesh. The communities selected are; Sajiara and Bahirakra within polder 29 in Dumuria and Gongarampur and Sukhdara within polder 30 in Batiaghata (**Figure 1 & 2**). The communities selected are connected with the highways linked to district and divisional city Khulna. The location of the communities are close the sub-district towns; the Botiaghata and Dumuria where there are presence of office of local government (Upazila Chairman), the local administration and the office of different departments such as; Department of Fisheries (DoF), Department of Agricultural Extension (DAE), Department of Livestock Services (DLS), Department of Women Affairs (DWA) as well as different NGOs.

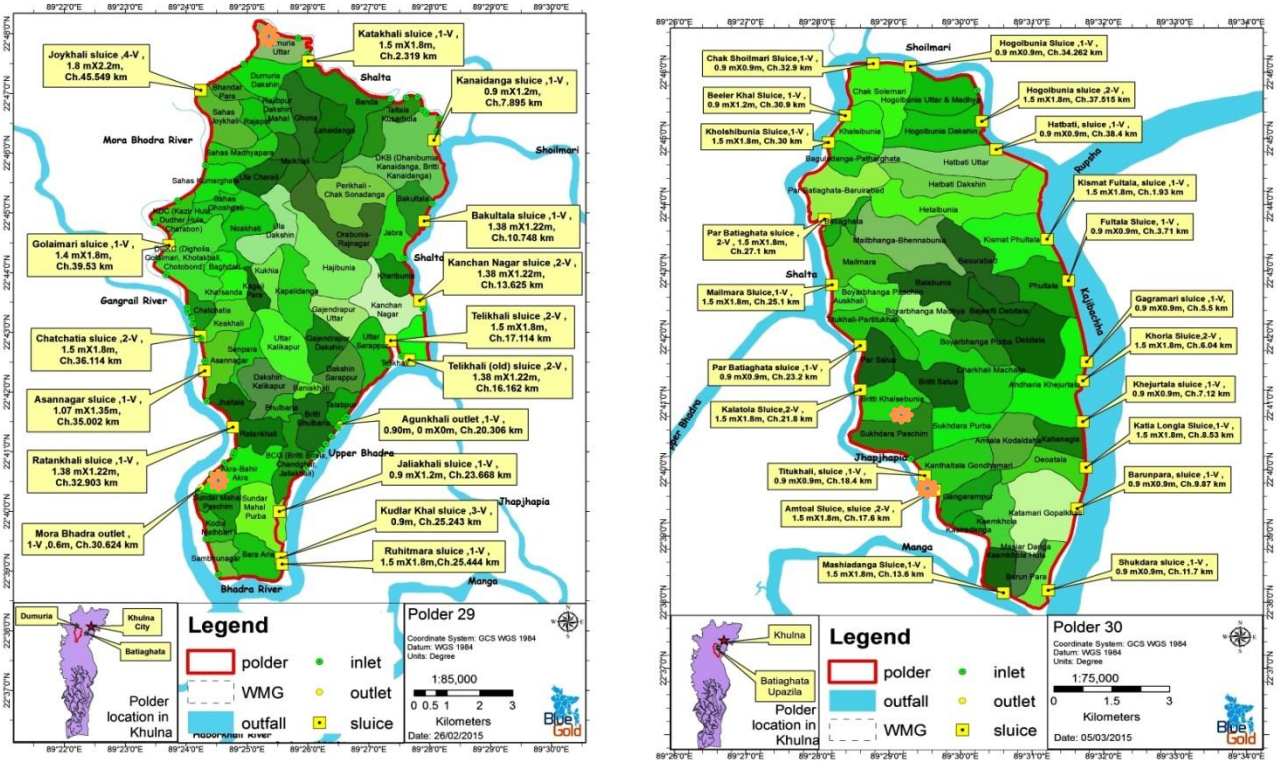

Figure 1. Location of the research sites in polder 29 in Dumuria and **2**. polder 30 in Botiaghata under Khulna District shown as (asterisk) in the map of the polders.

3.2. Selection of Women and Ponds

Women of sixty households with small homestead ponds are selected to involve in this participatory action research. The women selected are included under different treatments designed based on combinations of habitats (T1, T2, T3 and T4) and without habitat T5. There are 12 ponds selected in each treatment as replicates. The locations of the treatments with habitats are one in each community that is there are four treatments in four communities. The sites selected for the treatments are: T1 in Sukhdara in Botiaghata, T2 in Bahirakra in Dumuria, T3 in Gangarampur in Botiaghata and T4 in Sajiara in Dumuria. The ponds without habitat are distributed to all the four communities with 3 ponds in each community and total 12 ponds.

In the communities the location of the households and the ponds are close to each other. In the selection of ponds emphasis has been given to select ponds of women who have shown interest to

participate in the research located closer to each other in within the community. During visit to the communities in selection of women with ponds it observed that most of the large sizes ponds are belonging to better-off households are already under fish culture. It is the small ponds/ditches of poor households are overlooked for fish culture. Women of most of the households with small ponds showed interest to involve in fish culture with support from the project. So, women of households with small size ponds are selected. Initially although it is planned to select larger size ponds the sizes of the ponds are smaller ranged from 1.0-1.5 decimal (40-60m^2) to maximum 4 decimal (160m^2). Considering the interest of women and availability both seasonal and perennial ponds are selected for this research. Of total 60 small ponds selected for the research, the numbers of seasonal ponds is 30 and the perennial ponds is 30 (**1st Report** - **Appendix 1**).

3.3 Duration of the Project

The research project started in April 2014, it is initially planned to be continued until March 2015. Due to delayed rain and late stocking of fish and to collect data on fish production for complete grow-out season the project period is extended until June 2015. The project is extended further until September 2015 as no cost extension. It is extended further until 31 December 2015 with support from AAS program of WorldFish. Within this extension period during July information is collected about continuation of the fish culture activities by women with their own initiatives. Information will also be collected from the households from the four communities as well from two communities from the area not involved in fish culture to assess changes in empowerment of women because of their involvement in fish culture. It will be carried out by measuring the framework on 'Women Empowerment Agricultural Index (WEAI). This is planned to be carried out based on the recommendations of the final workshop of the project hold in June 2015 at Khulna.

3.4 Use of Habitats in Ponds

The designing of different habitats structure is done through discussions with experts taking into accounts the preference of the fish species to be stocked and their shelter, food habits and reproduction. Eight types of habitats; Water Hyacinth Ring Bamboo Mat Cage, Bamboo Braches, Concrete Ring Set, Aquatic Vegetation Cage , Rope Cage, Coconut Leaves and Bamboo Tubes in different combinations are used as treatments T1, T2, T3, and T4 There is another treatment T5, with ponds without having any habitat (Table 1 and 2). In the aquatic vegetation cages the plants used are Helencha (*Enhydra fluctuans*) and kalmi (*Ipomea aquatica*), in addition to its use for fish production both types of the aquatic vegetation are directly use for household consumption.

In 2014-15 production seasons, it came out that the combination of habitats in Treatment 2 that is with aquatic vegetation cage, rope cage, coconut leaves and bamboo tubes showed significantly higher fish production than other treatments. The outcomes have been shared to all the women and suggested them to use in their ponds the habitats combination mostly like T2 for getting higher production. During 2015-16 production season ponds those with CRS (concrete ring set) kept in their ponds, however, the other habitats except rope cages completely damaged. Considering the issue of sustainability and investment few women used rope cages through reconstruction but most of them used aquatic vegetation cages, bamboo tubes, coconut leaves and bamboo branches from local sources with their own initiatives.

Table 1. Habitats set up in small homestead ditches under different treatments in communities in the study areas.

Type of habitat	Description of the habitat	Purpose of use
Water hyacinth ring (WHR)	Floating structure, square in shape, size 1m^2, empty plastic bottle use as float, set up and managed by women, materials and water hyacinth collected from local source	Water hyacinth absorbs excessive nutrients from water. Some fish lay eggs in the root of water hyacinth and it work as good habitat for some type of fish
Bamboo mat cage (BMC)	Constructed using bamboo frame, cubical shape, 4 pieces bamboo mates placed parallel placed perpendicular equally placed, each piece 1 m^2, fixed structure submerged in water	Use to grow periphyton to use as natural feeds for fish like tilapia, mola punti and others. Some fish used it as substrate for laying of eggs
Bamboo branches (BB)	Dry, 2-3 m long, placed in edge of the ditches from banks towards waters, created bushy habitats for fish, mostly submerged, can be used from own source	Use to grow periphyton, provides suitable place for fish to hide from predators, most fish like tilapia and like this bushy habitats for building up their nest for spawning
Concrete ring set (CRS)	Concrete structure, cylindrical, 0.5 m height, use two rings in each set, submerged in to bottom in deeper part of ditch.	Use for a purpose to hold water to hold fish, some fish like tilapia, catfish use it as good habitat to build up nests for breeding and for taking shelter.
Aquatic vegetation cage (AVC)	Floating structure, square, 1m^2, empty plastic bottle float, put plastic sheet in bottom to hole soil to growth of water spinach	Aquatic vegetation cages are of similar uses like the WHR (absorbs excessive nutrients from water, fish lay eggs in the roots of the plants, use as good shelter for some fish), in addition some of these are use as fresh leafy vegetable directly for consumption by households.
Rope cage (RC)	Made of made of bamboo splits and ropes, size 1m^2 tied up tied by synthetic ropes, submerged in water	Used to grow periphyton natural feed for fish for like tilapia, punti. Snails and earthworms grow attached to the rope cages are useful feed for catfish
Coconut leaves (CL)	Dry, 2-3 m long, placed in edge of the ditches from banks towards waters, created bushy habitats for fish, mostly submerged, can be used from own source.	Use to grow periphyton, provides suitable place for fish to hide from predators, most fish like tilapia and like this bushy habitats for building up their nest for spawning.
Bamboo tubes (BT)	A bundle of six pieces of bamboo (each one 60 cm long) binding with a rope with presence of hole under water which is used as submerged.	Some bottom dwelling fish such as catfish – shing, magur fish like to live in this. Also, used as suitable devices for harvest of the fish those hide in these tubes

The numbers of habitats used in the treatments (T1-T4) are as follows: T1; water hyacinth cage 3/decimal, bamboo mat cage 3/decimal, concrete ring set 4/decimal and bamboo branches 2 edges of the pond. The habitats of T2 include; aquatic vegetation cage 3/decimal, Rope cage 3/decimal, Coconut leaves 2 edges of the pond and Bamboo tubes 4 set/decimal. T3 and T4 contains all the eight types of habitats used in T1 & T2 but the numbers per decimal or coverage of edges of the pond are 50% and 25% (1 decimal = 40.47m^2).

3.5 Fish Species Stocked in Ponds

Several species of fish grouped under six categories; carp, tilapia, snakehead, climbing perch, catfish and small fish are stocked in all the sixty ponds under five treatments (**Table 2**). These fish are chosen considering the suitability for culture in small homestead ponds. Snakehead, climbing perch and catfish have accessory respiratory organs can survive and grow in ponds with low dissolved oxygen and contents of high organic matters. In earlier days most cases small fish, catfish, snakehead and climbing perch entered in the ponds during flooding from outside natural sources. Due to over exploitation and destruction of habitats the availability of such fish in the natural sources reduced drastically. Therefore, the initiative on stocking of these fish is considered as enhanced fisheries in open water management as process of restoration of these fish. Other than those fish three major carp; rohu, catla, and mrigal are chosen considering its major importance in fish culture. Tilapia is selected for stocking considering its high level of performance to grow together with catfish and climbing perch in shaded ponds in which the environment is similar to small homestead ponds (**Kabir et al., 2015**). Due to omnivorous feeding habits with ability to survive even at low oxygen tilapia is always chosen as the candidate for culture in different pond environment.



Photos: (4) Woman managing the habitats in her pond (5) Tilapia foraging periphyton produced in braches used in small homestead pond and (6) Pond with water hyacinth cage and other aquatic plants

The sizes of carp and tilapia fingerlings stocked are large but the other fish stocked are very small. It is done considering the availability of fish available (Table 3). Fish stocked are supplied by local traders who collected the fish carp, tilapia, koi,, sing and magur from the nurseries, the fish species; mola, darkina, chela, kholisa, punti and chingri, taki are collected from people those harvested the fish from rice fields, ponds and low lands and kept as live. The collection of small fish from natural sources and transportation as live for stocking in ponds is a difficult task as the fish immediately die after harvest. In the Small Fish and Nutrition Project of WorldFish the techniques of collection and transportation of small fish as live has been successfully developed (**Saha et al., 2013**). The technique has been shared with the traders who supplied the fish to women in 2014-15 and in 2015-16. In 2014-15 the project provided the demand of fish and expenses incurred to the traders for supplying fish to individual women in the communities for stocking in their small homestead ponds. In 2015-16 women in the sixty women and the newly adopted women stocked fish in their pond with their own initiatives and investment from traders as well collecting from local sources.



Photos (7) a mobile fish fingerling trader supplying fish to women to stock in their ponds (8) Women are taking fish for stocking in their pond from traders (9) A woman is stocking fish in her pond

In 2015-16 production season, it has been explained that in order to continue the activities of fish culture women need to stock fish with their own investment. All the women agreed and in the meantime many households started stocking of fish in their ponds. Women with perennial ponds have conserved some fish as previous stock and used directly as a recruit for this year production. The species they kept as stocks are mainly; tilapia, catfish, climbing perch, snakehead and small fish 'mola'. So, in 2015-16 during July when the ponds are filled up with water by rain lot of fish are found in the ponds. During heavy rains in some ponds, the fish climbing perch 'koi' tried to crawling near the dikes. Women harvested large numbers of the koi and used for household consumption. In this year 2015-16, women stocked fish in their ponds based on their approximate estimate on the amounts of fish remain as stock in their ponds from the previous year.

Table 2. Fish stocking in small homestead ponds of women under different treatments (T1-T5) in 2014-15 production season

Common name	Scientific name	Size (g per fish)	Stocking Density (Number /decimal)	Source of fish
Indian Major Carp Rohu Catla Mrigal	*Labeo rohita* *Catla catla* *Cirrhinus cirrhosus*	70 to 80	3 5 2	Hatchery and nursery pond
Tilapia Nile tilapia	*Oreochromis niloticus*	25-30	25	Hatchery and nursery pond, grow-out pond
Snakehead Taki	*Channa punctata*	0.3	50	Ricefield, canal, ditch
Climbing perch Koi *(Vietnamese strain)*	*Anabas testudineus*	0.5	100	Hatchery and nursery pond
Catfish Magur Shing	*Clarias batrachus* *Heteropneutes fossilis*	0.4 to 0.5	15 25	Hatchery, nursery pond, ricefield, canal, ditches
Small fish Mola Darkina Chela Punti Kucho chingri Kholisa	 *Amblypharyngodon mola* *Esomus danricus* *Salmostoma phulo* *Puntius puntio* *Macrobrachium lamarrei* *Colisa faciatus*	0.2 – 0.3	 20 20 20 50 20	Pond, ricefield, canal and, ditch

Note: 1 decimal=40.47m^2

3.6 Establishment of Learning Centers

The use of Participatory Action Research (PAR) approach conducted using different sessions and tools based at a suitable place located within the community called Learning Center (LC). Four LCs are set up in four communities (one in each community) where women meet weekly to learn about the science on fish culture technologies in their ponds. The learning process included twelve learning sessions followed by practical sessions held at pond dikes followed by more observations and discussions in the center. Each of the sessions are equipped with a session plan developed by relevant experts and it included the uses of different Participatory Action Learning (PAL) tools with having theoretical discussion and practical sessions facilitated by the technical staff of WorldFish and BRAC.

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Photos: (10) Aquarium set up in each of the LCs as prototype of the small homestead ponds with habitat and fish (11) Women in the communities participated in the sessions in the Learning Centers (LCs) facilitated by Ms Saima Sharif Nilla, Technical Specialist of WorldFish.

The tools used in the sessions include; posters, flip charts, magnifying glasses, glass aquarium and microscope. The LCs sometimes visited by other villagers, students and teachers from nearby schools. The PAR session is in fact the heart of the learning process where there is an interface between researcher and villagers is infused, and where the women learned about the science on fish culture technologies and management of pond ecosystem. This is also where women share experiences and knowledge, and even share opinions about other social and gender issues. The PAR sessions started on October 26, 2014 and continued until 31 January 2015. In 2015, the PAL sessions continued and women those involved in previous year and those involved as new adopters from the communities participated. In order to continue the activities and encourages adoption by others development of strategies for continuation of the LCs through involvement DoF, NGOs with support from the BLUE GOLD and WorldFish program are important.. The list of the sessions and specific details are included in **Appendix 2.**


Photos (12) Women participated in the practical learning session are observing the presence of periphyton growth in bamboo branches (13) Women observing the benthos and detritus present sieving of pond bottom muds.

3.7 Collection of Data on Fish Production

The baseline information on fish production for each individual pond before the year of intervention is collected through discussion with women as recall data. The data on fish production for 2014 production season is collected based on regular monitoring of the households and the records they kept in note book supplied from the project. The number of fish harvested when needed daily or weekly is counted and weight of fish is measured using digital weighing balance. The data taken by the women themselves and the field staff collected the data every week from them.

For this purpose a digital weighing balance has been supplied to each of the group in the community (there are three groups in each community with 5 women in each group). The field staff of the project took necessary measure for proper record of fish harvest and uses. In order to get the complete record of fish production by end of production season, the perennial ponds are drained by making temporary dikes within the ponds. The fish are hold in *hapas* (net cages) in nearby pond as live and by counting the numbers and total weight released back into the ponds. For ponds those hold water and kept fish continued their harvest for household consumption and conserve some fish to use as stock for 2015 production season. The fish harvested from individual households by August'14 to March'15 and from April'15 to June 2015 have been collected. The specific detail on total amount of fish harvested from each individual pond is shown in **Report - Appendix 1**. The fish produced from these small ponds are harvested regularly and used for consumption of the households.

IV Results and Discussions

4.1 Fish Production

4.1.1 Fish Production by Treatments

Of total 60 women involved in fish production in their small homestead ponds using different combination of habitats for women with eight ponds there are very low level of fish production (<5 kg/pond). In eight months culture period from October 2014 to March 2015 ponds with habitats showed higher fish production than ponds without any habitats. The highest production obtained from pond s with habitats in treatment T2 which is 1785 ± 986 kg/ha and the lowest in ponds without any habitat in treatment T5 which is 769 ± 323kg/ha (Figure 2. The differences are highly significant ($p<0.01$). The analysis of fish production of 52 women with ponds having better success in fish production excluding

the ones with low success (eight women in ponds with <5kg/ditch fish production) showed higher level of fish production in which for treatment T2 the production is 2097±732 kg/ha and for treatment T5, 814±297kg/ha. In this case the fish production from treatments T1, T3 and T4 are 1093±142kg/ha, 1038±320kg/ha and 1340±251 kg/ha respectively. Compared to the baseline fish production from the ditches the fish production obtained under different treatments with habitats are 3-6 folds higher. The baseline production of the ponds is 379±305kg/ha.

The treatment showed highest performance in fish production (T2) comprised of four types of habitat combinations; rope cage, aquatic vegetation cage, coconut leaves and bamboo tubes. The several folds increase in fish production from the ponds with treatments compared to the baseline production are related to the use of choice of suitable species of fish which includes carp, tilapia, climbing perch, catfish and small fish. Uses of the habitats in ponds facilitate the shelter and production of natural food useful for the growth of the fish. For small fish it created a good environment for breeding of the fish to produce offspring useful to get higher production of such fish from the ponds.)

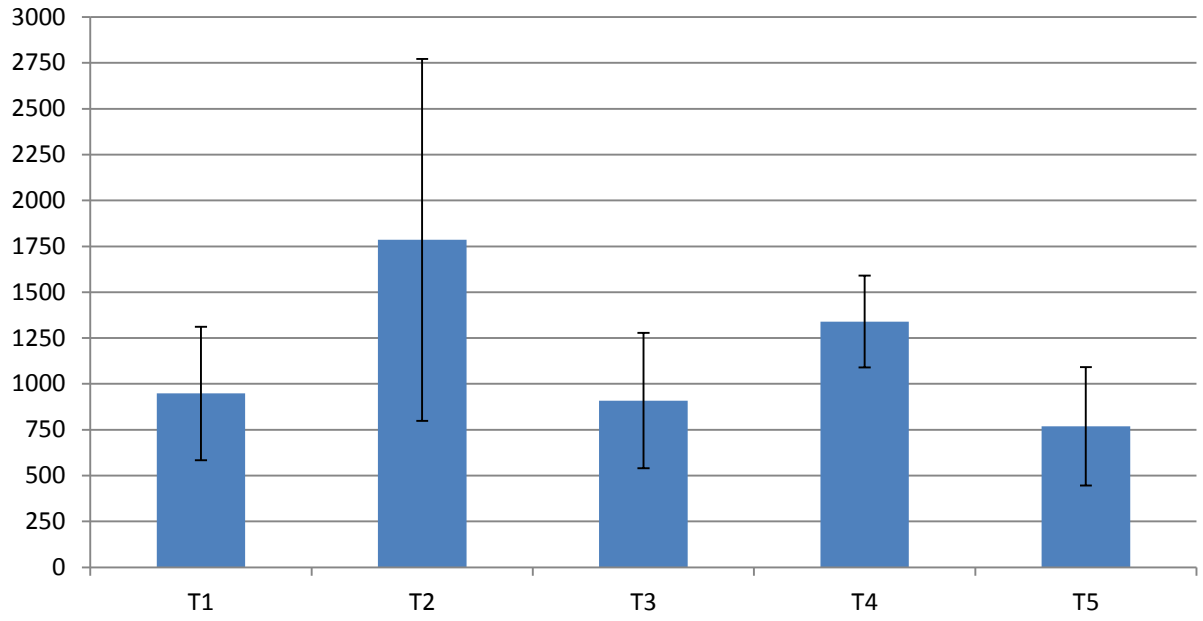

Figure 3. Fish production in small homestead ponds of women under different treatments (T1-T5) based on the production of sixty ponds for eight months culture period.

Of the treatments with habitats fish production from ditches with habitats T1, T3 and T4 is significantly lower than fish production in T2 ($p<0.01$). This higher production of fish in T2 is related to the more effective uses of the habitats in production of natural feed. In rope cage there was dense in production of periphyton and the system found to suitable for fish to graze due to having lot of open spaces surrounding the ropes. Similarly, the coconut leaves provided enough surface areas for the growth of periphyton and attachment of other aquatic animals use as food for the fish. The use of aquatic vegetation cages played effective role in absorption of nutrients, as a good shelter for the fish to live and a good substrate useful to lay eggs of the species of fish which breed within the ditches. It also used as good substrate for the growth of some natural food (periphyton, snails and larvae of insects) which useful for the growth of fish. The use of bamboo tubes not worked well to meet up the purpose due to low survival of the catfish. The habitats use not much created problem of water pollution. In other treatments the use of more numbers of newly made structures caused decomposition with poor water quality with poor performance in fish production. The lower fish production from the T5 without

any habitats showed positive about the importance of use of habitats for natural food production to fish to graze and grow faster. The combinations of the suitable species together with effective combination of habitats are useful to get higher production of fish from small homestead ponds managed by women.

4.1.2. Fish Production by Types and Species of Fish

Tilapia: For all the treatments the production of tilapia showed the high performance, the production is highest in treatment T2, 697±451kg/ha and lowest in treatment T5, 274±136kg/ha. The differences in production is highly significant ($p<0.01$).

Carp: Like tilapia the performance of carp; rohu, catla and mrigal is also high in all the treatments with highest in T2, 372±188 kg/ha and lowest in T5, 263±88 kg/ha.

Climbing perch: The production of climbing perch (koi) is highest in T2, 364±255 kg/ha followed by T4 263±110 kg/ha, for other treatments; with habitats; T1, T3 and without habitat; T5 the productions are low.

Small fish: The production of small fish small fish is higher in treatments T2 and T4 than other treatments which showed almost 10% contributions in total fish production. Of the small fish it is the mola which showed the highest production treatment T2, 47% of total small fish production and for T4, 38%. The contribution of chela T2, 23% and T4, 20 % and punti T2, 21% and T4, 31%.The contribution of other small fish darkina, chingri and kholisa is low T2, 9% and T4,11%.

Snakehead: Like small fish the production of snakehead is higher in treatments T2 and T4 than other treatments.

Catfish: Among the different species of fish the production of catfish (shing and magur) is the lowest in all the treatments.

The highest performance of tilapia is largely related to their voracious feeding habits and ability to survive in conditions with low dissolved oxygen. The fish has ability to use all types of feed effectively including the phytoplankton and the detritus more available in these ponds. The lowest performance of all the fish in T3 probably due to the pollution of the water due to use of all the eight habitats where raw materials (bamboo frames, mats) are decomposed caused mortality of fish and especially little scope to get reproduction and survival of the eggs and larvae of the fish. There may be positive relations between higher production of small fish and snakehead in treatment T2 and T4. The offspring of small fish produce use as a good source of food for the snakehead useful for better growth of snakehead in one hand but also the growth of the small fish through control of the population recruited through reproduction.

Table 3. Fish production types of fish from the ditches in eight months culture period (figures in the parentheses are the standard deviation).

Type of fish	Fish production (mean ± stdev) in kg/ha				
Treatment	T1	T2	T3	T4	T5
Carp	358 (156)	372 (188)	282 (154)	326 (122)	263 (88)
Tilapia	477 (201)	697 (451)	445 (197)	437 (204)	274 (136)
Climbing perch	15 (25)	364 (255)	47 (52)	263 (110)	89 (104)
Catfish	22 (37)	40 (36)	88 (96)	52 (39)	22 (37)
Snakehead	53 (34)	148 (113)	29 (35)	122 (62)	61 (66)
Small fish	22 (33)	164 (110)	19 (52)	141 (69)	60 (64)

4.1.3 Survival and Reproduction of Fish Stocked in Ponds

Tilapia breed in the ditches but due to low survival of the fish stocked and also the less survival of the offspring the survival or proportion of increase in number of fish was not very high. The results showed comparatively low survival of carp and tilapia in T2 than other treatments, however the higher production of fish obtained showed that there growth and size of fish in T2 was higher than others. The sizes of all the fish harvested fish in T2 are comparatively larger than the other treatments. It is also T2 and T4 showed that highest proportion of mola chela and punti are increased due to breeding and with good survival of offspring in the ditches. The poor results obtained in production of catfish are mainly related to stocking of very small size fish. The catfish normally showed higher morality in grow-out system if small fish of fries are stocked. The nursing of fry and stocking of large size fingerlings will be useful to get higher production of catfish. Further, it is always important to stock quality of fish produced in hatcheries and collected from natural sources in good conditions before stocking in ponds to get higher production as well. The lower productivity of catfish, snakehead and climbing perch in the treatments are related to poor survival and which may be related to stocking of very small size fish resulting high mortality of the fish.

Table 4. Survival and increase in population of species from the ditches of women involved in fish culture

Fish type/Species	Treatments/Survival rate/increase in population (%)					
	T1	**T2**	**T3**	**T4**	**T5**	**Total**
Carp						
Rohu	71	55	66	72	73	68
Catla	88	64	75	58	77	73
Mrigal	69	49	62	64	71	64
Tilapia						
Nile tilapia	72	59	72	59	58	64
Climbing perch						
Koi (Vietnamese strain)	6	25	14	30	10	17
Catfish						
Magur	8	10	28	14	5	13
Shing	6	4	40	6	5	12
Snakehead						
Taki	13	6	8	6	5	7
Small fish						
Mola	382	1280	252	974	755	724
Chela	163	1343	125	965	316	552
Punti	55	353	112	406	110	200
Chingri	38	151	19	146	65	82
Dankina	24	134	17	157	51	75
Kholisha	11	39	3	25	8	16

4.1.4 Fish Production from Seasonal and Perennial Ponds

Seasonal ponds must have been dry for part of this period, while in perennial the growth continued. Only one pond in T2 under perennial category has very high production than mean production of 11 seasonal ponds. For other treatments the fish production of both seasonal and perennial ponds are almost similar and there is no significant difference in production of seasonal pond and perennial pond ($p>0.05$). This is largely related to comparatively higher productivity of the seasonal ponds resulted more production of fish even within a shorter growing period; as due to complete drying the environment of the ponds improved good for fish to survive especially for those fish which breed and recruits (e.g. tilapia, small fish). In the Small Fish and Nutrition Project of WorldFish (**WorldFish, 2013***)* implemented in NW Bangladesh similar results are obtained for fish production in seasonal and perennial ponds in carp-mola polyculture.

Table 5. Fish production from seasonal and perennial ponds under different treatments for 11 months (Aug'14 – Jun'15)

Treatment	**Seasonal Pond**		**Perennial Pond**	
	Number of pond	Fish production (mean± stdev) in kg/ha	Number of pond	Fish production (mean± stdev) in kg/ha
T1	6	982 ± 406	6	914 ± 352
T2	11	1691 ± 975	1	2827 ± 0
T3	5	748 ± 266	7	1024 ± 406
T4	3	1304 ± 300	9	1352 ± 252
T5 (control)	5	752 ± 406	7	781 ± 284
Total	**30**	**1197** ± **753**	**30**	**1104** ± **495**

In 2015-16, the perennial ponds those hold water throughout the year with having fish remain as stock from previous year. Of those fish the koi, small fish and tilapia started breeding right from the beginning of the season in perennial ponds. On one hand this reduced the cost of stocking of fish and on the other hand it created opportunities to get higher production of fish as the production started right from the beginning of the season. So, it is expected that in 2015-16 there is a possibility to get significant level of variations in fish production from perennial and seasonal ponds in terms of productivity and net profits (as it may reduce the cost of stocking of fish) and with higher level of consumption of fish by households.

4.1.5 Fish Production based on Size of Ponds

The ponds used for the research are all small varied from 1.5 to 4 decimal (1 decimal=40.47m2). So, there is less scope to compare the size of the ponds on production of fish. However, some of the ponds those are up to 2 decimal sizes in most cases are considered as ditches and overlooked for fish culture. Therefore, it is worthwhile to look at how the use of Ecopond approach is useful to get fish production from small ditches located close to the households through involvement of women.

For analysis the small homestead ponds of the sixty women are divided to two categories; ponds with areas of 1-2 decimal and ponds with having 2-1 to 4 decimal. Overall the results of 33 ponds under 1-2 decimal and 27 ponds under 2.1-4 decimal categories showed no significant differences in fish production. The fish production obtained are 1168 ± 720kg/ha for 1-2 decimal and 1129 ± 522 kg/ha for 2-4

decimal ponds (Table 5). . The differences in overall fish production from ponds 1- 2 decimal and 2.1 to 4.0 decimal ponds is very similar and not significant ($p>0.05$). The results also similar to that obtained under Small Fish and Nutrition Project of WorldFish implemented in NW Bangladesh for carp-mola polyculture. There is lot of variation in ponds of two categories by treatments, so, although there are some difference specific to the treatments are found but it is less valid for comparison. In this regard the number of ponds of T3 and T4 are closer and when we look the differences in production it is almost similar for 1-2 and 2.1-4 decimal categories. It showed that the small ponds (ditches) are equally productive like comparatively large size ponds (Table 5).

Table 6. Fish production of ponds 1-2 decimal and 2.1 to 4 decimal under different treatments in the project areas

Treatment	Size of pond 1- 2 decimal		Size of pond 2.1 to 4 decimal	
	Number of pond	Fish production (mean± stdev) in kg/ha	Number of pond	Fish production (mean± stdev) in kg/ha
T1	10	903 ± 378	2	1170 ± 225
T2	9	1692 ± 1107	3	2066 ± 536
T3	7	849 ± 258	5	993 ± 509
T4	5	1370 ± 232	7	1319 ± 280
T5 (control)	2	743 ± 658	10	774 ± 281
Total	**33**	**1168 ± 720**	**27**	**1129 ± 522**

Note: 1 decimal = 40.47m^2

Photos (14 & 15) Tilapia fish harvested from pond by women to use for household consumption are weighed for keeping the record

Photos (16) Catla and (17) Mrigal harvested from pond by women for household consumption is weighed for keeping record.

Photos 18 Shing 19. Magur 20. Koi harvested from ponds of women farmers of Ecopond Project

Photos 21 and 22. Small fish (mola) and snakehead (taki) harvested from small homestead ponds of farmers for household consumption

4.1.6 Economic Analysis on Fish Production in Small Homestead Ponds by Women

It is always important to look at the economic analysis on use of technologies in order to understand the to what extent it is affordable for the households to continue and to what extent the technologies are useful to adopt by others within their resources base.

The participatory action research has been supported the majority of the expenses used for the research such as; construction of habitats and stocking of fish. It is not found feasible to made the estimation of economics unless it is completely taken up by women with their own initiatives based on lessons they have learned from the research regarding the use of suitable habitats. Considering this major emphasis is given to look at the issue in year 2, 2015-16 when all the sixty women are carrying out the activities using suitable habitats and fish in their ponds. In addition there are large number other women in the communities also adopted the technologies with their own initiatives. In 2015-16 women used the habitats in their ponds have got clear understanding about the which type habitats more effective in terms of cost, longevity in use and handling and overall to get higher production of fish. They look at the also what types of habitats useful to use are available in their areas from their own sources and they can collect from the communities. They found that the mat cages damaged quickly, the concrete ring sets are expensive and not showed good performance to meet up the purpose of holding water in the dry ponds. The bamboo rope cage are good but they like to build up with their own way without making it very expensive using large amounts bamboos. They found that the habitats like the aquatic vegetation cage, water hyacinth cage, bamboo branches, coconut leaves and bamboo tubes are easier for them to collect and to use in their ponds. And these cost less than the others.

Again, for farmers with perennial ponds it came out that it needs to stock less number of fish as the fish those conserve there reproduce and started production which cost them less. In addition to the fish they stocked in previous year few of them also stocked in their ponds few more other species of fish such as; silver barb and silver carp and common carp. Many of them stocked the small fish through collecting the fish from the natural sources which cost less and also they get the fish in good condition for stocking. In order to make an effective economic analysis the staff of the project collected the details about the habitats used, the fish stocked and the other cost by all the 165 women carrying out fish production in their small homestead ponds. In the meantime, some information about the cost have been received which is explained in the extended part of the report. In 2014-15 all the fish produced from the ponds are used for household consumption and it is important to get information about the market price of those fish species produced based on the size of harvest and also taking into accounts the seasonal variation in price of the fish. During the extended period of the project July-September 2015 it will be tried to collect all these information and taking into accounts with support from the economic experts of WorldFish it will be carried out and will be incorporated in the report to be submitted later after September 2015-16.

In July 2015 extensive visits by the project team members and discussion with women done to learn about what extent the technologies have been taken up by others and to what extent women with such ponds showed interest for adoption. Lot of positive outcomes came out and in all the communities many women those not involved in this research in 2014-15 and have ponds showed high interest to involve in fish culture in 2015-16. However, they like to get the knowledge about the technologies what their fellow neighbors already learned. In addition, it came out that a large numbers of institutions working in the areas on rural development observed the success of women in fish culture in small ponds and should interest to learn about this. During July to September 2015 it is planned to collect detail and concrete information about this. As it is a research unless the learning comes out we could not expect the adoption immediately. Now, it is the year when it is expected that the adoption of the technologies will be observed and in addition to continuation of the activities by those who are involved it will be taken up by others within and outside the communities. In our follow up works during July-September 2015 it will be possible to capture this information. More outputs about the adoption of the approach by women are described in the 2nd part of the report.

4.2 Gender Issues

4.2.1 Changes in Knowledge of Women

Fish culture has been perceived as men dominated activities in Bangladesh. It is not easy to involve women directly in fish culture activities due to social and cultural barriers. Other than social and cultural the factors hindering participation of women in fish culture are their lack of knowledge, confidence, and less skills The lack of ownership, access to resources and capital for investment to purchase inputs are also important factors hindering the participation of women directly in fish culture. Due to less mobility women involve in fish culture also suffer due less availability in getting supply of quality fish fingerlings. At the end intervention of the project in the participatory assessments women of all four communities stated that they achieved significant level of knowledge about the science on fish culture technologies which includes: understanding about different types of natural feed production in pond using management practices, the suitable species of fish, food habitats of the fish, different types of habitats to be used in ponds and the benefits of use of the habitats useful to create suitable environment for the fish as well as enhancement of natural food production for the fish stocked in their ponds.

The process of learning is found to be useful for women to achieve knowledge and to involve directly in fish culture activities in their small homestead ponds. The Participatory Action Research (PAR) and the use of Participatory Action Learning (PAL) tools and direct application of the knowledge in to practice in their ponds are important (**Photos 23 &24**). The establishment of Learning Centers (LCs) within the community and the active participation of women in the PAL sessions (total 12 sessions on various topics; specific details are shown in 1st Report, **Appendix 2** with well-designed session plans are guided by a module developed by the relevant experts. Four LCs, one in each community, have been set up are equipped with different tools. The facilitation and mentoring support from the project staff and the regular sharing among the members taking into accounts the practices they applied their ponds helped the women to learn about the complexity of science on fish culture technologies within one year period. The objective of establishing a LC in each community is to create a place with a good learning environment where women to come, sit and share their knowledge. It is a different prototype learning that enables them to a feeling of understanding a real life and practical session in a laboratory by using different equipment such as; plastic bottle, pencils and paper, aquarium, microscope, and magnifying glass. Women farmers put samples of live fishes in aquarium and they discuss small groups what they have observed, prepared poster, draw diagrams, and demonstrated it by fixing on the wall of the LCs. Sometimes the neighbors and visitors visited the LCs and the group present and share their major findings to them. In 2015-16 production season the activities of the LCs continued in all the four communities with facilitation from the staff of WorldFish and partner organizations which as well as the Lead Women Farmers in the communities. In order to sustain the LCs it is important to provide some facilitation support which can be through BLUE GOLD program or other program. The learning sessions followed by practical sessions and process of experimentation with advancement of their knowledge leading to growing interest on further experimentation and science based learning.


Photos 23. A Woman is observing the natural food of fish using microscope and 24. A Woman is working with diagram to fix up the fish and natural feeds useful to explain the food habits of fish stocked in ponds

Women gained knowledge and skills on technology of pond ecosystem, natural feed and its importance, fish species and food habits, habitat restoration, which fish production is good, which breeds well and which is good for household consumption. It is a new method of learning and found to be very effective for them.


Photos: 25 & 26. Women collected mud from pond bottom, sieved and look at the availability of benthic feed available in the mud of their ponds.

A follow up participatory assessment by members of the women group about the use of the technologies for fish production have been conducted in each communities carried out based at LCs. The results obtained valuable insights about the relative importance of use of knowledge about of the science based application of the technologies such as; natural feed and its importance, the fish species and food habits of fish and the use of different habitats and their importance. It tried to assess the positive changes of the lives, perception and attitudes about the uses of small homestead ponds, their role in decision-making and their self-confidence on use of science on fish culture technologies. With minor variation women in all the communities has given almost equal importance of use of these knowledge for fish culture in their small homestead ponds. Women put the highest score on knowledge about the natural feeds and its importance in ponds. They have also provided high score about the knowledge on the importance of fish species stocked in their ponds and the food habits of the fish.

They have given good score for the knowledge on habitats in ponds and it uses for shelter and in production of natural feed for fish. The results of the uses of different types of the habitat structure in ponds and evaluation of its impacts on production has provided a good understanding about the benefits of use of such habitats in ponds.

Photos 27 *& 28* . Participatory assessments about the science on technologies carried out by women in the communities involved in fish culture.

Women now have better understanding about how the natural feed is developed sufficient in amount in the pond for the fish to grow. They know that there are different kinds of natural food of fish in ponds such as; detritus, bacteria, plankton, worms, insects, snails, aquatic plants, earthworm, rotten leaves. Women know that plankton floating in the pond water, benthos such as worms, larvae of insects and snails grow on bottom and insects, frogs swimming around the water are used as natural fish feed. They learned that proper management of these natural feed in ponds will be helpful for them to achieve increase fish production (**Figure 3**). Women have well described about different habitat system. These habitats keep the fish in place and the produce natural feed for the fish. Earlier during the rainy season most of species enter in to the ponds had lost with the outflow i.e. that finds their way from the pond to outside. Now the existing habitat allows them to keep their fish in the ponds throughout the year.

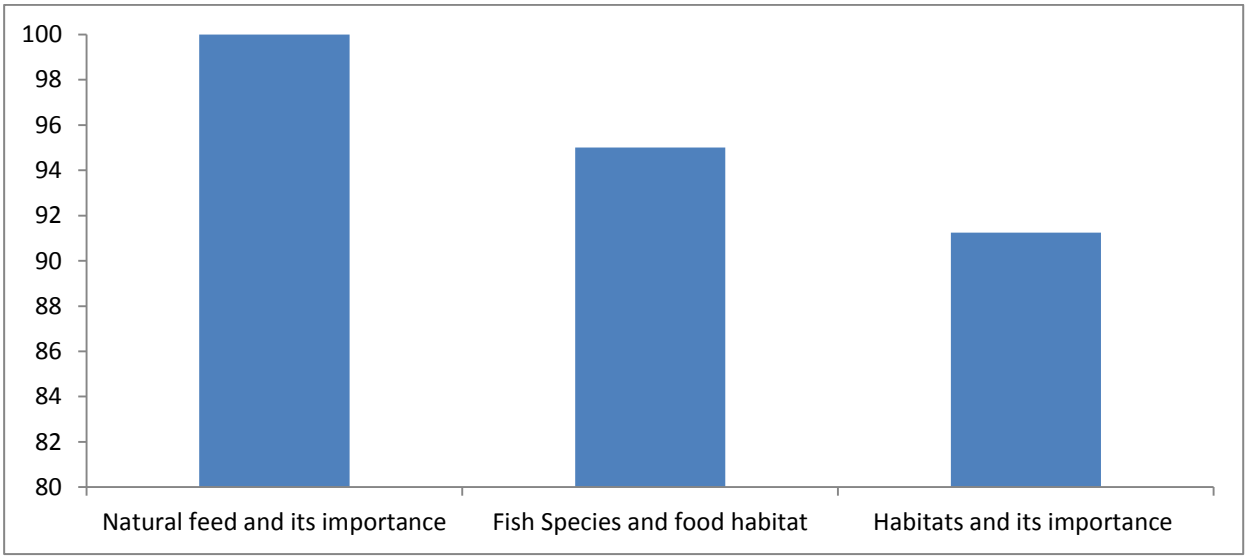

Figure 3. Knowledge about the science on fish culture technologies with its effectiveness in use in small ponds for fish culture by women

Women have extensive knowledge that diverse habitats can increase fish production. Fish appear to be growing faster, reproducing more and regular consumption from these ponds increasing. The diversity and intensity of habitats appears to create a “reef effect” that provides the necessary conditions for a diverse number of fish species to flourish. They have increased their knowledge on habitat restoration and practices that support aquatic habitat restoration and conservation. They used eight major habitats associated with local fish species: Water hyacinth ring, Bamboo Mat Cage, Bamboo braches, Concrete Ring Set, Aquatic Vegetation Cage, Rope Cage, Dried Coconut Leaves and Bamboo Tubes.

- Coconut leaves and bamboo branches are used to facilitate shelter and creation of good environment for fish to reproduce.
- Rope cage submerged in water enhances the growth of periphyton and useful for the fish the small larvae or fry of fish to feed natural feed
- Aquatic vegetation cages with floating plants useful to provide shelter of the fish, again helps to grow periphyton in roots. These floating plants, women directly use for their household consumption as fresh spinach. Based on the size of ponds the aquatic vegetation cages can also be make larger useful to facilitate the fish as well as use it regularly as fresh leafy vegetables for household consumption.
- Water hyacinth rings useful to provide shelter of the fish, again helps to grow periphyton in roots. The roots of water hyacinth are normally used for the attachment of eggs of different species of natural fish
- Rope cages in ponds are useful for attachment of snails, the growth of worms, insects useful for fish to eat
- Bamboo poles provide shelter for the bottom dwelling fish species especially for the local catfish; shing and magur.
- Concrete rings installed in pond bottom useful to hold water for longer period in ponds useful to conserve the fish to be used for production in the follow up production season not required stocking. For holding of water and conservation of natural fish species in ponds this is important. In practice the use of the concrete rings and holding of water sufficient to hold fish not work effectively. Therefore, taking into accounts the cost and less effectiveness of use of rings in 2015-16 the use of such rings have not been suggested for women those adopted as new.

4.2.2 Changes in the Perception of Women

There are big changes in perceptions of women about potential of use of small homestead ponds for fish culture. Women and other members of their households earlier thought that these ponds filled with lot of mud, bushes and other materials are not suitable for the fish culture, now they realized its potentialities of use for fish culture. Few of the ponds those are used for fish culture earlier there is no choices about the species of fish for stocking. Most cases the species of fish they received from the ghers or natural sources (rice fields or ditches) they stocked in their ponds. A structured questionnaire is used to collect quantitative information on issues related to improvement of knowledge individual women, a few of the questionnaire included collection of information from the men of the households. At the end of activities of fish production an exercise on participatory assessment is also used. The outcomes of the survey and the exercise showed that now women are very clear about the species of fish they need to stock in their ponds to get good results. The knowledge about the species of fish to be used, the stocking density and source of the fry they need to stock are known to them. They realized that such knowledge about the fish species is very important for getting good production of fish from their ponds.

Of the species they stocked in their ponds based on the performance in the total fish production and because of its higher preferences in uses for regular household consumption through regular harvest

(by angling) they ranked the tilapia the highest. It is followed by carps (rohu, catla and mrigal) and then climbing perch, the koi. Carps normally not use for regular harvest and consumption farmers try to keep it in ponds until it grows up to large size. For entertainment of guest carps are also considered as the best choice. Few women ranked mola high as they have received good production from their ponds and they used the fish regularly for household consumption. The women are very positive about mola as they aware about the importance of this fish as source of micronutrients vitamin A, calcium and iron. It is observed that women and her daughter directly harvest mola and other small fish from their ponds to use regularly for household consumption using a small piece of seine net which they can handle without any problem.

4.2.3 Practices by Women in Fish Production in Small Homestead Ponds

Traditionally, women help men mainly in feeding of fish and fertilization of ponds and in some women of poor households also support main in repairing of nets, making of fish basket, drying and processing of fish. Involvement of women in fish culture in small homestead ponds has brought a new dimension in fish culture. In which majority of the activities such as; building and setting of habitats, stocking of fry in ponds collecting from the fingerling traders, observation of fish in ponds, harvest of fish have carried out though active participation of women.

This is happened due to changes in the knowledge and the attitudes of the women in all the four communities. Women involved in involved in stocking fish fingerlings in ponds. In few cases the male members of their households helped them in collection of the fish from nurseries if it located far away from the communities. Although, the development of the frames and the building up different habitat structures physically hard, it is men who constructed the big structures/frames and women provided support by organizing the materials like coconut leaves, bamboo tube. Men helped the women in installation of habitat structure in ponds and the movement of these structures when it is required. Pond monitoring and observation of fish are very interesting and new thing for them. Women applied their leanings on their own pond – to monitor which fish breeds or which not, poaching of fish, and condition of the habitat structure used. They monitored carefully the habitats to look at which fish take shelter on it and the movement and feeding behavior of the fish.

Stocking of fish fingerlings – Women played major role in stocking of fish in ponds, the fish stocked brought to their ponds by local traders, and from the trader it is women who received the fish for stocking from the trader.

***Construction of habitat structure* and placement in ponds:** Men members of the household played the major role as it need to bring the raw materials to make the frame for the cages; however the women take part in the making of these in their place, for habitats like coconut leaves, getting of bamboo branches done by women as well.

Harvesting of fish from ponds: The households started to consume fish from their ponds around two months after stoking of fish. Traditionally women not involved directly for harvesting of fish from their ponds. Out of sixty it is found that eleven of them harvest the fish by netting in ponds. However, most of the women preferred to harvest fish from their pond by angling. The presence of lots of habitats in ponds created problems for harvesting the fish by using nets as it need to move the habitats for using net. The main purpose of the harvesting is to meet the demand of the children and consumption of the house. In general, daily harvest of small indigenous fish for family consumption is done by women with the help of children. This experience is illustrated by one woman respondent in Sukdhara community who harvested fish by net independently in her pond. She reported harvesting the fish by herself and also supporting other women of her group to harvest their fish. According to her statement, some women felt shy at the beginning but the situation has changed now. The male members of the family are happy with this new role of women

Monitoring of the Ponds and Observation of Fish – the activity is mostly carried out by women in all the communities

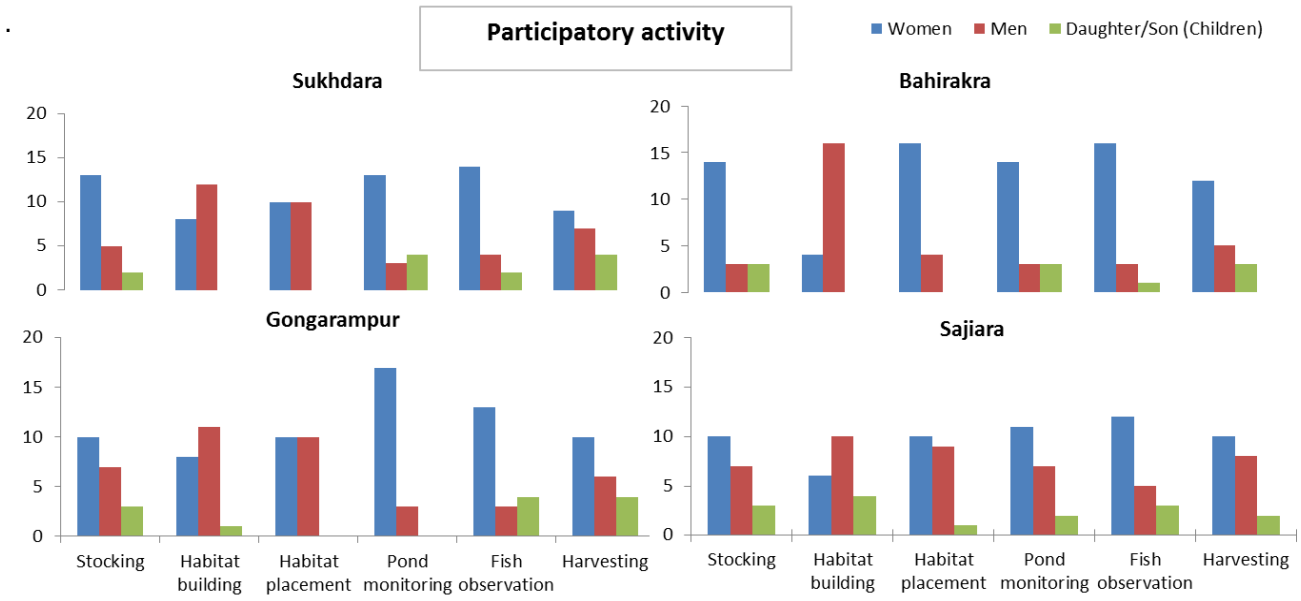

Figure 4. Participation of women and other household members in activities of fish culture management in small homestead ponds (taking the total score 20 for the individual activity)

Photos: 29, 30 & 31. Harvest of fish from ponds by angling, using caste net and complete drying of pond

4.2.4 Women Role in Decision-Making

The role of women farmers to support to their households has changed. All of them are now using their pond as an important source of fish for their regular household consumption. Moreover, their increased knowledge have gained after participating in the Ecopond project made them to play major role in decision-making in their households and make them respectful for their contributions. The changes in role of decision-making are not a simple process, it has influenced by so many factors from community expectation to economic circumstances of household and family norms and the individual characteristics of the parties involved. Participation in Ecopond has, not surprisingly, had mixed effects on farmer's reported roles in these processes. The farmers have the ability to take decision independently in management of their ponds for fish culture.

"With the involvement of this project I can save my household's expenditure (money). It does not need to go to the bazar (market) to buy fish for the household. There is a major change of such situation now. Supported by project I did research on the habitat and grow more fish than before in the pond. I hope that would be an income source for me in future if I continue this" – A Woman Farmer of Sajiara Community. For small homestead ponds it looks not much realistic about the expectation woman made to use fish both for household consumption and income. However, in 2015-16 it showed that women due to their improved they not tried to more production but also using more number of small ponds for fish production using the Ecopond approach. In their pond women are producing fish with having high demand and price therefore, it also showed that even they sale small amount of fish after regular household consumption it will be possible for them to get income as well.

During the Participatory Evaluation of the research by the community in the session women reported that their involvement in the project increased the extent to which they are consulted in decision-making related to fish in their households. The areas of decision making include fish stocking, fish culture management practices to be undertaken in this upcoming season, harvesting and uses of the fish for the purpose of consumption, gift to others and sale as well. In some important areas the women take the decision along with their household men members. Women farmers have the ability to know which fish is better to stock and they collect the fish from the fish traders and the cost to be incurred.
Pond management: Before starting of the project in those ponds under fish culture is undertaken it mainly men (87%) took the decision about pond management which has been changed. With their full confidence now women in around 68% of the households are able to take the decisions of pond management with their own.
Fish harvesting and uses: Harvesting of fish is the most important task of fish culture and in these areas people generally harvest fish for their own consumption. Of the women farmers 45% of them with their own took decisions about harvesting of fish for the purpose. It is around 37% women farmers who took the decision in consultation with their men in taking decision about harvesting of fish from the ponds. It came out that although women consult with men in most cases it came out that is the opinions of women are valued and accepted by their fellow men members of the household.

The result thus obtained has challenged gender-sanctioned norms whereby men are designated as farmers and women are regarded to the role of helper. Involvement of farmers in processes such as organizing field management has reinforced the notion that these women can tackle difficult issues successfully. One woman from Sajiara told that "*It is the first time I came out from the premises and talk in front of outsider and actively participated regularly in the learning sessions"*.

4.2.5 Self-Confidence of Women

Increased in Self-confidence: **The** knowledge on fish production and the performance obtained by women are useful to build up their self-confidence and positioning within the household and communities. Involvement of farmers in the participatory research made positive changes in gender norms related to access to knowledge on science about the technologies of fish culture with increase in fish production and increase support to the household in fish consumption. All the women farmers have greater confidence in their own abilities and are introducing themselves as "Fish Farmer Researchers" to visitors with their level of confidence. It was observed very clearly during the visits of high officials in the project areas. Women demands them as farmers researchers because like the researchers they are carrying out the activities with logic and understanding taking into account why and what they are doing with expected outcomes in mind. In the community other farmers with ponds not involved in the Ecopond research also come to women farmers and they made discussion on fish culture related issues and the problems they face in managing their ponds for fish culture.

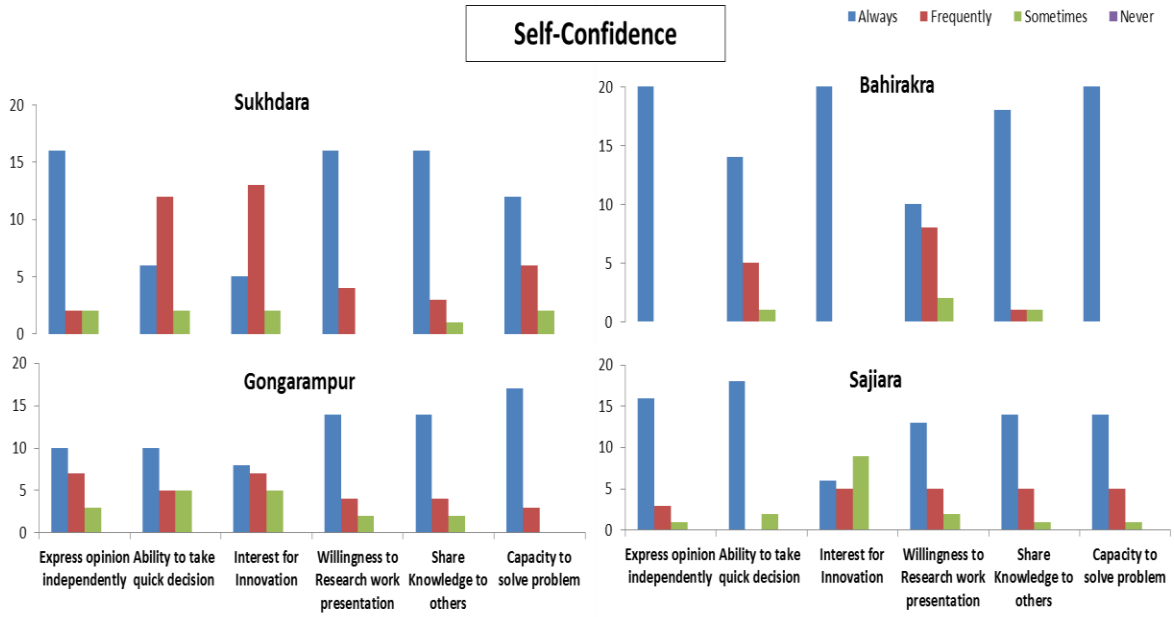

Figure 5. Participatory assessment on the level of self-confidence of women from four communities participated in the research (considering a total score of 20 for each criteria of the evaluation)

The participatory assessments of the self-confidence of women carried out based on the criteria (always, frequently and sometimes and never) on the following areas: capacity to express their opinion, ability to quick decision, interest for innovation, willingness to research presentation, share knowledge to others and capability to solve problems. Overall came out that women involved in fish culture in their small ponds under the Ecopond project most of them feel confidence. Women also shared their experiences with staff and high officials of several international and national NGOs like ASA, Uttaran, CARITAS , HEED BANGLADESH, Nijera Kori, BRDB, BRAC, Bureau Bangladesh, BWDB, Shusilon and Ad-din. They visited to them and showed lot of interest about the achievements the women made in carrying out fish culture successfully in small homestead ponds. The women were highly praised by the higher officials of these NGOs. It is not possible to organize to organize a group meeting with the experts of these institutions due to limited time. However, it will be good to organize such meetings with these stakeholders taking in to accounts the scale-out of the program in future for making the program a sustainable.

Farmers of the each community noticed an improvement in their inter-personal relationships with their household members due to the participation of the research project. Women farmers in Sukdhara and Sajiara said that before the men of their household members thought that women would be incapable of understanding the issues related to fish and had a habit of undermining them. The farmers said that now they have received recognition from them. The technical specialist who is also a women scientist mentioned:

"*In Sajiara village the women did not want to come to us and show any interest when we visited their houses to discuss about the research issues. Now we are surprised to find that the farmers feel free to talk with us and even the outside neighbor and visitors — I think this this is one of the most significant changes in attitude made*". Initially the challenge of their participation was made by establishment of LC within their community and facilitation of the session by women staff. The elderly women and men observed the activities and gradually through discussion with their women member who directly involved as well observing successes in production of fish in their ponds and regular consumption of fish both women and men of the households motivated.

WorldFish and partner NGO BRAC provide a project in which women are called upon by their own name in their group; previously these women are often referred with respect to their relation to men. The fish farmer shared their acquired science knowledge gained from learning sessions with their family members. In all villages, the women feel confident for their work. Because of increased self-confidence and changes in the conversations taking place in the household, some women in Gangarampur and Bahir Akra villages says:

"Supported by Ecopond Project we did research on identifying different species of fish and their habitats in the homestead ponds. That influenced me to productively use other ponds of my neighbor in future."

This challenged gender-sanctioned norms whereby men have been designated as farmers and women are considered to the role of helper. Women farmers involved with the research have started to move forward with their new identity as farmers and built on their strengthened capacities. In this research, the women fish farmer researchers have to face some visitors. Communicating with visitors of the project has helped farmers to develop self-confidence in communicating their needs and, therefore, they are now better able to avail support and gain access to information. Most of them are now confident to continue their research in future. All of them believe that this research outcome should be shared with other people within and outside of the community.

V Discussions

This research project presents women-led and ecosystem based approach to provide access to the small homestead ponds as well as increase the fish consumption of nutrition and positive changes of women. Though it is a very short time period (one year) project to bring positive changes of women, but surprisingly some major changes have been notified. Even the household members of the women fish farmers took it positively and helped the women to do research work in the ponds with interest and great willingness. Women fish farmer researchers felt that they have got appreciation, and their contribution is valued by the household members, the family and community. On Bangladesh social perspective, this change at this point brought lots of hope to involve women directly in fish culture.

Production of more fish and regular consumption of the household is the core focus of the women led research initiative. PAR has created opportunities and interest to act as key actor in research processes for the first time which enable women to build new skills and begin to see themselves and their capabilities differently. Altering mindsets and behaviors about gender is a long term process, and is one that needs to emerge from local recognition of a need for change.

The other purpose of the project is to bring changes among the farmers in order to help them develop the capacity to address fish issues. Women communicate with technical specialist of WorldFish with courage whenever they are facing problems related to fish. They have different experiment with different habitat structure in the learning session; these learning sessions are very helpful way to get technical support for any fish related problems. Communication between farmers, research organizations, government and non-government agencies, and other stakeholders are not formed at expected level which is very useful to continue the project. The weekly meetings provide a venue outside the home for social interaction and of mobility. Such interaction of experiences can lead to the development of strong support that enables women to act together in the face of unacceptable practices. The fish farmers have committed to use this acquired scientific knowledge of fish habitat and natural food in pond when they would release fish in pond in future. Therefore, it is a common

understanding that some small indigenous fish can also fulfill their regular household fish consumption and without using any types of commercial feed.

Involvement of community people in the process of Ecopond is vital for sustainability. It is true that in the context of sustainability there needs a strong and conscious desire and effort of the community people to play supplementary and complimentary role. The research was designed in such a way that creates ownership among the community people by involving them through participatory approach. The process of "OWNERSHIP" by the community people must be taken into serious consideration for institutionalizing the impact. Through process of critical analysis on the activities and outcomes the project is trying to develop a clear vision including the ways of transferring the "ownership" to the 'community' and connecting them with local support providers. It is expected to develop an effective MODEL on fish culture by women to play major role the most critical problem of reduction of malnutrition of the members of poor households especially the minor children, pregnant women and lactating mother who are the most surffers.

VI. Conclusion and Recommendations

The small homestead ponds can be used successfully for fish production by women using a new dimension of aquaculture which includes the use of effective habitats and management of ponds environment. The species of fish carp, tilapia, snakehead, climbing perch (koi), local catfish (shing and magur) and different types of small fish are useful for culture in these ponds. However, in order to improve their contributions especially for catfish and small fish some measures need to be undertaken. Like tilapia and carp it is important to stock large size fingerlings of all the fish for getting production. All of these fish are of high demand and for the small fish has special preference to households as it can provide the important micronutrients requirements (Vitamin A, Calcium and Iron) of the household members especially women and minor children. The use of the habitats and its management increase the production of fish to 2-3 folds and for one with the right combination of habitats it become more than 6 folds higher production obtained than baseline production without adding any fertilization or supplementary feed in the ponds. It is recommended to use these habitat combinations for all along with use of good quality fish seed. If fertilization and supplementary feeding to some extent is added it may increase production at higher level. However for fine tuning of the technology it is important to conduct further research in this regard.

It is important now to develop an effective strategy on how the findings of the research can be disseminated large numbers of women with having access to small homestead ponds in the country. Our survey in the CCAFS program of WorldFish showed that such ponds more available in areas in Barisal region as well. CCAFS is working for dissemination another innovation on establishment of microhabitats in water logged rice fields to get increased production of natural fish in the area and have lot of scopes to combine this work. WorldFish thus recommend developing strategy with the partners and donors to support in the process which will be useful to develop a highly productive resilient based system for fish production and fulfillment of nutritional demand of the households in the southern region of Bangladesh.

2nd Report on
Empowerment of Women and the Adoption and Dissemination of the Ecopond Approach in Southern Bangladesh

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Empowerment of Women and the Adoption and Dissemination of the Ecopond Approach in Southern Bangladesh

I Introduction

Bangladesh is considered as the suitable country for its favorable resources for fish production. The agro-climatic conditions with presence of large water resources provide good condition in this regard. Traditionally, like many other activities fish culture or production of fish is within in the domain of men and women activities are mainly confined household works based in the homestead areas due social and cultural restrictions. Nowadays, women are involved in fish production especially in their homestead ponds. They actively involved in fish culture in homestead ponds, nurseries, cages and even in rice fields. However, the role of women in aquaculture has not been sufficiently recognized and inadequately addressed. It is therefore, necessary to understand related issues and develop gender sensitive interventions in aquaculture for their empowerment. This survey aims to broadly understand the role of women in different dimension of empowerment through their active participation in fish production in small homestead ponds.

The Ecopond Project implemented from April 2014 to June 2015. The project extended until September 2015 as no cost extension and continued up to December 2015 with support from the Aquatic Agricultural (AAS) Program of WorldFish. The purposes of the extension of the Ecopond Project after its completion are:

- To measure the empowerment of women involved in Ecopond initiative using the details methods of the Women Empowerment Agricultural Index (WEAI) based on the recommendation of the final workshop of the project.
- Follow up the approach whether it is continued or not and if continued and how it is continued without any input support from the project with continuation of only the activities of the learning centers.
- Whether the approach is adopted by the other women in the communities with having small homestead ponds
- Look at the avenues for development of proposals for dissemination of the approach to other communities to have broader impacts on fish production, fish consumption for improved household nutrition, income and overall empowerment of women.
- Uptake of the initiative for its dissemination by other organizations, projects/programs (e.g. BLUE GOLD Program, CREL Project of Winrock International, CRS project and Odisha in India)

The major part of the 2nd report covered the details about the outputs and outcomes of the studies related to the Women Empowerment Agricultural Index (WEAI). It briefly brought the current update about the continuation and adoption of the initiatives by large numbers of women in the communities and the potential improvement in production, consumption of fish and income of women involved. Finally in conclude about the uptake of the initiative by several projects and programs in Bangladesh and in the South Asian region.

The final report of the project thus is the combination of the 1st report and the 2nd report. The Appendixes of the two reports are included at the end the 2nd report with specific indication. The contents of the 1st and 2nd report are included at the beginning together with page on list of abbreviations used.

II Fish Production in Small Homestead Ponds by Women: Moving towards Empowerment

2.1 Empowerment of Women

Since 1995 Beijing Declaration and Platform for Action that increased attention on women empowerment and women's rights on the international stage, the movement towards gender equality has continued to expand (UN, 1995; UN Women, 2014). Women's empowerment is a central key to promote development around the world. Different scholars defined empowerment according to the need of their work. Friedman's (1992) analysis of women's empowerment as different kinds of power: economic, social, political and psychological. Schuler and Hashemi (1994) defined elements of women's empowerment in Bangladesh that includes a sense of self and vision of a future, mobility and visibility, economic security, status and decision making power within the household, ability to interact effectively in the public sphere and participation in groups. While on other hand Rowlands (1995) described it as a process whereby women become able to organize themselves to increase their own self-reliance, to make choices and to control their own resources. However the dictionary meaning of empowerment is that it "the empowerment of a person or group of people is the process of giving them power and status in a particular situation (Collins Dictionary). Empowerment of women means to let women survive and let them live a life with dignity, humanity, respect, self-esteem and self-reliance. Women's empowerment is multi-dimensional and complex and requires a wider framework. In fact many of them value it because of its fuzziness, which gives them breathing space to work it out in action **(**Alkire, 2007**).**

It has seen that various scholars define empowerment in various ways on the basis of their work. However, five major domains of empowerment used for measurement of Women Empowerment Agricultural Index (WEAI) are; participation in decision making on production input, access to resources, control over income, leadership and time spent have been taken into consideration to assess overall empowerment situation.

2.2 Women Empowerment in Agricultural Index (WEAI)

The Women Empowerment in Agriculture Index (WEAI) is a new survey based index designed to measure the empowerment of women involve in the agricultural sector. As described by Alkire and Foster (2011), the WEAI is an aggregate index, reported at the country or regional level based on individual level data collected by interviewing women and men within the same households. The Index is a significant innovation in its field and aims to increase understanding of the connections between women's empowerment and agricultural growth. It measures the roles and extent of women's engagement in agriculture in five domains: (1) decisions about agricultural production, (2) access to and decision-making power over productive resources, (3) control over use of income, (4) leadership in the community, and (5) time use. It also measures women's empowerment relative to men within their households (**IFPRI, 2012**).

The WEAI developed to track the change in women's empowerment levels that occurs as a direct or indirect result of interventions under Feed the Future program of the US Government's Global Hunger and Food security Initiative. This current initiative is to look at the changes in the empowerment of women as a result of the intervention of fish production in small homestead ponds by women using 'Ecopond Approach'. It measures women's empowerment relative to men useful to understand about the areas to be improved.

2.3 Methodology to measure WEAI

The measurement of WEAI composed of two sub-indexes: one measure the five domains of empowerment for women, and the other measures gender parity in empowerment within the household. The five domains (5DE) index enables to understand how women are empowered and disempowered. It is an aggregated index develops based on information of individual men and women with in the household.

Sixty women involved in fish production under the Ecopond project during 2014-15 from four communities; Sajiara, Bahirakra, Gangarampur and Sukhdara are selected for collection of information for the measurement of WEAI. Of them, 20 households (30%) are selected randomly to collect information for measuring Gender Parity Index (GPI) in addition to WEAI. Twenty women and 20 men from two communities Dewatala and Araji in Dumuria Upazila those are not involved in fish production under the Ecopond project are selected for comparison. These two communities have been selected are not involved in project on fish production, each of them have a small homestead ponds normally not use for fish production and mainly uses for household purposes such as washing, cleaning

Table 1: Domain, indicator and weights in the women's empowerment in agricultural index

Domain	Indicator	Definition of Indicator	Weight
Production	Input in Productive decision	Participation in aquaculture and agricultural production (e.g., what inputs to buy, fish to stock, crops to grow, what livestock to raise, etc.) Sole or joint decision-making over cash-crop farming, livestock, and fisheries	1/10
	Autonomy in production	Autonomy in agricultural production (e.g., crops to grow, what livestock to raise, etc.). Reflects the extent to which the respondent's motivation for decision making	1/10
Resources	Ownership of assets	Sole or joint ownership of major household assets	1/15
	Purchase or sale of assets	Whether respondent participates in decision to buy or sell his/her owned assets	1/15
	Access to and decisions on credit	Access to and participation in decision-making concerning credit	1/15
Income	Control over use of income	Sole or joint control over income and expenditures	1/5
Leadership	Group member	Whether respondent is an active member in at least one group (e.g., agricultural marketing, credit, water users' groups)	1/10
	Speaking in public	Whether the respondent is comfortable speaking in public	1/10
Time	Workload	Allocation of time to productive and domestic tasks	1/10
	Leisure	Satisfaction with the available time for leisure activities	1/10

Source: Alkire et al. 2012

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In order to make this selection initially a list of 20 women with small homestead ponds total 40 women having potential to involve in fish production with willingness have been made and from them 20 women and 20 men are selected randomly. The team members of WorldFish who selected the women in two control communities are involved in the selection of the sixty women who are involved in the Ecopond project. Although, they selected them randomly, they found almost similar situations in terms of empowerment in relations to agricultural activities. A questionnaire developed consisted of six major areas (a) demography of the household (b) production input and autonomy (c) access of resources (d) control over resources, (e) leadership and (f) time allocation (Appendix 1).

In order to measure the roles and engagement of women in agriculture five domains (5DE) are used. The 5DE are: (a) decisions about agricultural production (b) access to and decision-making power over productive resources (c) control over on use of income (d) leadership in the community and (e) time use. This sub-index assesses whether women are empowered across the five domains examined in the WEAI in the households and communities. The second sub-index reflects the percentage of women who are as empowered as the men in their households. The households that have not achieved gender parity and show the gap, that need to be closed for women to reach the same level of empowerment as men. For this purpose principal man and principal woman living in the same households are selected for interview.

WEAI is thus an aggregate index that shows the degree to which women are empowered in their households and communities and the degree of inequality between women and men within the household. Therefore, progress toward empowering women in agriculture will be achieved by empowering them in the five domains and achieving gender parity within the household. A woman is defined as empowered in 5DE if she has adequate achievements in four of the five domains or is empowered in some combination of the weighted indicators that reflect 80 percent total adequacy. But we can also explore the range of achievements among empowered and disempowered women more closely. Each woman has an empowerment score, which is the percentage of domains (or, equivalently, weighted indicators) in which she has achieved adequacy.

2.4. Domains and Indictors

2.4.1 Domain 1, Production: Indicators - input in productive decisions and autonomy in production

Two indicators used in this production domain. One indicator is on input on decision on the participation in fish production in ponds (e.g., stocking of fish, contact to sources of fish, habitats, feed and harvest of fish). It includes about sole or joint decision-making over the activities of fish production. The answer scale for the question regarding input in decisions is 1=self, 2=spouse, 3= jointly with husband or any other members of the family 4 =others members of the household. For each activity, a sub-indicator was created that considers the individual adequate in her or his participation. For analysis self or jointly decision is considered as 1 and other response or no response is 0.

The other indicator of the production domain is the autonomy in production decision. An individual is adequate on autonomy if his or her actions are relatively more motivated by his or her own values than by coercion or fear of others' disapproval. The autonomy in production includes decision on (a) which types of fish to stock in ponds for production (b) which fish to harvest for household consumption and sale (c) whether to engage livestock rearing (d) whether to rare poultry (e) whether to engage vegetable cultivation. The answer scale for questions regarding the extent to which the individual feels he or she can participate in decisions is 1 = take all decisions, 2 = partly take some decisions and 3 = no decision made. Each of the these questions mentioned above is aimed at capturing a different kind of motivation

2.4.2 Domain 2, Resources: Indicators - ownership, decisions on purchase and sale and access to and decision about credit

To capture the individual's control over productive resources, three indicators are used: (1) ownership of resources; (2) decisions regarding the purchase and sale of resources; and (3) access to and decisions about credit. The ownership indicator examines whether an individual has sole or joint ownership of land and assets. A person is considered to have adequate achievements if he or she reports having sole or joint ownership of asset. All types of assets are considered here. The individuals who live in households that do not own any type of asset are considered inadequate on ownership. Although the ownership indicator covers all types of assets, this indicator refers only to agricultural productive assets, namely, fish ponds, fishing gears, agricultural land; fish, livestock chickens, ducks, and pigeons.

As in the ownership indicator, a person has adequacy in this area but she has no right to sell or buy the assets. We therefore, asked, "Who is the person who can decide regarding the purchase, sale, of land and assets?" Individuals who live in households that do not have any right to sell and buy any type of asset are considered inadequate and, hence, are assigned the value 0 for this indicator. This indicator assumes the value 1 if the respondent has, alone or jointly, at least rights considered to sell or to buy over that type of asset.

The third indicator examines decision-making about whether to obtain credit and how to use the proceeds from credit from various sources (nongovernmental organizations, formal and informal lenders, friends or relatives and credit associations). To have adequacy on this indicator, a person must belong to a household that has access to credit even if they did not use credit and if the household used a source of credit, must have participated in at least one decision about it. First, the indicator "access to credit" is created, which assumes the value of 1 if the respondent lives in a household that has taken a loan

2.4.3. Domain 3, Income - control over the use of income

The single indicator for this domain measures the degree of input into decisions about the use of income generated from the activities (1) food and cash crops (2) livestock productions (3) non-farm activities (4) fish production in ponds (5) poultry rearing, and (6) fruits as well as the extent to which the individuals feels he or she can make own personal decision regarding the share of household expenditure, and the constraint he or she face in decision making processes.. A person is considered adequate on this indicator if he or she has input into decisions about control over income generated.

2.4.4 Domain 4: Leadership in the Community – Group member, speaking in public, building infrastructure in community and feel comfortable to protest misbehavior of the community people

This fourth domain aims to capture the individual's potential for leadership and influence in his or her community. The domain comprises four indicators (a) whether the person belongs to an economic or social group (b) whether the person feels comfortable speaking out in public concerning their knowledge on fish production they gained, (c) whether the persons feel comfortable in deciding on infrastructure to be built in the community and (d) whether the person feel comfortable to protest the misbehavior of the community people. This shows whether the person is a member of at least one group including co-operative, NGO credit society or group, water user group, local group, association, network, fish production group related learning center based group. There are so many NGOs that may also be an impotent source of fish production information or inputs.

A person is considered adequate on this indicator if he or she has participated in a group and feels comfortable to speak freely in public and the protest of one's misbehavior. The indicator of whether the person is comfortable speaking up in public is constructed based on responses to questions regarding the person's ease in speaking up in public for three reasons: (1) to share their learning about fish production in ponds (2) to help decide on infrastructure (such as small wells, roads) to be built, (3) to protest the misbehavior of any person in the community. The three reason-specific indicators are aggregated into the indicator "speaking in public." The respondent is considered adequate in speaking in public if he or she is comfortable speaking in public. The answer scale for questions regarding the extent to which the individual feels he or she can feel comfort to speak in public is 1= yes comfortable, 2 = yes but with difficulty and 3 = not at all comfortable.

2.4.5 Domain 5: Time Allocation – workload for productive and domestic tasks, satisfaction with the time available for leisure activities

This domain consists of two indicators measuring the allocation of time to productive and domestic tasks and the second captures the individual's satisfaction with the time available for leisure activities.

Respondents are asked to recall the time spent on different activities during the previous 24 hours starting at 5:00 a.m. on the day before the interview. The individual is defined as adequate on workload if the number of hours he or she worked per day was less than the time line of 10.5 hours in the previous 24 hours. The individual is considered inadequate (have an excessive workload) if he or she worked more than 10.5 hours in the previous 24 hours with plus 50 percent of the time in domestic tasks as the secondary. The productive works are considered here as primary activity and household work as secondary activity. The last indicator asks whether the individual is subjectively satisfied with his or her available time for leisure activities such as morning walk, leisure/entertainment (TV, Radio), rest and spend time with children, neighbor and grand-son from 1=strongly dissatisfied, 2=dissatisfied, 3=neither dissatisfied nor satisfied, 4=satisfied and 5= very satisfied.

The indicator "leisure time" considers the respondent adequate if he or she ranks his or her level of satisfaction is 4 to 5. Each person is given a binary score in each of the indicator, reflecting whether she has adequate or inadequate achievements in each indicator.

Overall, a woman or man is defined as empowered in 5DE if she or he has adequate achievements in four of the five domains or is empowered in some combination of the weighted indicators that reflect 80 percent total adequacy or more. The rationale behind the choice of the 80 percent cut-off for determining total adequacy is discussed in the computing 5DE section. The 5DE convey the percentage of women who are empowered and the intensity of disempowerment.

2.4.6 Measurement of Gender Parity Index (GPI)

The second sub-index is the gender parity index (GPI) which measures women's empowerment relative to that of men by comparing the 5DE profiles of women and men in the same households. A woman is assumed to achieve gender parity if her achievements in the five domains are at least as high as those of the primary adult male in her households. The GPI reflects the percentage of women who have achieved parity and, in cases of gender disparity, the average empowerment gap that women experience relative to their male counterparts. While the 5DE score is calculated using all women in the sample, the GPI score is not calculated for women living in a household where no adult male is present. The overall WEAI is constructed by calculating the weighted average of the 5DE and GPI as follows:

WEAI = (0.90 × 5DE) + (0.10 × GPI)

It thus gives a broad picture of women's empowerment by showing not only the proportion of women who are empowered and have gender parity but also, for the remainder of women, the depth of their disempowerment and gender disparity. Values for the WEAI and its sub-indexes range between 0 and 1, with higher numbers indicating greater empowerment. In the survey, most but not all cases, the primary men and women are husband and wife. The GPI shows the percentage of women who achieve parity with their male counterparts. In cases of gender disparity, the GPI reflects the relative empowerment gap between the women's 5DE score and the men's.

The GPI can thus be increased either by increasing the percentage of women who enjoy gender parity --allow detailed analyses of gender differentials in empowerment in agriculture, or, for those women who are less empowered than the men in their household, by reducing the empowerment gap between the men and women of the same household.

Similar to 5DE, we compute the GPI to celebrate gender parity in a positive sense; however, its construction immediately facilitates analysis of households that lack gender parity. The GPI combines two key pieces of information: (1) the percentage of women who have not yet achieved empowerment or gender parity relative to their male counterparts (within a given population) and (2) the extent of the inequality between those women who lack parity and the men with whom they live. The Gender Parity Index (GPI) is a composite index that reflects the percentage of women who have gender parity as well as the empowerment gap between men and women in households not having gender parity.

Measuring the 5DE results in a number ranging from zero to one, where higher values indicate greater empowerment. The score has two components. First, it reflects the percentage of women who are empowered (He). Second, it reflects the percentage of domains in which those women who are not yet empowered (Hn) already have adequate achievements. In the 5DE formula, Aa is the percentage of dimensions in which disempowered women have adequate achievements: 5DE = He + Hn (Aa), where He + Hn = 100% and 0 < Aa < 100%. This can also be written, following the Alkire Foster methodology, as {1 – (Hn x An)}, where An = (1 – Aa) and reflects the percentage of domains in which disempowered women on average do not have adequate achievements. First, the 5DE score can be increased by increasing the percentage of empowered women. Second, the 5DE can be increased by ensuring that disempowered women are empowered (or, have adequate achievements) in a greater percentage of domains.
The innovative GPI also ranges from zero to one, with higher values indicating greater gender parity. This sub-index is similar to the 5DE. First, it reflects the percentage of women who have gender parity. Specifically, it shows the percentage of women who are living in households with adult primary men where the women's empowerment scores are at least equal to the men's in their household (HGPI). Improvements in either the 5DE or GPI will increase the WEAI.

According to Alkire et al. (2013), a household enjoys parity if the woman is empowered or her empowerment score is greater than or equal to that of men in her household. Thus, the gender parity gap is zero if the household enjoys gender parity. Otherwise, the gap equals the difference in the male and female aggregate empowerment scores.

2.5 Results and Discussion

2.5.1 Descriptions of the Quantitative Analysis

In communities under project intervention 37% women are empowered in 5DE whereas in communities under nonintervention only 5% is empowered across the all domain. GPI showed that 53 % of women have gender parity with the primary men (their husband) and 47% of women have gender no parity in intervention area. In non-intervention only 10% women have gender parity and 90% women have gender no parity with their primary men in the household. Of the 47% of women who are less empowered, the empowerment gap between them and the men in their household is large at 17%. In the non-intervention area, 90% women are less empowered, the empowerment gap between them and the men in their household very large at 34%.

Table 2: Result of five domains with value of the Women Empowerment Agricultural Index

Indices	Women in communities under project intervention	Women in communities under non - intervention group
Disempowered Headcount (Hn)	63%	95%
Empowered Headcount (He)	37%	5%
Average Inadequacy Score (An)	57%	91%
Average Adequacy Score (Aa)	43%	9%
5DE Index [He+ (Hn* Aa)]	0.641	0.140
Percent of women with no gender parity (HGPI)	47%	90%
Percent of women with gender parity(HWGP)	53%	10%
Average Empowerment Gap (IGPI)	34%	17%
GPI [1-(HGPI* IGPI)]	0.837	0.845
WEAI= 0.9x5DE +0.1xGPI	0.660	0.211

The WEAI for the intervention areas is 0.660. It is a weighted average of the 5DE sub-index value of 0.641 and the GPI sub-index value of 0.837. It identifies the domains in which women are disempowered as well as the relative degree of disempowerment. The figure: 1 describes the overall pattern of women's disempowerment across the five domains in intervention and non-intervention areas. The key domain that contributes the most of the disempowerment and then within each key domain identify the indicators that contribute the most to disempowerment - continuous measure of empowerment that draws on the individual-level data for the identified indicators.

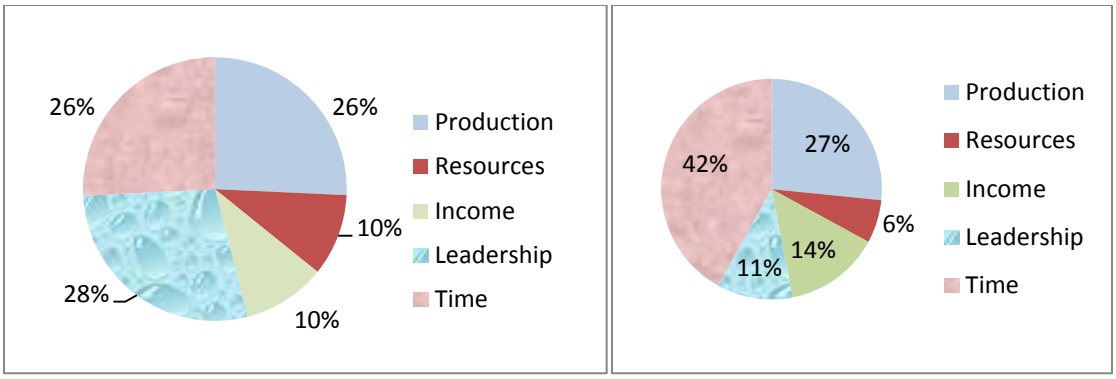


Figure 1: Pattern of women disempowerment in five domains (a) intervention (b) non intervention

The key domain that contributes the most of the disempowerment and then within each key domain identify the indicators that contribute the most to disempowerment - continuous measure of empowerment that draws on the individual-level data for the identified indicators. Figure 1 (a) and (b) showed that the production, leadership and time domains contribute the most to women's disempowerment in intervention areas. In nonintervention area, production, income and time domains contribute the most to women's disempowerment.

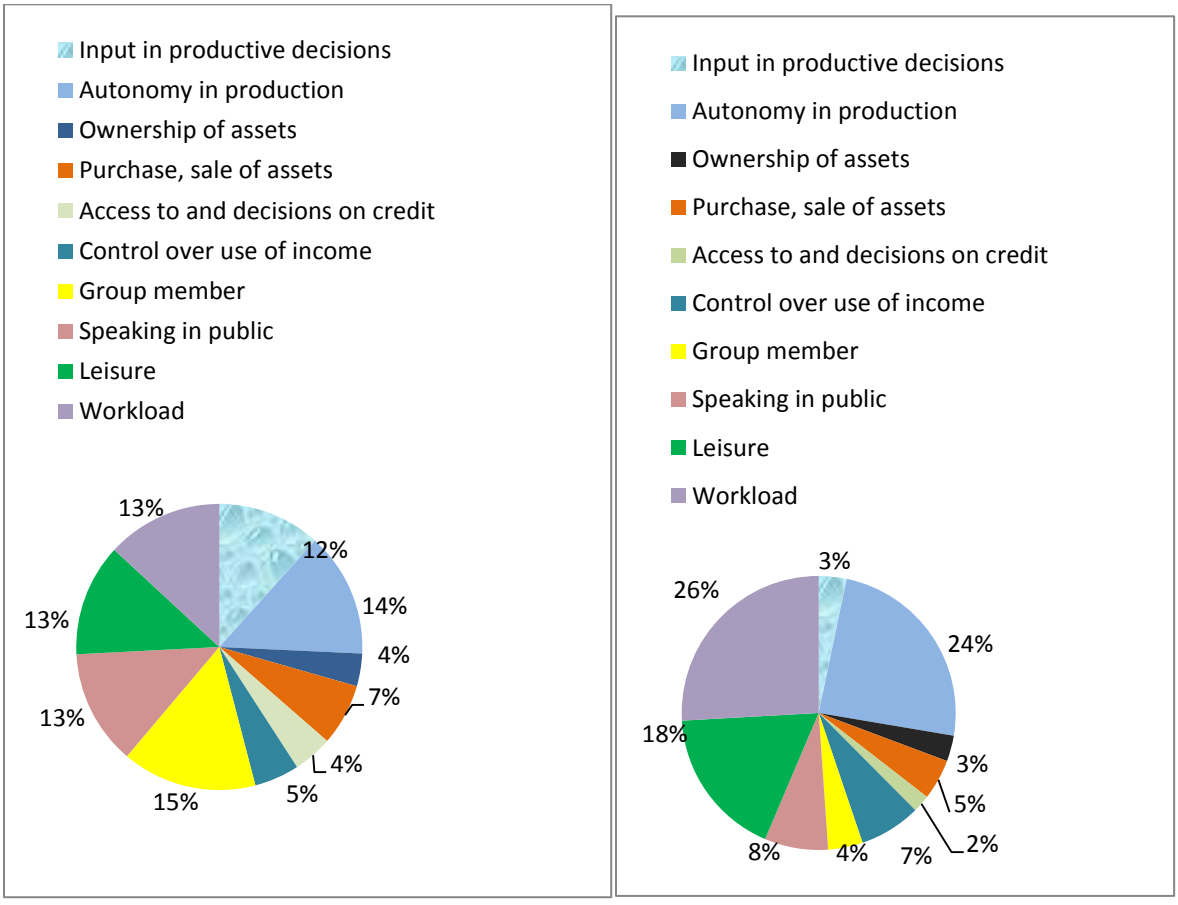


Figure 2. Domain identifies the indicators contribute the disempowerment of women in communities under project (a) intervention and (b) non-intervention

Fig 3 (a) and (b) showed that the contribution of each domain indicator of women disempowerment in intervention and non-intervention areas. In the intervention area ownership of assets and access to decision on credit emerges that contribute most to disempowerment in the resource. In the non-intervention area input in productive decision, ownership of assets, access to decision on credit appears that contribute most of the disempowerment in production and resources. Average number of decisions, concerning credit, taken by female is the number of credit decisions that the female respondent has made solely or jointly, averaged over the lending sources used.

. In areas with intervention the gender parity index, it indicates that in production the average empowerment gap in production is 23 percent, in resource 53 percent, income 100 percent, leadership 0 percent and time 50 percent in intervention area.

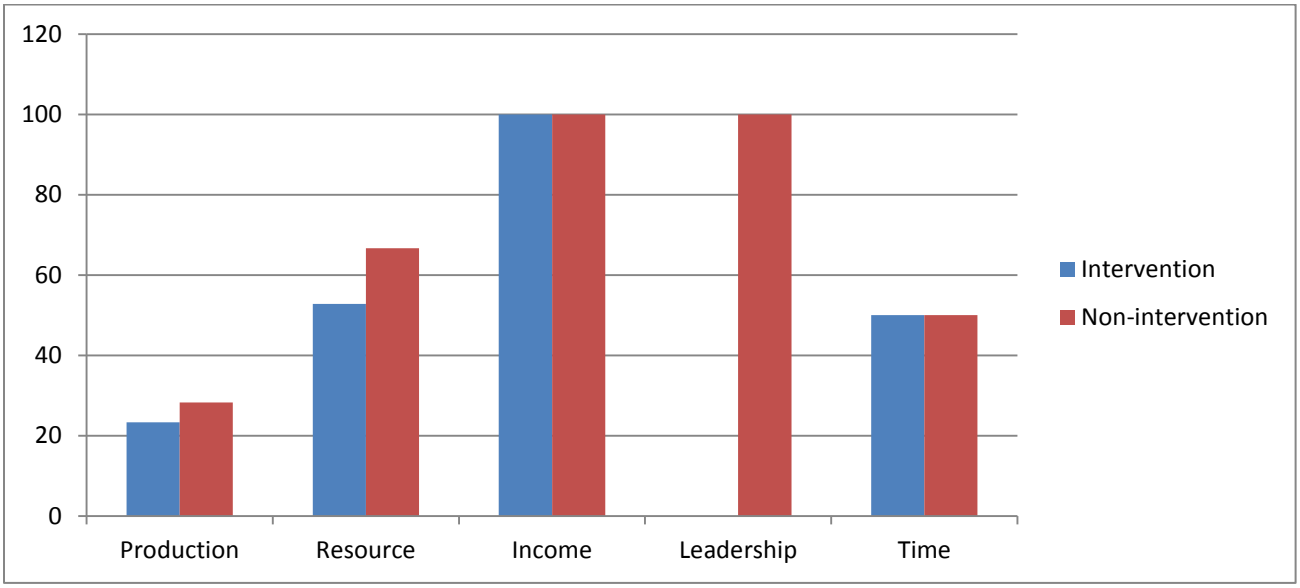


Figure 3: Average empowerment gap of men and women in five domains in intervention and non-intervention areas

In non-intervention area, 28 percent, resource 67 percent, in income 100 percent leadership 100 percent and time 50 percent. In production, resource and leadership domains, the average gap of women empowerment is lower in intervention area than non-intervention area (23 percent vs. 28 percent, 53 vs. 67percent, 0 percent vs. 100 percent).

2.5.2 Qualitative Descriptions of the Results under Different Domains

(a) Participation in Fish Production

In fish production in small homestead ponds women involved in various activities; stocking of fish, contact the sources, habitat use and management and harvesting of fish for household consumption. **Stocking of fish in ponds:** Most women reported that they themselves take the decision for stocking fish as they have got the knowledge on which fish would be stocking for their ponds. Women collect the fingerlings from their own, either from their own pond, neighbor's ponds or sometime from their fingerling traders. Although majority women take the decision stocking of fish however, purchase of fish seed found to be difficult for them due to limited mobility and lack of reliable source of quality fingerling to be purchased as fair price.

In non-intervention area only 5% women take the decision on fish stocking independently, as the ponds are not treated as pond for production of fishes. In other cases most of the men solely take the decision on fish stocking, because they think it is not the domain for women.

Habitat use and management: Women in Ecopond project participated in establishing different types of habitats in their ponds which include; coconut leaves, bamboo branches, vegetable cages, water hyacinth rings and from previous year some of them used the rope cages, concrete rings and bamboo tubes with technical knowledge on habitat to increase fish production. Women take decision on type of habitats in the pond, and they collect these habitats mostly from the natural sources. Women have gained knowledge on usefulness of habitats and in the previous project they got higher production of fish using these habitats with minimum use of supplementary feeds. Few women involve their husband in making the water hyacinth cage and vegetable cages and repairing the existing habitats.

In non-intervention areas in few cases use bamboo poles and branches of trees are used in ponds. They used these not as habitats but used as for security purposes to protect from poaching of fish although these served both the purposes and it is the men who took the decision about the use of these habitats.

Harvesting of fish form ponds: Harvesting of fish is done by rural women if they have the required expertise and are aware of the technology to make different kinds of gear. In the areas with project intervention 56% women take decision independently on when or how they harvest the fish for household consumption with their children. Culturally, women not fish when husband or other men members at home in their ponds especially when it is deep to get down and it makes them wet. They cited two causes for that mainly harvesting with net is very difficult for women and women are not interested for harvesting. In the communities under non-intervention men are solely responsible for taking decision on harvesting of fish from their ponds.

(b) Autonomy in Fish Production

Autonomy in production activities is measured in terms of extent of their involvement along with decision in different selected activities viz. crops, vegetables, fruit trees, rearing poultry and livestock.

Cash crop production: Majority out 65% of total 57 households under project invention involved in cash crop production and among them 14% women takes decision against cash crop. All of them are widow and they have only marginal land holdings. Women also participated in harvest of crops, processing, cleaning, peeling and drying. In non-intervention area, those households are involved in agricultural cash crop and no women take decision in this regard.

Vegetable and fruit production: Women participation rates for vegetable gardening and fruit trees are higher than any other activities and women have relatively higher freedom. They are primarily responsible for seed processing, storage, and for growing most of the family's fruits and vegetables. In these areas 45% women took decisions for seed collection, growing, harvesting to selling. In these cases vendors come to their home for buying the fruits and vegetables. In non-intervention area, in case of fruit trees (11%) and vegetable gardening (17%) women take independent decision.

Cattle, goat, and poultry rearing: In the farming system, cattle, goat, pig, pigeon and poultry are most commonly reared animals. In the intervention area, a system on sharecrop out business for livestock is practiced by the community people. Under this system, cows or goats or pigs are given to women (commonly women) for rearing by men (parents and husband or through purchased by their name).

They do all rearing activities including feed, shelter and vaccine (if required). When the livestock grown up they sell it and get the half share of the selling price. Poultry rearing is a traditional activity performed by women for income generation, being in this case only source of income under their control. The women apply their own methods of rearing, breeding and management, based on the experience handed down from the elder family members. The findings depicts that woman participation is 84% in collection of poultry, feeding poultry, taking care of poultry and 11% take jointly decision with their husbands. In the case of joint decision their husbands play role in selling of eggs and poultry.
In non-intervention communities 64% women take the decision independently regarding poultry and 29% women partly take decision with husbands and earn small amount of money from selling the poultry and eggs.

(c) Resources – ownership and access

In a patriarchal society like Bangladesh generally men has ownership, access over all resources and women have no ownership or less access to resources. Therefore they have less scope to take decision on any resources. Of the four communities under project intervention two –Sukhdara and Bahirakra are completely Hindu communities, the Gangarampur dominated by Hindu households but there are few Muslim. The community is a Muslim community in which of total 15 household only one is of Hindu religion. In case agricultural activities the resources include; agricultural and homestead land, ditches and ponds, livestock and poultry, farm equipment (mechanized and non- mechanized) and means of transport.

Women those have access in different resources; all of them not able to take decision regarding the sale or purchase of resources. Only 8% in agriculture, 11% in homestead land, 13% in small ponds, women have access and decision making. Those who live in their parental care can take decision on agricultural, homestead land, pond and ditches. In case of agricultural land, it is the widowed and one woman who purchased land on her own able to take decisions. Some of them have partial decision make role in selling and purchasing of major resource.

In non-intervention area, women have less access to homestead land (5%), livestock (18%) and poultry (64%). They do not own any other resources mentioned in this survey. Except in poultry they do not have control in selling and purchasing the resources. All the respondents in intervention areas are involved in Learning Sharing and Documentation (LSD) from which they have received knowledge.

Access and use of credit: They also involve with credit group or co-operatives or any informal associations which created opportunities for them on savings and taking loans. Respondents received an amount of loan from NGOs (65%), mainly from BRAC, Grameen Bank, and ASA, formal institution (27%) like bank and cooperatives and relatives (8%) with an interest. Women reported that most cases they are excluded from loans from commercial banks because of lack of land ownership, their access to institutional loans was further restricted by their lack of education, confinement to household activities, lack of familiarity with loan providers and restrictions on their mobility. It is really surprising that although women receive loans from the NGOs as microcredit in the households the men members take the loans for uses.

They used the loan in buying boat, motor bike, to start a poultry farm, to buy cows, to purchase land and some invest the loan in business. Therefore, it is always important how women can directly use the microcredits and get directly outcomes of the investment. In non-intervention area, only 13 % take credit from mostly on NGOs, one from relatives and one from money lender with a high rate of interest. They used the loan for the treatment of husband and most of them lent the money to their neighbors as money lender.

(d) Income – control over the use of income

In this domain the average gap of men and women empowerment of intervention areas and the average gap of men and women empowerment is non-intervention areas is equal i.e. 100 percent. In both cases the informal income coming from the poultry, livestock, vegetable and fruit. They contribute a part of their income to meet household needs and the rest they use according to their own. Widow women hold relatively more control over their income than others (Hemlata from Gangarampur, Chandana from Sukdhara, Purnima from Bahirakra and Rexone from Sajiara).

In the non-intervention area, 80% women have small amount of earnings from poultry and livestock and out of them 60% can spend their earning basically children education for buying khata, pencil, book and household expenditure (60%) and for their own purpose. Now a day's women are seen more concerned about their children's education and findings show that more than half of the women (60%) participate in children's education through taking care of them. Another explanatory factor is that women who are widow and abandoned have full control over the household income.

In the intervention area, women with their limited income from the poultry, livestock and vegetable cannot contribute more to household income so household level decision making is not significant. In non-intervention area 75% women take decision on household activities. As such, almost all economic decisions are ordinarily done by men.

(e) Leadership - Group member, speaking in public

Women of intervention area achieved significant level of knowledge about the science on fish culture technologies which help them to be able and potential to deal with the activities. Some of them worked as informal leaders and had to share their knowledge with the community people, project staff and the external visitors. In this way they become more vocal and learned to overcome their shyness and feel confident to speak up on knowledge of natural feed, habitat in public. Involvement of farmers in the processes such as organizing themselves has reinforced some of them to tackle difficult issues successfully. Women applied the learning not only their fish related activity, but in family as well as their community by taking decision on infrastructure to be built in their community.

To better understand the status of women' for leadership and influence in the communities where they live, the baseline survey asked women about their comfort level in speaking up in public regarding the knowledge on natural feed and habitat and species related work, infrastructure (small wells, roads, water supplies) to build in the community and to talk or protest the misbehavior of the community people.

In the intervention area all 57 women are involved with Learning, sharing and documentation Center. It was reported that in the intervention area, 26% involve with NGOs along with learning and documentation center. 11% involve with water management committee along with NGO and LSDC. 11% of them are the leaders of the different credit group.

It is recognized by the household and family that women play a significant role in fish culture in the implementation area. Fish culture activities of women at village level have enhanced their position within the households and families. Almost all women interviewed noted that their position has somewhat improved due to such involvement. In our earlier report it has found that women's participation in fish culture in ditches has changed the attitudes of family members, including their husbands, mothers-in-laws and other female relatives. The new identity of women as fish famers with new knowledge about the science on fish culture technologies they have increased their perceived value, respects within the households, families and to some extent self- confidence. Women farmers

involved with the research have started to move forward with their new identity as farmers and strengthened their capacities.

We selected the nine items for measurement of the self- confidence giving 5 weightage for each criterion. We used Likert scale for measuring self- confidence. The assessment of self-confidence of women carried out based on the criteria (1 = strongly disagree, 2 = disagree, 3 = neither disagree nor agree, 4 = agree and 5 = very disagree) on the following areas: capacity to express their opinion, have clear understanding on activity, ability to quick decision, interest for innovation, willingness to research presentation, share knowledge to others, capability to solve problems and freedom on mobility.

We asked each participant and give the weightage. Each item responses may be summed to create a score for a group of items. Likert item is treated as indicating a 'better' response than the preceding value and scales. Multiple the probable criteria (5) into areas we got the value 45. Add one's total score and divided by 9 to get the average score. In this way we find that in intervention area 72 percent women are agree, 28 percent are disagree. In non-intervention area, 100 percent fall in disagree.

(f) Time – Workload, Leisure

The management for fish production in small homestead ponds require less time, women can carried out after completion of their usual household works. The activities sometimes are recreational, attractive, interesting, natural, conservation related, based on the existing habitats and less labor is required. The survey revealed that most women's (56%) involvement in fish cultivation in the morning time within 9-12 am. 30% women do it in the afternoon during 12:00-2:00 pm and 16% do it in the evening. Some women prefer to do it very early in the morning 7:00-9:00 am (26%). The works in pond include feeding, harvesting, watching fish in the pond, and to clean the dike.

Women take care of both the children and elderly people of the households whenever they get time to take little rest. To describe their leisure time as rest, to see the Television, sewing and knitting, spending time with household members, children and grandson. Of the women 77% have leisure time in the evening and 53% get their leisure time at night and they spend their time seeing television. 51% spend their time in afternoon after completing of their household work they take rest.

The women in non-intervention are not involved in fish culture in pond. Only three women are involved in some activities like watch the fish pond and provide feeding to the fish.

III Continuation and adoption of Ecopond Approach

In 2015-16, the year after the intervention of the project in addition to 60 women with 60 ponds who were involved in the Ecopond research (during 2014-15) total 160 women with 265 ponds continued and adopted the technology as new adopters in all the four communities (**Table 3**). Of the communities adopted the approach the numbers are higher in Sukhdara and Gangarampur in Batiaghata than in Sajirara and Bahirakra in Dumuria. This is related to comparatively greater advancement of women of the two communities with presence of their perennial ponds with having presence of some of the fish from the previous stock and use throughout the year with, higher level of motivation and less problem due to climatic factors. The low level of adoption of in the ponds of women in Bahirakra are related to climatic factors, most of the ponds in the communities are seasonal and during this year it is facing severe problems of flooding due to damage of the polder areas. In addition, to such problem due to motivation farmers those involved continued the production and in addition, few of them adopted the approach as new. On the other hand the women in the Sajiara community (Muslim) faced cultural barriers to involve in fish culture. Although, during the period those involved are highly motivated and continued their activities and few of them adopted the approach as new as well.

Table 3. Women in communities involved in fish production in their small homestead ponds

Upazila (Sub-district)	Community	Year 1 (Aug 2014- June 2015)		Year 2 (July 2015- June 20 16)	
		Number of women	Number of pond	Number of women	Number of ponds
Batiaghata	Sukhdara	15	15	74	162
	Gongarampur	15	15	45	62
Dumuria	Bahirakra	15	15	21	21
	Sajiara	15	15	20	20
Total		60	60	160	265

Opportunity for regular household consumption, production and uses of species of fish of having preference for consumption by the households, the less expensive in production of fish from their small ponds which are largely unused or having low level of fish production motivate the households to continue their own production without any input support from the project. The factors those motivated women to continue and adopted the activities of fish culture in their homestead ponds includes about the success in their fish production in the previous year, the opportunity to get harvest of fish for regular household consumption.

Fish production in large size ponds are normally carried out in Bangladesh following semi-intensive management dominated by polyculture using different species of carps. This includes the uses stocking of fingerlings every season and application of regular feeding and fertilization for production of natural food. Over the years farmers are also practicing the intensive culture of the fish (e.g. pangasius, tilapia, and anabas) using industrial pelleted feeds with very high level of production using high investment. The small size homestead ponds of the poor farming households used for production of different species of fish by women with success are always overlooked for fish culture.

This project explored the technologies of fish production in these small homestead ponds by women taking into accounts the existing physical conditions by using suitable species of fish (carp, tilapia, local catfish, anabas, snakehead and different species of indigenous small fish) largely depending on natural feed production. The participatory research conducted with farmers, the habitats used, suitable species of fish stocked, the establishment of learning centers in each communities with active participation of the women in the participatory learning sessions all brought the success in production. Although, there are variations in productivity of the ponds under different treatments women in all the treatments achieved success and highly motivated for carrying out activities. The results of the research showed that how women with such small intervention are enthusiastic to take part in the sessions and eager to use their leanings to get increase fish production from their ponds. The results of the follow-up year which is continued (June 2015 to May 2016) showed that due to high level of interest all the women those involved continued as well most of the women with all their small homestead ponds (total 160 in four communities with 265 ponds) adopted the approach with their own initiatives with minimum support of continuation of the learning centers with facilitation from the project staff (extended period).

Initially the research was largely developed as a technical but over the period in incorporated many of the important issues related to the empowerment of women. The outcome obtained made visible the decision making role of women in their participation and implementation of the activities through active participation. It also signified the leadership of some of the women through the activities which includes their role in sharing of the lessons in the communities and ability to speak in the public (visitors, in workshops). The women made big changes in which they able to motivate their men members showing

the success and the overall achievements. They able to generate community interest through bringing most of the women with small homestead ponds under the Ecopond approach using their own initiatives with minimum support from the project.
Of the follow-up works the measurement of the Women Empowerment Agricultural Index (WEAI) is one of the first initiatives in the field of agricultural focusing on the fish production system (described in Chapter 2). The results showed a significant level of empowerment of women in various domains in communities with the Ecopond project in comparison to women in communities without such initiative in the same areas.
.In summary it can be mentioned that the continuation and adoption of the Ecopond approach are the results of the following:

- It brought changes on no fish production (or limited amount) to a success in bulk amount of production of fish suitable species with high preference that is like 'No' to 'Yes'.
- It is simple for them to adopt with their own (160 women adopted in their 265 ponds), using fish of previous stock and adding as new stock (perennial ponds) collecting from traders and from natural sources locally (small fish, snakehead), using largely local materials (coconut leaves, bamboo branches, water hyacinth cage, vegetable cages and some habitats – rings, bamboo tubes and rope cages of previous year).
- The cost involvement for stocking of fish and habitats is low due to presence of fish of previous year (for perennial ponds) around BDT 550/pond (Annex 1 Table 3) and women are expecting comparatively higher production of fish than previous year
- Women are looking forward for getting cash income from sell of fish in addition to household consumption due to increase fish production
- Most of the women started harvest of fish, the record of October and November 2015 (2 months) showed on average consumption per household 3512g, 2865g for Sajiara, Bahirakra in Dumuria (Annex 1 Table 1) 2737g and 3332g for Gangarampur and Sukhdara in Botiaghata (Annex 1 Table 2) communities respectively.

IV Conclusion

In the 1st part of the project covered the outputs and outcomes of the use of the small homestead ponds using habitats and suitable species of fish in a way that fish production and household fish consumption increased and bringing lot of positive changes related to empowerment of women.
This report clearly demonstrated about the methods to be used for measurement of the Women Empowerment Agricultural Index (WEAI) effectively using five domains with indicators focusing on the fish production activities and other related aquaculture and agricultural activities women involved in communities with Ecopond and outside communities. The results showed that the involvement of women in the fish production activities under the Ecopond project significantly empowered women as compared to women in communities without such intervention.

The learning of the empowerment of women from Ecopond can be applied in other projects and programs where the gender issue is important more importantly the issue of women empowerment is vital to achieve and with a solid basis on how to measure the level of improvement in empowerment of women through application of WEAI In practice.

The Ecopond initiative has been taken up for promotion with 500 women in Khulna near the Sundarbans through CREL project for implementation in 2016-17. In two CRS supported project of CARITAS Bangladesh implementing in the Southern and Northwestern regions of Bangladesh the initiative going to be undertaken. For both CREL and CRS projects WorldFish is providing necessary support for its promotion through capacity building of the project staff and providing monitoring support.

The initiative is expected to be uptake for promotion in Odisha, India under a collaborative program with WorldFish to be started in 2016 for a period of 5 years. It is also expected to disseminate the initiative to all the women with small homestead ponds in the polder areas of the BLUE GOLD program and WorldFish is making necessary coordination with the program in this regard.

1st Report

Appendix 1: Fish production from individual small homestead ponds of women under different treatments with different combination of habitats (T1-T4) and without habitats (T5)

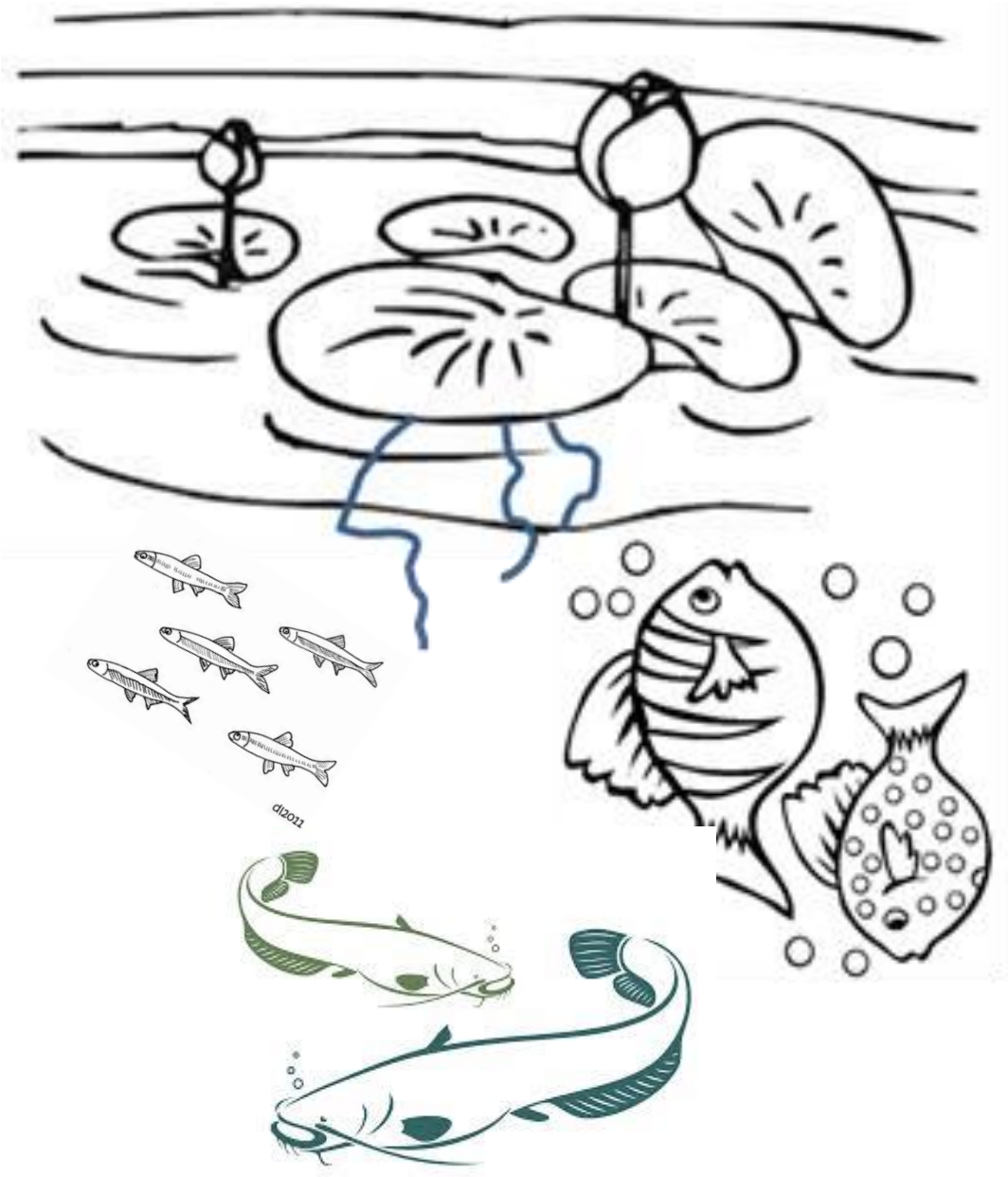
Name of women fish farmer	Type of pond	Area (decimal)	Fish production from Aug-Mar'15(kg/pond)	Fish production from April – June '15 (kg/pond)	Total fish production (kg/pond)	Total fish production (kg/ha)
Treatment T1: Water hyacinth ring, bamboo mat cage, bamboo branches and concrete ring set; .Sukhdara, Botiaghata						
1.Archona Mondol	Seasonal	3	12		12	1011
2.Basonti Roy	Perennial	3	16	3.2	19	1589
3.Chanda Roy	Seasonal	2	10	1.7	11	1385
4.Hira Roy	Seasonal	1.5	7		7	1091
5.Kajol Mondol	Perennial	2	8	0.2	8	1012
6.Konika Mondol	Seasonal	2	9		9	1115
7.Lucky Mondol	Perennial	2	8	3.0	11	1354
8.Nilu Mondol	Perenial	1	1	0.9	2	483
9.Provati Sarker	Seasonal	2	1		1	179
10.Rekha Mondol	Seasonal	2	11		11	1313
11. Rinku Gain	Perennial	2	8	2.6	11	1335
12. Tumpa Mondol	Perennial	2	7	1.6	9	1109
Treatment T2: Aquatic Vegetation Cage, Rope Cage, Coconut leaves and Bamboo Tubes , Bahirakra, Dumuria						
13.Bijoli Mondol	Seasonal	2	22		22	2664
14. Ivy Rani Biswas	Perennial	2	23		23	2827
15. Kolpona Biswas	Seasonal	3	20		20	1657
16. Lakshmi Mondol	Seasonal	2.5	19		19	1868
17.Rabita Mondol	Seasonal	2	12		12	1479
18.Rita Mondol	Seasonal	1.5	15		15	2540

19.Bijoli Mondol-2	Seasonal	2	5		5	605
20.Monju Mondol	Seasonal	2	3		3	375
21.Monju Rani Biswas	Seasonal	1.5	17		17	2818
22.Nilima Rani Biswas	Seasonal	1.5	11		11	1837
23.Purnima Mondol	Seasonal	1	0		0	81
24.Rekha Mondol	Seasonal	2.5	27		27	2674
Treatment T3: All the eight habitats (use 50% intensity than T1 & T2); Gangarampur, Botiaghata						
25.Bijoli Roy	Seasonal	3	9		9	753
26.Gouri Roy	Perennial	2.5	13	4.5	18	1752
27.Mira Mondol	Perennial	3	11	3.0	14	1161
28.Monila Begum	Perennial	1.5	3	2.0	5	838
29.Promadini Kobiraj	Seasonal	3	4		4	331
30.Puspo Sarker	Seasonal	2	7		7	897
31.Rima Mondol	Perennial	3	20	5.7	26	2120
32.Shongkori Kobiraj	Seasonal	2	8		8	1043
33.Shova Kobiraj	Perennial	2	5	4.6	9	1172
34.Suchitra Kobiraj	Seasonal	1.5	4		4	714
35.Toma Kobiraj	Perennial	1.5	8	2.3	10	1645
36.Trilata	Perennial	1.5	5	1.5	7	1151
Treatment T4: All the eight habitats (use 50% intensity than T3)						
37.Amena Begum	Perennial	2	12	4.5	17	2069
38.Anwara Begum	Perennial	2.5	18	1.3	19	1923
39.Fatema Begum	Perennial	2.5	12	1.1	13	1281
40.Nahar Begum	Seasonal	1.5	10		10	1645
41.Nazma Begum	Perennial	2.5	16		16	1542
42.Rexona Begum	Perennia	3	16	7.3	23	1896

	l					
43.Taslima Begum	Perennial	2.5	12	4.2	16	1610
44.Aklima Begum	Perennial	3	11		11	923
45.Fatema Begum-2	Perennial	2	12		12	1422
46.Madhury Chakraborty	Seasonal	1.5	7		7	1081
47.Nazma Begum-2	Perennial	4	21	0.6	22	1342
48.Rina Begum	Seasonal	1.2	6		6	1187
Treatment 5: Control – no habitat structure (3 pond in each community)						
49.Beauty Mondol	Perennial	3	12		12	979
50.Mitali Mondol	Perennial	4	13	2.0	15	931
51.Nomita Mondol	Seasonal	4	22		22	1347
52.Chumki Begum	Perennial	1.5	7		7	1208
53.Rahima Begum	Seasonal	2.5	9		9	888
54.Momotaz Begum	Seasonal	2	2		2	278
55.Chandona Sarker	Seasonal	3	6	2.5	9	710
56.Dipali Mondol	Seasonal	3	9		9	745
57.Torulata Sarker	Perennial	4	8	0.2	8	479
58.Anita Mahalder	Perennial	4	13	3.4	16	1014
59.Hemlata Kobiraj	Perennial	4	6	2.2	8	509
60. Lipi Begum	Perennial	4	13	2.9	16	993

1st Report Appendix 2: The Participatory Action Learning Sessions to build up the knowledge of women about the science on technologies of fish culture in small homestead ponds along with the Ecopond Science Facilitators' Guide

Topic of the session
Food Chain
PAR 1: Sunlight and phytoplankton
PAR 2: Nutrients and phytoplankton
PAR 3: Phytoplankton and zooplankton
PAR 4: Periphyton
PAR 5: Phytoplankton, zooplankton, periphyton and fish
PAR 6: Riparian Inflows
PAR 7: The Benthos
Habitat
PAR 8: Fish, organisms, and structure
PAR9: Holes as structure
PAR109: Depth
Habitat
Fish Behavior
PAR11: Feeding and Food Chains
PAR 12: Reproduction



A Farmer's Guide to Pond Ecology

Foreword

Aquaculture has been the driving force in Bangladesh to increase fish production for millions of consumers, both rural and urban. It is a success story that has achieved remarkable increases in fish availability.

Before aquaculture became the dominant focus of fish production, Bangladesh was dependent upon, and well supplied by, a diverse and productive natural fish population. While this might not be adequate to provide fish for today's population, there continues to be a significant quantity of fish that come from natural sources.

This guide provides a series of experiments and methods that help direct a program of learning about pond ecology, food chains and fish biology. By means of learning how the ecology of a pond works, a habitat approach to fish productivity can be achieved that provides a sustainable, resilient and diverse source of fish for food, income and enjoyment.

AUTHORS: Alexander Kaminski, Saima Sharif Nilla, & Zohura Khatun, and Kevin Kamp.

Kaminski, A., NIlla, S. S., Khatun, Z. & Kamp. K. 2014. Ecopond Science Facilitators Guide: A farmer's guide to pond ecology. WorldFish Center Field Guide for Blue Gold funded Ecopond Project. Khulna: Bangladesh.

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Eco-Ponds PAR Calendar 2014/2015

PAR No.	PAR Title	Week 1 – 26/10	Week 2 – 02/11	Week 3 – 09/11	Week 4 – 16/11	Week 5 – 23/11	Week 6 – 30/11	Week 7 – 7/12	Week 8 – 14/12	Week 9 – 21/11	Week 10 – 28/11	Week 11 – 04/01	Week 12 – 11/01	Week 13 – 18/01
1	Sunlight and phytoplankton	S	O	F										
2	Nutrients and phytoplankton		S	O	F									
3	Phytoplankton and Zooplankton				S + O + F									
4	Periphyton					S + O + F								
5	Zooplankton + Periphyton and Fish					S + O + F								
6	Riparian Inflows						S + O	O + F						
7	Benthos*	S + O + F												
8	Structures								S + O + F					
9	Holes									S + O + F				
10	Depth										S + O + F			
11	Feeding and Food Chains											S + O + F		
12	Reproduction												S + O + F	

Table Key		Comments
S	Setting up experiment	*The experiments have a logical flow and should be completed in a sequential order. PAR 7 on benthos should follow PAR 6, however, due to the winter season and subsequent drying of the rice field, this PAR had to be moved forward to week 1. Seasonality plays a large role and thus some room for flexibility is allowed. PAR 12 on reproduction is also very dependent on the seasons.
O	Observation	
F	Finalize experiment and present results	
	Setting up and maintaining aquarium (3 weeks)	

WEEK 1

Facilitator's prepare the communities and help organize the farmers, working with farmer and community leaders. By this stage facilitators have organized the PAR schedule with communities. Facilitator's have put up a large 1 sqm diagram of a cross section of a pond (Annex 2) explaining how this will be used to create an entire food web for a pond throughout the 12 week PAR process. The first week is about setting up the first experiment (PAR 1) and explaining the PAR process. In this specific case, PAR 7 will also be done in week 1 in order to view the benthos in a rice field before the field dries up. Usually PAR 7 would be done in week 8.

PAR 1: What is the effect of sunlight on growth of phytoplankton?

Summary:

This experiment will allow farmers to measure the effect of sunlight on phytoplankton growth. This is done by using a series of bottles of water in which the same amount of water from a pond and some nutrients are added. One is kept out of sunlight while the other bottle is kept in full sunlight and the others are in various % of sunlight. The difference of the color is noted by the farmers by inspecting the color with a magnifying glass so they can become familiar with phytoplankton morphology. They make conclusions and try replicate the color with colored pencils.

Materials:

- 9 plastic bottles of 2 liter volume
- 10 gram fertilizer
- Pond water from same pond
- Color pencil

Process:

Engage the farmers in a discussion about phytoplankton. To start, ask the farmers:

1. Why do some ponds appear to be very green and some ponds are not so green?
2. Which ponds in the community are greenest?
3. What makes the pond green?
4. What other things in the community are green (grass, leaves, rice, trees)? What do you think the relationship is between green grass and green ponds?

Facilitaitr's should suggest to farmers that they would like to engage them in research to help them understand what makes ponds green and how to make them more, or make them less, green.

To do this, farmers will be using plastic bottles, pond water and some fertilizer. Farmers will divide into groups of 5-6 people. Each group will be doing a set of three experiments. They will do two bottles for each experiment. One experiment will be putting the bottles inside the house. The second experiment is putting the bottles under a tree. And the third set of bottles will be put in a place where they get sunlight all day.

Experiment

- Farmers are divided ion 3 groups of 5.

Treatment: Have each group get 6 bottles.

- Using water from the same source (pond) each group will fill their bottles to 5 cm from the top. Into each bottle farmers will add one small pinch of urea and one small pinch of TSP. Each group will have ba total of 3 bottles. 1 bottle will be marked “FS”. 1 bottle will be marked “PS”. And 1 bottle will be marked “NS”.

- The farmer group will place the bottle marked FS in an area with full sunlight. They must agree on the place to put these. The second bottle, marked PS, should be placed under a tree with a high degree of shade and sunlight. Let the farmers agree which tree they want to place these under. Finally, the third, bottle marked NS, will be placed in a dark areas inside one of the member’s house.

- The facilitator will ask:

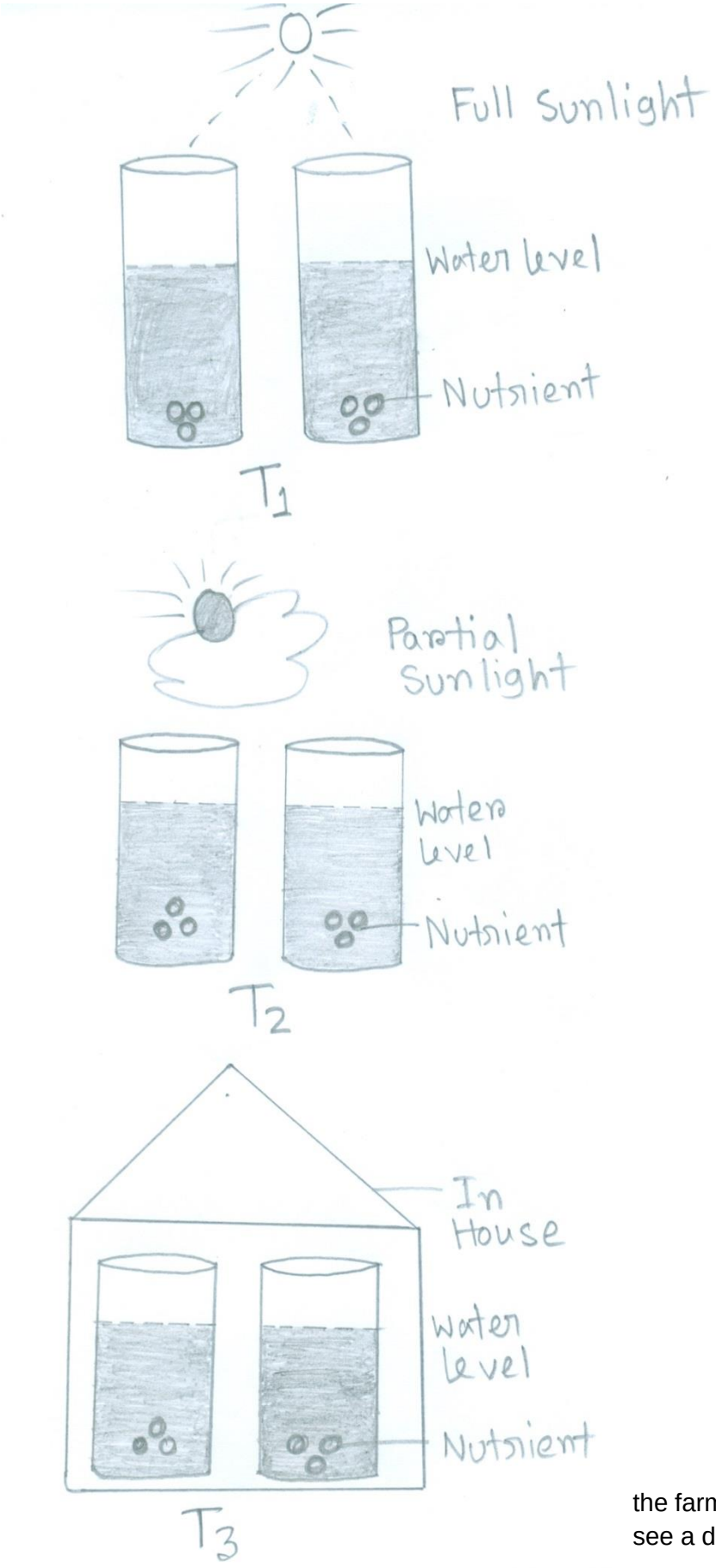
1. What do you think you will see after one week? After 2 weeks? After 3 weeks?
2. Why did we put fertilizer in the bottles?
3. What is the difference between the fertilizer for your rice and for the bottles? Why is it similar?

Data collection:

Before the farmers put their bottles in the places they agree upon, they need to make an observation on color. After one week, the farmers will bring out the bottles to observe and record the color of the water in each bottle, by ranking: 1 for lowest color, 2 for medium color and 3 for highest color. For the first observation, since the color is the same for all bottles and it is not very green, it should be recorded as a “1” for all of them. At the same time they will use color pencils to illustrate the changing color of the water over 3 weeks.

Week #	**Colors**		
	Treatment 1	**Treatment 2**	**Treatment 3**
0	1	1	1
1			
2			

Diagram 1



Analysis:

After week #3, the farmers should be able to clearly see a difference in the

colors of the water in the three treatments. Ask the farmers:

1. Why is the color of the water stored in the house the same color as when we started, or not very green?
2. Ask the farmers to look very close, with a magnifying glass. What do they see? Are they all the same shape?
3. What caused the treatment in the sunlight to turn greener than the others?
4. Which bottles had the most fertilizer? (they all had the same!)
5. From your experience, do some vegetable plants grow well in the sunlight and some grow better in the shade?
6. Do you think fish production might be the same?

Conclusion:

Farmers have learned about the importance of sunlight in pond management, as well as the effect that shade can have in ponds. Farmers begin to understand the importance of shade and sunlight. Farmers are also introduced to phytoplankton and they can place this on a cross section diagram
If the farmers are interested, the facilitator can show them close-up photos of different types of phytoplankton.

NOTES:

Farmers make observations on PAR 1 in their own time and present what they have found to the facilitator in week 2. After some discussion (found in the analysis section of PAR1), the facilitator can start the preparations to commence PAR 2.

PAR 2: What is the effect of nutrient (fertilizer) on growth/concentration of phytoplankton?

Summary:

After learning about the relationship between sunlight and phytoplankton, farmers will be asked to perform an experiment where a series of bottles of fertilized water are used. Different types of fertilizer are added to each bottle, in different amounts. This PAR facilitates farmers to understand the importance/effect of fertilizer on a pond's productivity of phytoplankton growth, thus resulting in food availability in a pond.

Materials:

- 9 plastic bottles of 2 liter volume
- 100 gram fertilizer (TSP & Urea)
- Pond water and soil from same pond
- Real materials (urea, TSP)
- Color pencil

Process:

Farmers will be asked questions about what they think a "nutrient" is. What is the role of nutrients in providing food in a pond? Can they identify the source of various nutrients in a pond? What about in a rice field? Farmers will be asked to think of their own ponds and linking what they learned in the previous PAR about how green their ponds are and how much fertilizer they use in their ponds. Farmers will attempt to understand the role of fertilizers in ponds and when they are necessary to use, and how you can possibly maintain the health of a pond without fertilizers.

Experiment:

- Farmers will be split into three groups (the same groups from previous experiment can be used).
- Group learning process, five farmer in each treatment, each group will own 3 bottles.
- The groups will have to inoculate 1 inch level of soil into each bottle from the same pond where water was collected

Three treatments and 3 replications

- Treatment 1: 16 granular of fertilizer (TSP & Urea)

- Treatment 2: 4 granular of fertilizer (TSP & Urea)
- Treatment 3: No additional fertilizer

- Farmers must cut the bottles at top to make a cylinder shape

- Fill each bottle with same amount of pond water from the same pond

- Give 4 (2+2) granules of fertilizer (Urea & TSP) in 3 bottles, 16 (8+8) granules of fertilizer (Urea & TSP) in 3 bottle, no fertilizer (Urea & TSP) in 3 bottles,

- Keep all bottles exposed to 100% sunlight for 3 weeks to see the differences

Data collection:

Farmers will be asked to monitor the time required to change the water color of different treatments.

Farmers will also monitor color change in different treatments and observe color of water , soil and density of water. Farmers will use color pencils to determine the changing color of the water and soil. Density will be compared through feeling, observation and discussion.

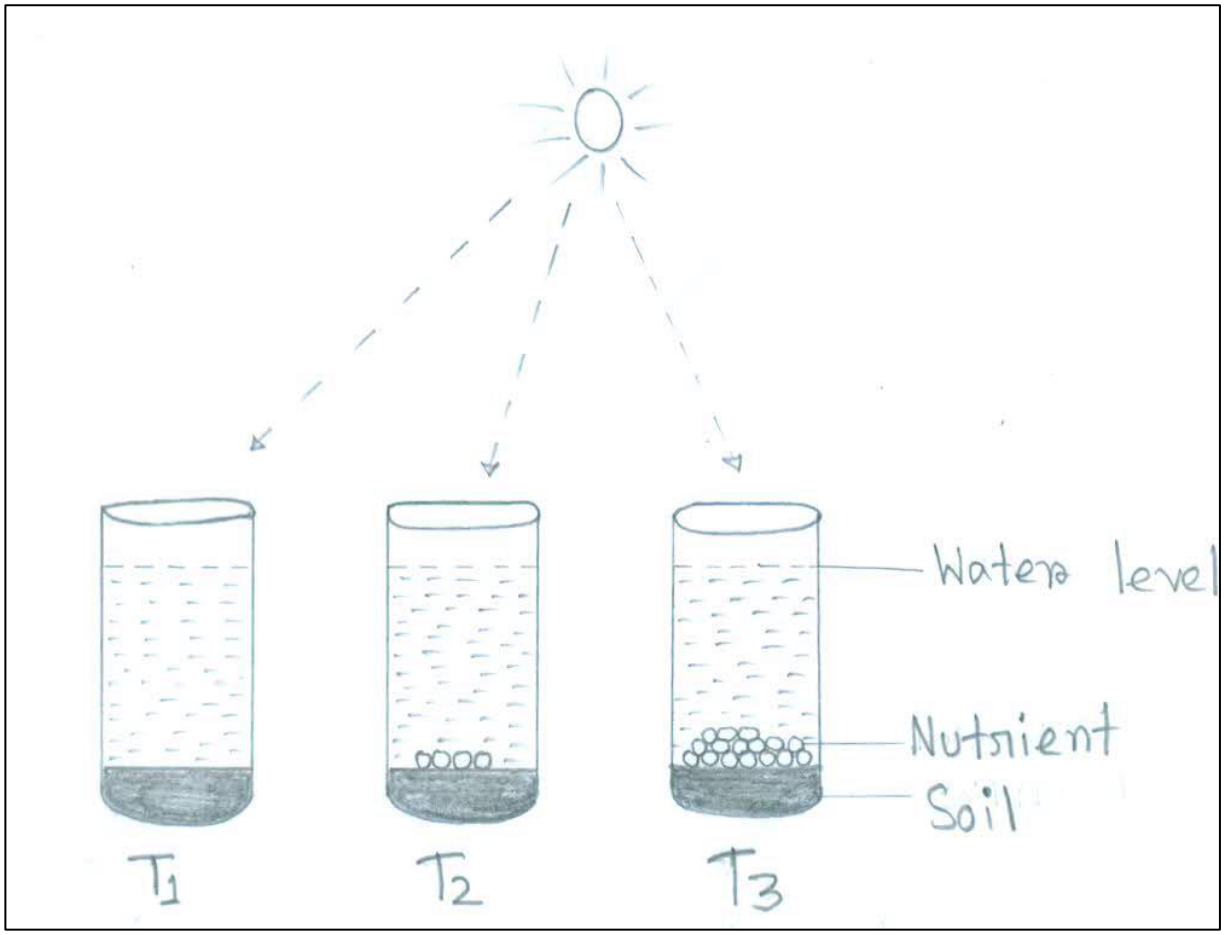
Farmers will then compare results and be asked to bring a sample from their own ponds to compare the quality of their water to the different bottles that are treated in the experiment

Week	Colors		
	Treatment 1	Treatment 2	Treatment 3
1			
2			
3			

Analysis:

- Farmers will be asked to determine why the color of the water is changing?
- What is the reason for the color change?
- How does fertilizer affect the pond? Why is it good? But also why can too much be detrimental?
- Is there a way to have healthy nutrient rich pond water without using fertilizer? How can this be done?
- Each farmer will bring sample of water and soil from their own pond to compare with experimental water and soil and determine through observation and discussion the amount of nutrients in their own ponds by comparing it the various color levels in the experiment?
- Discussion and debate amongst farmers about how they treat their own ponds and how this may have affected the nutrients in the water and fish production.

Diagram 2



Conclusion:

The farmers will learn the importance of the effect of fertilizer on growth of phytoplankton (nutrients) for fish production in ponds. They will be able to determine the amount of nutrients in their own pond through comparison and learn that various levels of nutrients are required for a healthy pond environment, but that too much fertilizer may also be detrimental to the pond. Farmers will discuss other sources of nutrients and see ways in which they can influence the color of the water and nutrient amount without fertilizer.

WEEK 3

Farmers will collect the final observations from PAR 1 and present the results to the facilitator in their original 3 groups. A discussion following from the 'analysis' in PAR 1 will commence and

take up most of the day. Farmers will also collect observations and data from PAR 2 and present this to the facilitator. Facilitator will make sure they are on course with PAR 2.

WEEK 4

Farmers will collect the final data from PAR 2 and present this to the facilitator. Discussions will commence as per “analysis” section in PAR2. Facilitator will then commence and complete PAR 3 on the same day.

PAR 3: What is the interaction between phytoplankton and zooplankton?

Summary:

The experiment objective is to understand the interaction between phytoplankton & zooplankton and the development of food chains in pond fish production systems. The farmers will understand through observation that phytoplankton is eaten by zooplankton which in turn is eaten by many fish. This will begin the next step of the food web that farmers create. By the end of the experiment they will place zooplankton onto their food web.

Materials:

- 3 over fertilized bottle from previous experiment
- Magnifying glass/ microscope
- Organic fertilizer (cow dung)

Process:

Farmers will use the three bottles from each group from the previous experiment. A discussion on sunlight, photosynthesis, nutrition and the creation of phytoplankton will remind farmers on the previous experiments. The farms will be asked what they think eats phytoplankton. Did they know that there were different kinds of plankton? They will be asked how much plankton do they think exists in their pond and which fish may like eating zooplankton. Farmers will be introduced to zooplankton.

Experiment:

- The same 3 groups will bring the 3 bottles from their previous experiment along where there is now plankton. If plankton is not available, farmers will collect some from ponds.

- Farmers will isolate and find zooplankton from their ponds and add this separately to a glass with phytoplankton. They will observe the zooplankton eating the phytoplankton under a magnifying glass/microscope.
- Every farmer will get a chance to look through the microscope to observe what they see.
- All research farmers will sit together and disucss what they see. They may be asked to draw the different organisms they see.
- Farmers will observe how zooplankton consumes phytoplankton.

Data collection:

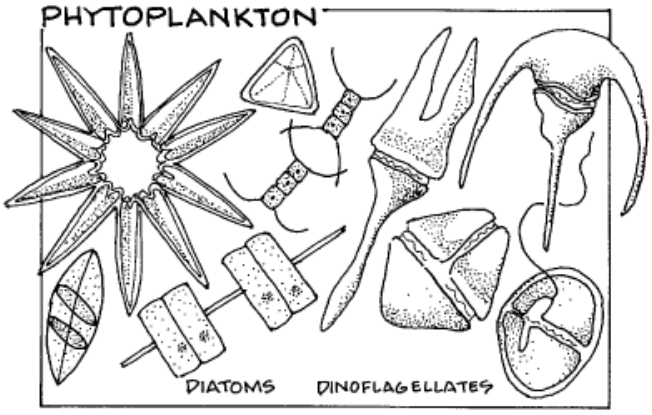
Farmers will ask be asked to share what they saw in the glass and describe zooplankton and phytoplankton. Using pencils they will draw what phytoplankton and zooplankton looks like from under the microscope. They will then name the fish that they think eat the different types of plankton.

Analysis:

- Comparison of different observations from previous experiments to link them together/
- Farmers can start thinking of the food chain as it starts with the sun, photosynthesis, phytoplankton, zooplankton and certain fish that may eat plankton. They add this to their food web from PAR 1
- Why is sunlight important in ponds? Farmers can discuss the amount of sunlight that may be in their ponds and determine how much phytoplankton they have in their ponds?

The importance of phytoplankton and zooplankton in the food chain needs to be conveyed and famers should be able to identify how to make sure that they have adequate amounts of both in their ponds.

(Source: Gulf of Maine Research Institute, 2012)



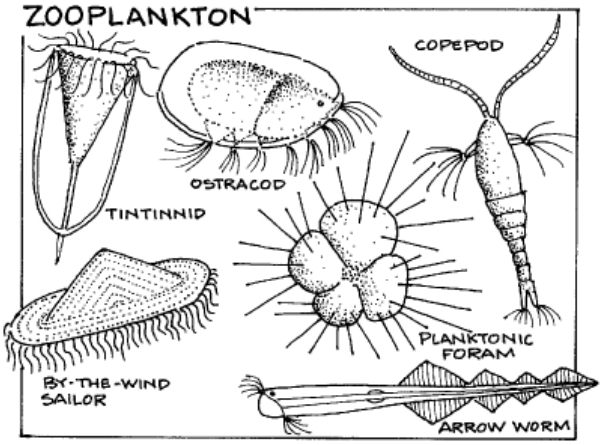
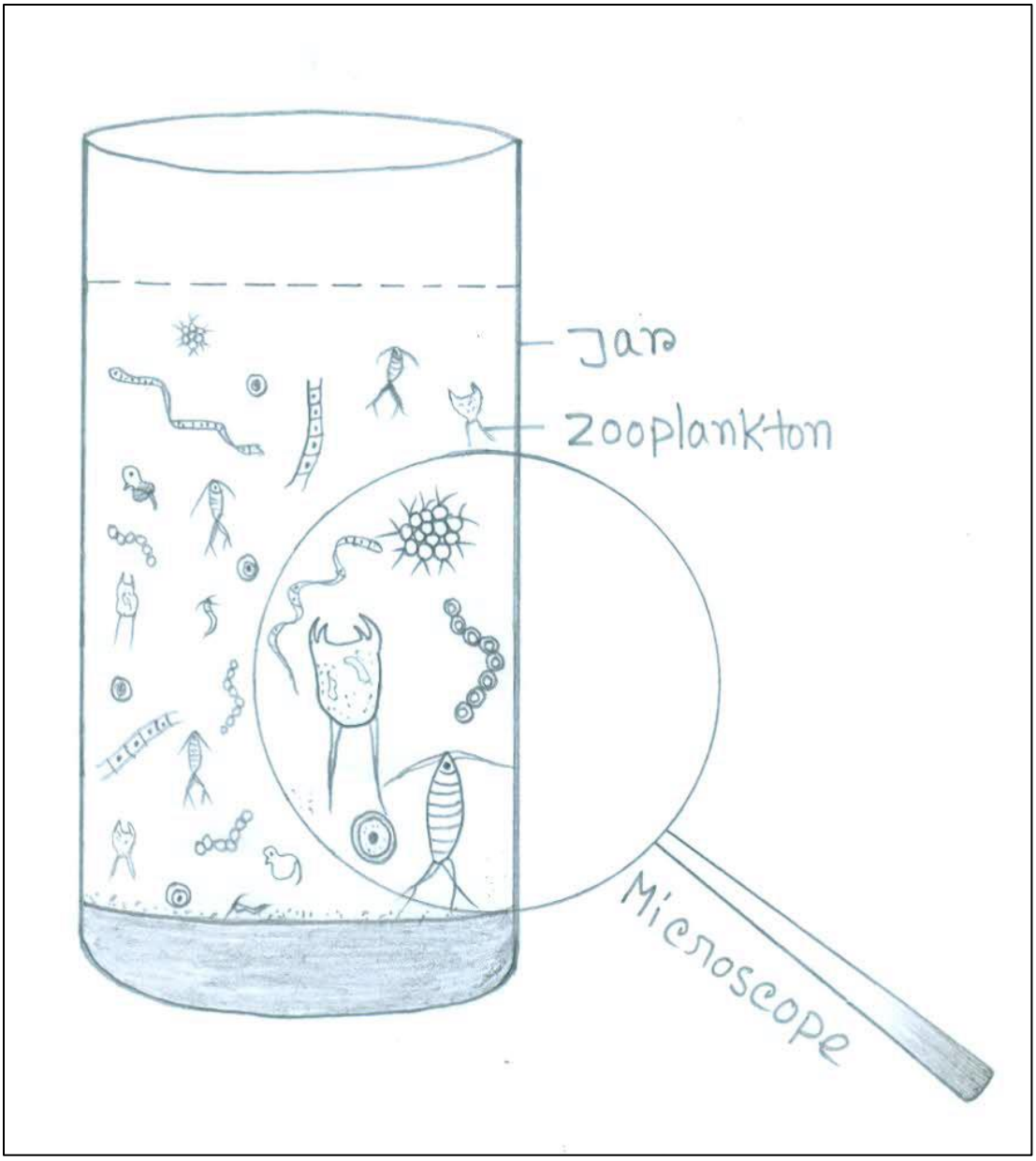


Diagram 3



Conclusion

Farmers have learned about the interaction between phytoplankton & zooplankton and will get a basic understanding of a food chain. They will also be able to determine the important role of plankton in a pond and together with amounts of sunlight, shade, and fertilization describe the connectivity between these variables. Farmers will also be able to name certain species of fish that thrive on feeding off of plankton.

WEEK 5

In week 5 facilitators will complete both PAR 4 and PAR 5. PAR 4 will introduce the concept of periphyton and link it to the previous PAR 3 on phytoplankton and zooplankton. PAR 4 will also be able to differentiate between different types of plankton and where they can be found. PAR 5 will show how various fish feed phytoplankton, zooplankton, and periphyton.

PAR 4: What is periphyton and how is it used in a pond?

Summary:

So far farmers have learned about photosynthesis, phytoplankton and zooplankton. In this PAR farmers will also observe and learn about periphyton which is formed on various surfaces. Farmers will collect various surfaces and objects where periphyton accumulates and observe the organisms under a microscope. On the same day, farmers will link with PAR 5 and feed periphyton, zooplankton, and phytoplankton to various fish. Farmers are thus completing the next step of the food web. They will be asked to add their results to their cross section diagram of a pond which they started with PAR 1.

Materials:

- Microscope/magnifying glass
- Tools (knife) to scrape off periphyton from various surfaces

Process:

This PAR is used to highlight the importance of periphyton which is a single algae that attaches itself to rocks and branches. Periphyton is an important contributor to production in a pond. Farmers have already learned about phytoplankton and zooplankton. Farmers will be asked to look under rocks, sometimes outside ponds, as well as within ponds to try and isolate and differentiate between phytoplankton, zooplankton, and periphyton. In the next PAR, on the same day, farmers will test which fish eats which one. Picture cards of zooplankton, phytoplankton, and periphyton will also be made and farmers will begin placing them on a cross section diagram of a pond which will be used throughout the entire 13 week PAR process. This will be the next step in the food web diagram which will be completed in week 12.

Farmers are asked about where they see periphyton growing and what roles do they think it plays in a pond. They set their own theories about what roles it plays and where it is found and then set out to identify and gather some periphyton. Discussion around differences between farmer ponds also commences.

Experiment

- Farmers are briefly told about periphyton by facilitators and they begin to look for it around their ponds. Farmers make observations where they are found and they bring a few samples to compare results under a microscope.
- Phytoplankton and zooplankton is brought in to compare the results under a microscope and start a discussion on where these organisms may be found in a pond.
- Farmers will move onto PAR 5 and begin experimenting with various fish to see which fish eat which organism.

Data Collection:

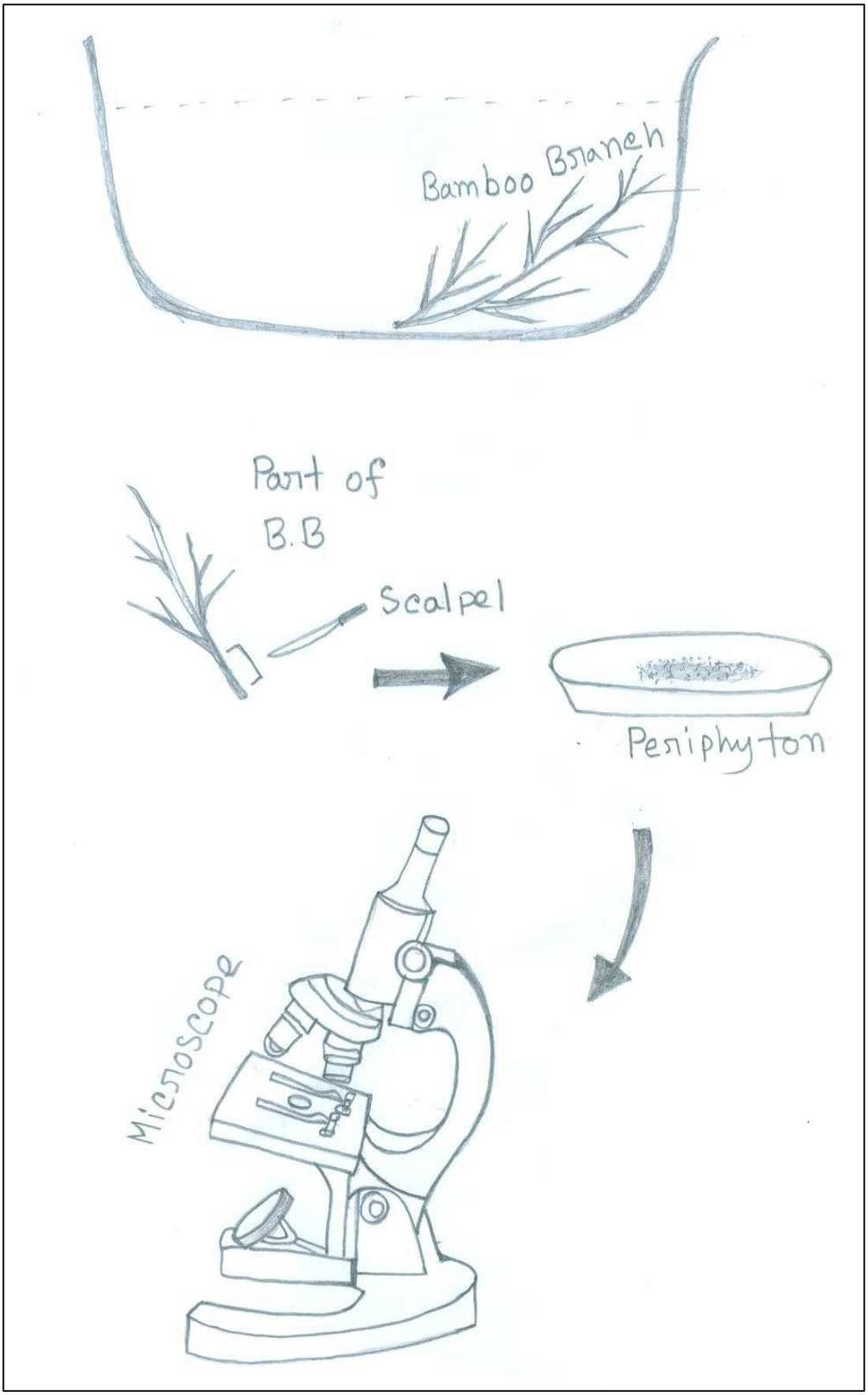
On a big sheet of paper farmers will note where they found phytoplankton and they will draw the differences between the 3 organisms as they see it under a microscope. Farmers will then add these as picture cards to a cross-section diagram of a pond.

Organism	Source
e.g. Phytoplankton	Water hyacinth
Zooplankton	Surface of pond
Periphyton	rocks

Analysis:

- Where did you find the periphyton? Why is it that some periphyton can even grow outside the pond?
- What is the difference between periphyton, phytoplankton, and zooplankton?
- Periphyton is a good source of nutrients that can be found all over a pond? What might be the benefit of having more (or less) periphyton in your pond?

Diagram 4



Conclusion

Farmers have learned about the difference and functions of phytoplankton, zooplankton, and periphyton. They understand that these organisms play a vital role in the health of a pond. They will learn in the next PAR, on the same day, that various fish live off of these organisms at different levels in the pond. They will thus start growing their food web diagram.

NOTES:

PAR 5: How and which fish feed on phytoplankton, zooplankton, and periphyton?

Summary:

PAR 5 is completed immediately after PAR 4 on the same day. Farmers have been introduced to various forms of organisms and plankton and now they will determine which fish feed on these organisms. This experiment looks to take the next step to determine the food chain in a pond. Using the other experiments as a basis, farmers will determine which fish eat plankton and again highlight the importance of plankton in ponds for fish growth. Farmers will watch how certain species of fish feed on phytoplankton, zooplankton, and periphyton.

Materials:

- 3 Plastic jar
- 5 different small fish (Puti or Mola or Darkina)
- Water
- Plankton from previous experiment or plankton can be collected from suitable pond nearby.

Process:

Farmers will be asked to name which fish they think eat which kinds of plankton. Which fish do they have in their ponds that eat plankton? They will then observe what the feeding looks like by putting various kinds fish into a jar with plankton in it. The starved fish will be placed in a plastic jar with plankton and farmers will observe and document the fish activity.

Experiment:

- Farmers will remain in their three groups and each have a large plastic jar (boyum).
- Each group is made up of 5 farmers and each farmer will bring a different kind of fish. They will be asked to bring fish that they think eats plankton. Each fish will have to be starved for a few days.
- Farmers will then place each fish one by one into the plastic jar and observe the feeding habits of the fish.
- Farmers will be asked to determine which fish eats which type of plankton and to determine where in the pond can plankton be found and thus where those fish may be found.

Data collection:

- Observe the fish behavior after putting fish in the water with plankton. Group discussion continues. Each farmer group presents what they saw to the other groups and the facilitator tries to facilitate a discussion around food chains and fish behavior.

Organism	List of Fish
Phytoplankton	
Zooplankton	
periphyton	

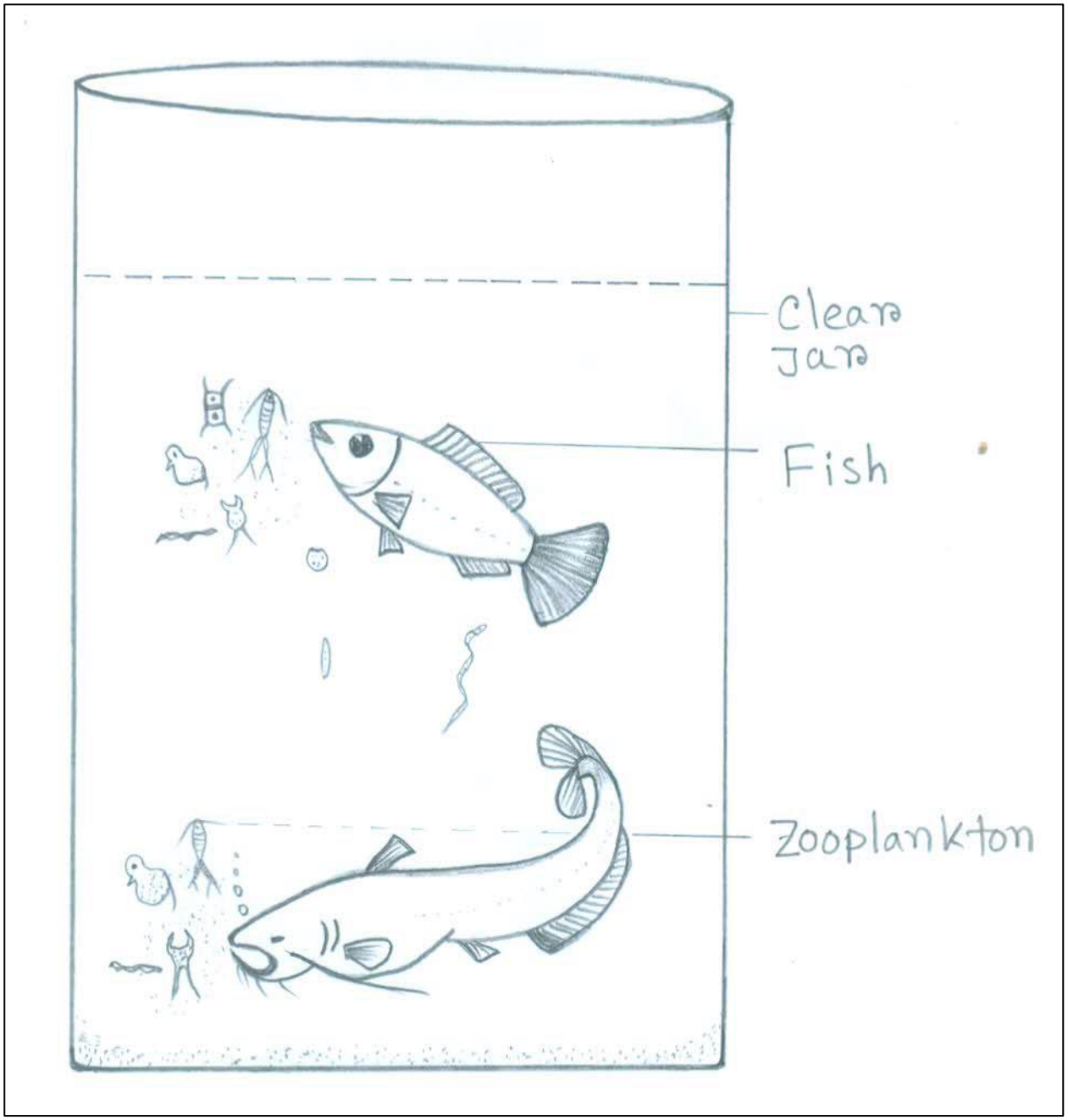
Analysis:

- Farmers will recall previous experiments and begin drawing a food chain which will be completed as the remaining PARs are completed.
- Facilitators will explain the importance of nutrient, zooplankton & phytoplankton in a pond system for fish growth & survival.
- Farmers will be asked to think about their ponds in relation to how much sunlight it gets, what levels of phytoplankton and nutrients they may have, what levels of fertilizer they may have, and finally list the species of fish that they have. In this way farmers can begin to make links and determine which ponds between the 15 farmers are run in various ways. Some farmers may have different colors of water with different types of fish. Some farmers may have more fish. Farmers begin to see that various forms of ponds exist and that some maybe healthier than others, all of which are attributes to various variables such as sunlight, color of water, amounts of fertilizer, amounts ok plankton etc.
- Diagram on next page

Conclusion:

The farmers will learn the importance of the presence of plankton in pond for fish growth and develop further understanding of food chains. Farmers will begin to determine amounts of sunlight, shade, plankton, fertilizer, nutrients in their pond and how that corresponds to the type of fish that they have. They can see the beginning of the food chain and other conditions required for fish cultivation.

Diagram 5



WEEK 6

Farmers begin construction of materials and structures needed for the 2 week PAR 6 experiment. In week 6, farmers will spend most of the day constructing the platforms that will catch riparian inflows. For the next week, farmers will observe what they find. In week 7, farmers will present the results.

PAR 6: What are the various types of riparian inflows that make their way into a pond and what effect do they have in a pond?

Summary:

This experiment will allow farmers to observe and measure the different types of inflows that find their way into the pond from outside. The positives and negatives of various inflows are discussed. Farmers also identify alternative sources of nutrients. Over the top of a pond, farmers suspend a piece of very clean white cloth. This is done over a number of locations on the pond. Farmers make 24 hour observations of what they find on the square meter of cloth and make calculations about what and how much is reaching the pond surface in one week. They discuss calendar possible differences i.e. falling leaves in autumn.

Materials:

- white cloths 1 sqm of each (3x3=9)
- Ropes 1 kg
- Bamboo poles 16x3= 48
- Bamboo sticks 16x3=48
- weighing balance

Process:

Suggest to the farmers that you would like to engage them in research to help them understand what riparian materials flow into the pond every day and what their benefits are. Farmers are asked to primarily focus on organic inflows and the types of things that come from the canopy of trees such as leaves or insects.

Engage the farmers in a discussion about riparian inflows in ponds. To start, ask the farmers:

- Do any substances fall into the pond from outside?
- If yes, what are those substances and how many?
- Do you think all of these substances are beneficial for the pond?
- If yes, which are beneficial and which are not beneficial and why?
- What is the importance of identifying and measuring inflows in a pond? What effects do you think they have?
- Which part of the pond will receive more inflows? What kind of inflows?

Design:

- The experiment will require using a 1 sqm of white cloth, bamboo poles, bamboo sticks, ropes and weighing balance. The white cloth will be held up by bamboo poles in the water where it can catch various inflows from above.
- The farmers divide into 3 groups of 5 people again. Each group will be doing the experiment similarly in one pond with a total of 3 ponds.
- The participants would be asked to select 3 ponds that have different amounts of shade and each pond will have 5 farmers collecting data. Farmers should also locate three different types of ponds based on the amount of negative and positive inflows that may be found there. One example would be to find a pond that has many leaves compared to one with very little leaves.
- At the end of the experiment the farmers would be able to see the difference. Farmers will locate areas in the pond where riparian inflows can be captured and further studied. Each pond has 3 white cloths and farmers need to place them in strategic areas around the pond using the ropes and bamboo poles to secure the cloths. Bamboo sticks can be used around the rim of the cloth to make the structure stronger. Different types of inflows and debris are expected to find their way into the pond. Structures such as twigs, branches, leaves, sand, bird feces, insects, fruits etc. must be monitored. Farmers will be asked to observe and document every 24 hours what they find, and even measure certain inflows such as levels of dust, number of insects etc. to understand the amount of debris. The experiment will go on for 1 week.

Data collection:

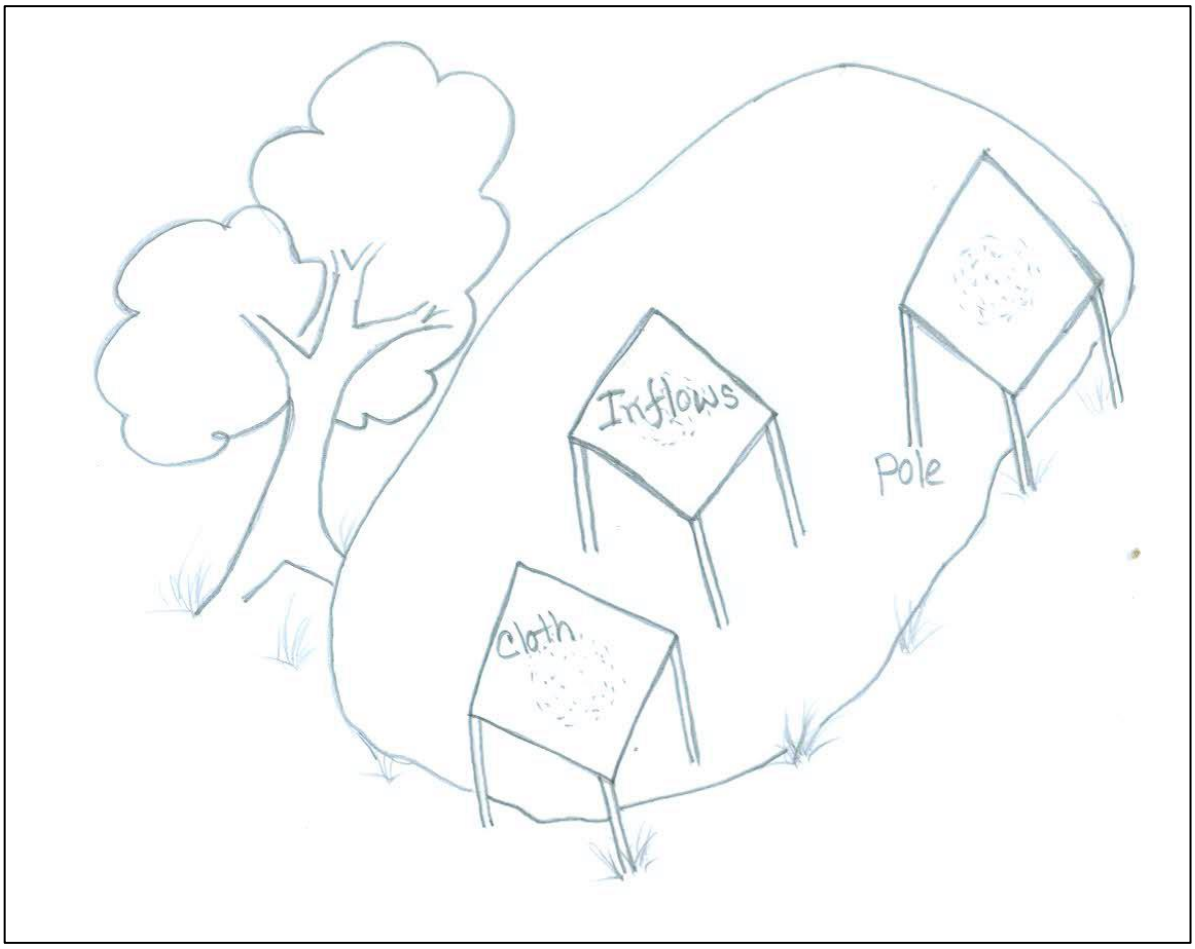
Day	Type of Inflow	Number	Source of inflow	Effects
Day1	e.g. Branches	3	Trees and wind, or cutting down mangos	Positive, provides floating structure for fish
Day2	e.g. Bird Feces	5	From birds nest	Provides nutrients
Day…..				
Day7				

Analysis:

- What is the link between this experiment and the one prior to this on nutrients? What role do some inflows have on providing nutrients?

- Some inflows such as leaves can have positive impacts in a pond by providing nutrients, however as discussed in the previous experiment, excess nutrients can also be negative, therefore how can an excess of leaves be negative for a pond?
- What are the specific inflows, where did they come from, how did they get into the pond, and what effect might they have on the pond?
- Identify what are natural inflows such as twigs or branches and perhaps some man-made ones such as plastic materials?
- Which inflows have positive effects on the pond, and which ones have negative effects?
- Have you noticed any inflows that have positive/negative effects in your pond?
- How might you take measures against the inflows that cause negative effects?
- What other inflows might we find that are not here?
- What man-made inflows do you contribute to your pond? Cooking oil, soap, used-water, detergent etc.?

Diagram 6



Conclusion:

How can farmers manage the inflows in their ponds? How can they identify that some inflows are good and some are bad. More so, can they identify that an excess of some inflows, such as leaves, may have a negative effect too. Farmers need to think about the inflows they find in their pond and manage them successfully. Farmers can also see that some inflows may be source of organisms and plankton, which is the next phase of the PAR experiments.

NOTES:

WEEK 7

Farmers use this week to collect the final data from PAR 6 and present the results. Week 7 is used to discuss the results and dismantle the riparian inflow structures. Discussions should follow from the “analysis” section of PAR 6.

WEEK 8

In this week farmers start, observe, and finalize PAR 7 on the benthos. Facilitators should begin by taking the whole group of farmers to a rice field to view organisms found in the mud and soil. The water in a rice field may be clearer and shallower and thus easier to spot and observe some organisms. For the purpose of this specific PAR programme, since it started in the beginning of winter, PAR 7 has been moved to week 1 whilst there is still water in the rice fields before they dry up. Naturally however these PAR experiments should be sequential. In this case however PAR 8 begins in WEEK 8 as PAR 7 has already been completed..

PAR 7: What organisms are found in the benthos of a pond, and what importance do they have in the pond ecosystem?

Summary:

This experiment is to get farmers to think about different levels of depth in a pond and that other sources of food may be available for fish (not just plankton as shown in previous experiments). This allows farmers to keep adding to their food web. Farmers first observe the bottom of a rice field where they observe different organisms and then apply this to what they find in their own ponds.

Materials:

- 15 X 2L bottle
- Sieve
- White cloth
- Magnifying glass, measuring tape, clear plastic glass
- Periscope

Process:

Engage farmers with questions about different layers within a pond. Ask people questions:

- What living and non-living things will you find at the bottom of a pond?
- How do you think these things got there?
- Did you know that some fish live in the benthos, which ones do you think live there, and why?

- What role does temperature and dissolved oxygen play in the survival of these fish? What difference does depth in ponds make for some fish?

In order to find out these questions, all famers will be asked to collect a sample from the bottom of their pond. They will bring their sample to the meeting and be asked the above questions. Farmers will define the benthos, and make a list of organisms and fish that may be found there. This will lead to discussions later on food chains and specific behaviors of fish. They will also compare samples and estimate what are the reasons for some people having more organisms then others?

Design:

- The 15 farmers will view a natural rice field benthos (they may also use a periscope for this). They will make notes and list what they find and see how various organisms interact with each other and with the environment.
- They make observations for about 10 minutes and record all organisms they see. The farmers will then each bring one 2L bottle (used in PAR 1 and PAR 2) with a sample of mud from the bottom of their home pond.
- They will use a fine mesh sieve to separate the organisms and debris from the mud and clean it with some clear water. They will place the contents of their bottle onto a white cloth (the same one used for the PAR 6 on riparian inflows) and start identifying the organisms and debris.
- Discussions about the names and behaviors of certain organisms commences: why are they there, and what is their role in the pond ecosystem?

Data collection:

Type Of Organism	Number	Description	Eaten by which fish
e.g. Snail	5	Small organism	Tilapia

Analysis:

- Farmers will compare the number of organisms that they have from their pond sample. Farmers with more organisms will be asked to explain why think they have more organisms in their pond by linking it to the other experiments done previously, likewise farmers with less organisms will try to explain why they may have less.
- Farmers will discuss what the role of organisms is in the pond ecosystem and how many fish depend on them.
- Farmers will also discuss which the more prevalent organisms are and which ones are beneficial for a pond.

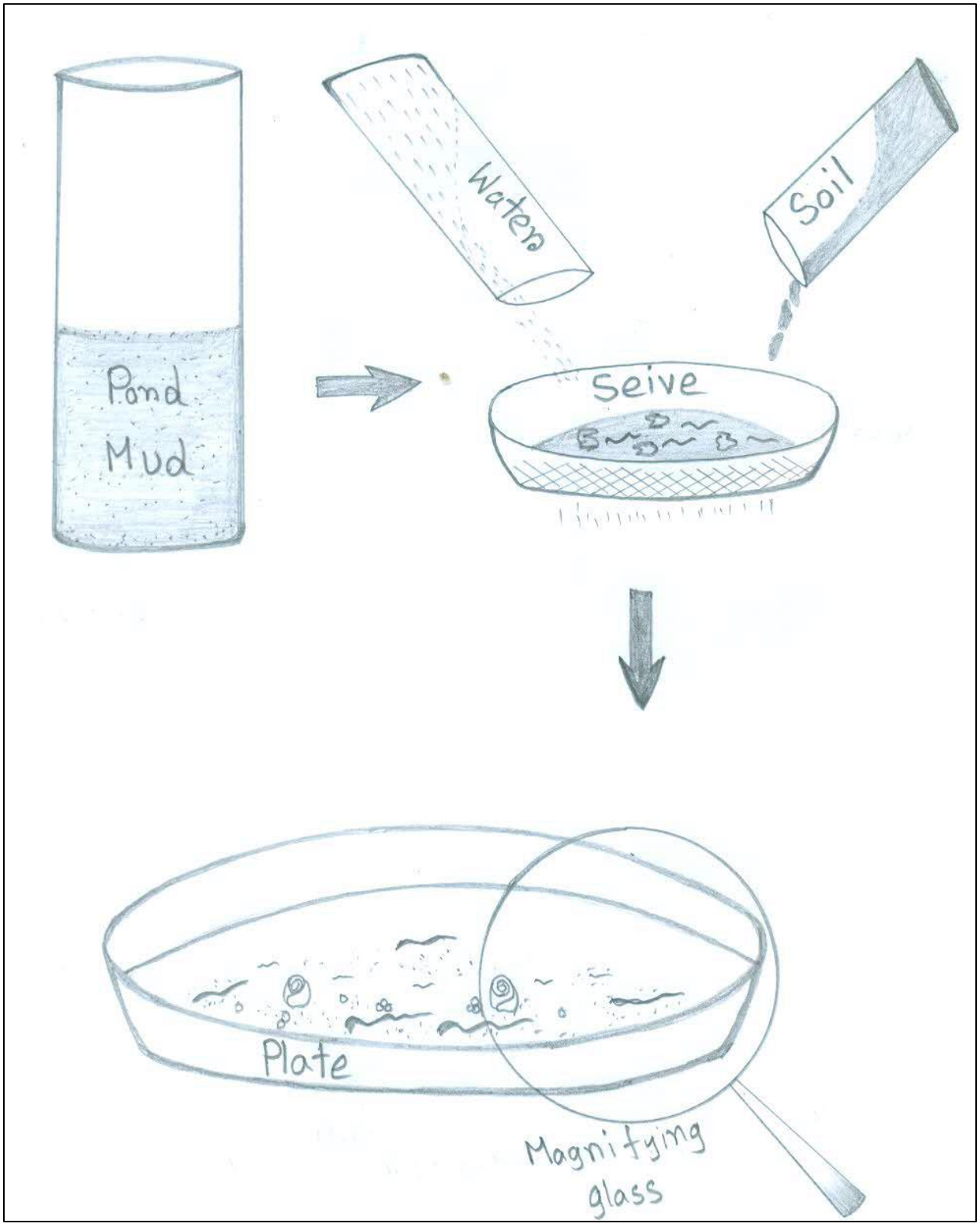
- Farmers will identify the benthos and determine its role in the pond ecosystem by looking at what organisms are found there and what fish may prefer the benthos and which may prefer the surface for instance?
- Diagram found on next page.

Conclusion:

Farmers have been introduced to the concept of a benthos and are able to identify certain organisms. They are also able to identify fish that may depend on these organisms and that may be found in the benthos. Farmers add to their knowledge of food chains by placing location as a factor as well as being able to see fish behaviour and depth in a pond, and why these aspects are necessary in understanding pond ecosystems. Farmers learn that deeper ponds may be beneficial (this will be verified in a separate experiment in PAR 10).

NOTES:

Diagram 7



PAR 8: What role does structure play in housing organisms and how do various fish use these structures?

Summary:

This experiment naturally follows from the previous PAR where farmers identified organisms in the benthos. Farmers are asked to identify organisms on other structures in the pond as well, aprticularily on the surface.

Farmers learn about why various structures are important in ponds. Farmers are engaged in discussion about the types of things that are normally floating in ponds. These are usually living floating plants, or non-living structures such as broken branches. Farmers also begin to understand that some structures such as roots and stems may be fixed in the pond. Farmers are also engaged about the various organisms associated with these structures. A discussion on which fish use which structure follows. Notes are made and farmers are told to replicate what they have learned in an aquarium the following week in PAR 9.

Materials:

- Periscope
- 15 Transparent plastic 2.5L pot/jar “boyum”.
- Microscope/magnifying glass

Process:

Farmers are asked to think about the types of organisms that exist elsewhere in the ponds, and not just in the benthos. Farmers are required to think about the sources of these organisms, where do they come from, and where do they live in the pond. Farmers will find that some organisms prefer to be located around living structures such as water hyacinths whilst other are located around dead drifting structures such as palm leaves or branches. Protruding roots from nearby trees and plants that are rooted in the floor and embankment of the pond also play a role in harboring organisms. What fish use these structures therefore to feed? Why do some fish prefer to be at the top of the pond, and why do some fish stay around other solid structures. Is it only for feeding purposes, or could there be other reasons for why fish use these structures, such as breeding, or shelter?

Experiment:

- The two farmer groups are asked to view multiple ponds. One group is tasked to locate and collect free floating structures that are both living and non-living. This group will collect living water hyacinths and dead floating structures such as branches. The other group will use a periscope to locate more fixed structures such as roots from trees on the embankments or plants that are rooted in the walls and floor of the pond (and thus cannot be removed).

- Farmers will collect some of these plants and floating structures in a bucket where they are vigorously shaken to remove all organisms. Farmers make observations of the organisms remaining in the bucket. A number of different plant species might be used to compare.
- Instead of destroying some of the living structures farmers also use a periscope to observe these structures and habitats and the organisms that live on them. If possible, some parts of these structures, such as roots or stems, may be carefully removed from the pond with scissors or a scalpel for further observation, although it as advised that farmers don't damage these structures too much.
- Famers will observe and note the various organisms, their sources, and the type of fish that may be found there as well. Farmers will determine the importance of various different kinds of structure for harboring organisms and the role they play in feeding, breeding, and sheltering for various fish.

Data collection:

Type of Structure	Where is it found	Name of organisms	What fish are found there?	What purpose do fish use the structure?
Floating wood	Surface	Snail Worm	Puti	Feeding
Water hyacinth	surface	Fry		
		snail		

Analysis:

- Which structure is living and which is non-living?
- What kinds of organisms are there and why are they important?
- Is the size of the structure a factor in how many organisms and fish are found there?
- Is the depth at which a structure can be found a factor in how many organisms and fish are found?
- Which structures attract which fish, and why? What role does structure provide for fish?
- Do different plants attract different organisms and fish? What is the difference between structures?
- What kind of structure do you find in your pond? Which ones are more beneficial for your pond, and which ones are less beneficial? How may you replicate these structures either through handmade devices, or finding different organic materials?
- How can you manage or manipulate the various structures in your pond for your benefit?

Conclusion:

Farmers have learned that structure plays a vital role for harboring organisms and for fish behaviour, namely, for feeding, breeding, and shelter. Various living plants may be free floating,

or are deeply rooted and fixed in the pond. Other non-living structures also play a role for fish and organisms. Farmers have now understood that organisms are located in almost all areas of the pond from top to bottom and that fish are found in all these areas too. They have a greater understanding of the food chain that they are constantly adding to, as well as understanding the behaviour of some fish.

Diagram 8.1

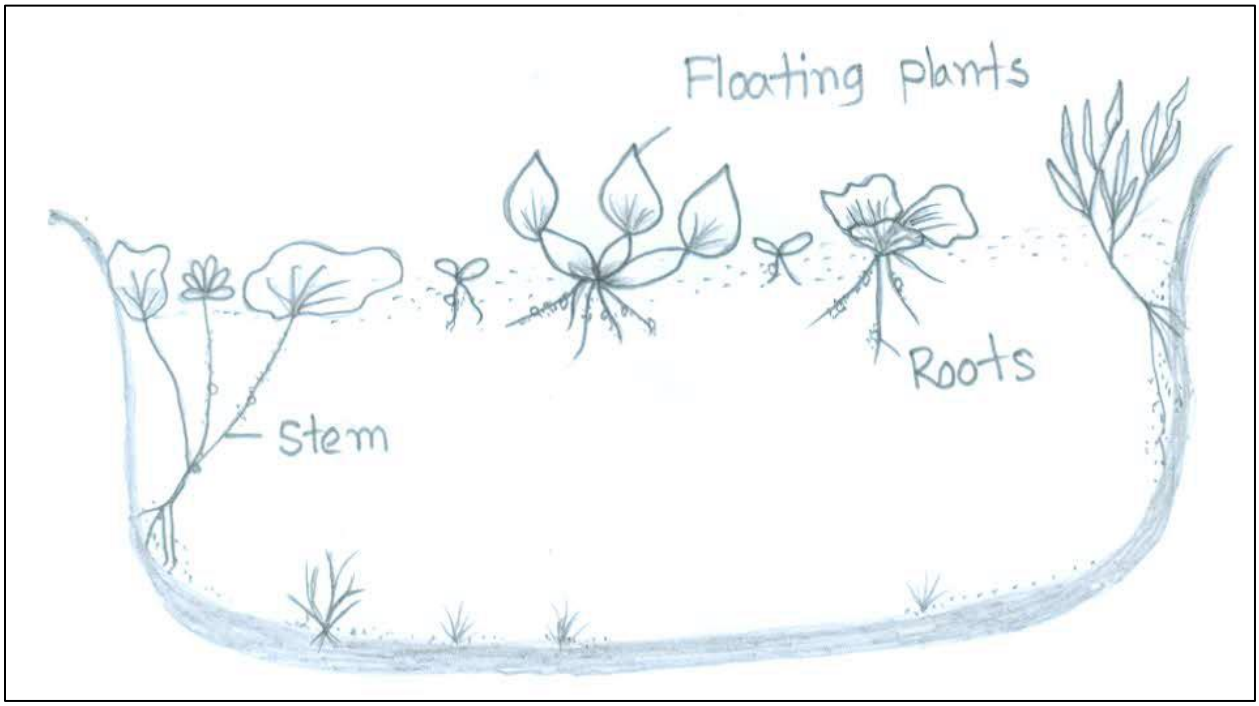
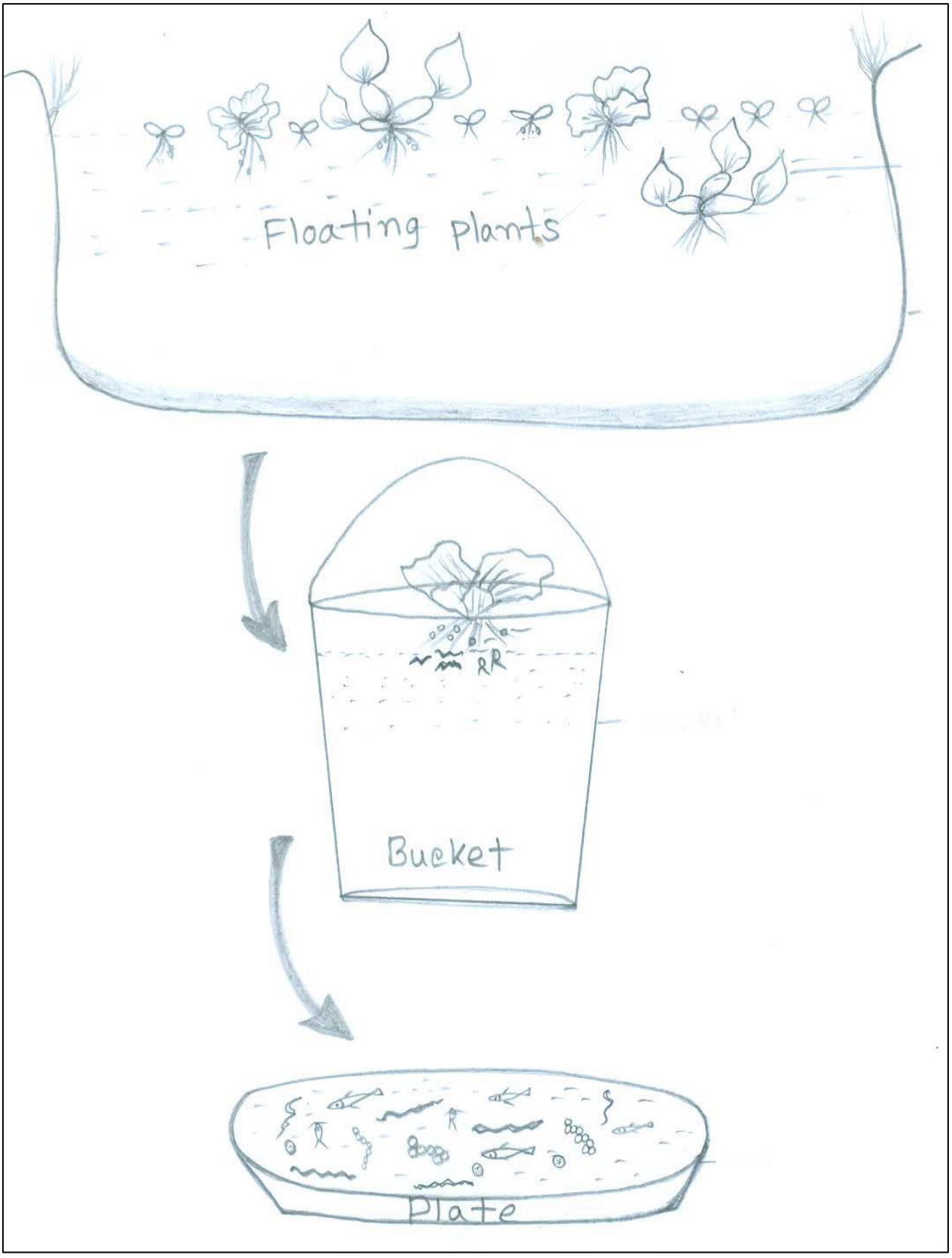


Diagram 8.2


Floating plants
RR
Bucket
Plate

WEEK 9

Week 9 marks the beginning of the aquarium phase of the research. The facilitator need to organize transport to carry the aquarium to the filed as well as find a suitable place to keep the aquarium for 3-4 weeks. Facilitators will use the aquarium for PARS 9, 10 and 11.

PAR 9: Which fish use holes as a habitat in ponds and why?

Summary:

Now that farmers understand that fish use various available structures in a pond, especially for breeding, feeding, and shelter, they will now learn how some fish create their own structures. Farmers will be engaged in thinking about the types of fish that live in holes either made in the soil by fish themselves or used in natural holes occurring in bamboo or other structures. This can be done by using an aquarium and creating artificial holes from both organic and non-organic materials. Different types of fish that farmers identify are added to an aquarium and different types of materials that make holes of different sizes, shapes and lengths are added (facilitators simply observe and suggest some species of fish that may be useful). Farmers make observations about the shelter preferences of different fish. In order to apply what they learned in the previous experiment thy will also place other structures that they already identified in the previous experiment and they will monitor different fishes preferences for different structures, as well as where they prefer to be located in an artificial pond environment. This aquarium will be used in the remaining experiments as well.

Materials:

- Aquarium
- 2 different kinds of PVC Pipe (cut into various sizes)
- Living (water hyacinth) and non-living structures (dead branch) from previous experiment
- Fish which like holes (shing, magur, snakehead etc) and also other fish that use floating structures (for comparison of shelter preferences)
- Different size of materials that can make holes such as bottles, bamboo tubes etc. (chosen by farmers).
-

Process:

Taking what farmers learned in the previous experiment they will be asked to set up a habitat aquarium (artificial pond). They will look for various fish aggregated devices that they found before, or plants that fish may like that they identified in the previous experiment. The facilitator will also introduce holes as a type of structure by placing PVC pipes and bamboo in the aquarium. A number of fish will be introduced into the aquarium and the farmers will see which fish use hole structures and which fish use other structures. Whilst they will mostly collect data on which fish use holes and for what purpose, they will also be able to confirm some of their

theories on which fish use which structures from the previous experiment. The latter is therefore a test for the farmers to implement what they learned before at the same time. By the end of the experiment, farmers will have created an ideal artificial pond environment which they will maintain throughout the remaining duration of the PAR experiments.

Experiment

- 15 farmers will use the knowledge they have learned so far to set up an artificial pond in an aquarium. They will use clear water and add various structures that they have identified from the previous experiment. They may also add a little bit of soil to replicate the benthos that they learned about in an earlier experiment.
- The farmers will also add “hole structure” replicas such as PVC pipes and bamboo to the bottom of the aquarium. They will add the fish that they think may use these holes. They will then observe how some of these fish prefer hole structures compared to some of the other floating structures that they identified in the previous pond.
- Farmers will then add fish that they learned abo0ut in the previous experiment and observe the difference between which fish sue which structures. While they will mostly collect data on the fish that use various holes, they will be able to confirm what they also learned in a previous experiment. Unless major differences are found, there is no necessary need to observe this. Facilitators can simply use data sheets from the previous PAR 7 to confirm what they learned.

Data collection:

Type of structure	Size of structure	Types fish	Number of fish	Usage of structure
e.g. bamboo	30 cm (1 cm~)	Shing	10	shelter
e.g. PVC Pipe	20 cm (2cm~)	Shing	5	shelter

Analysis:

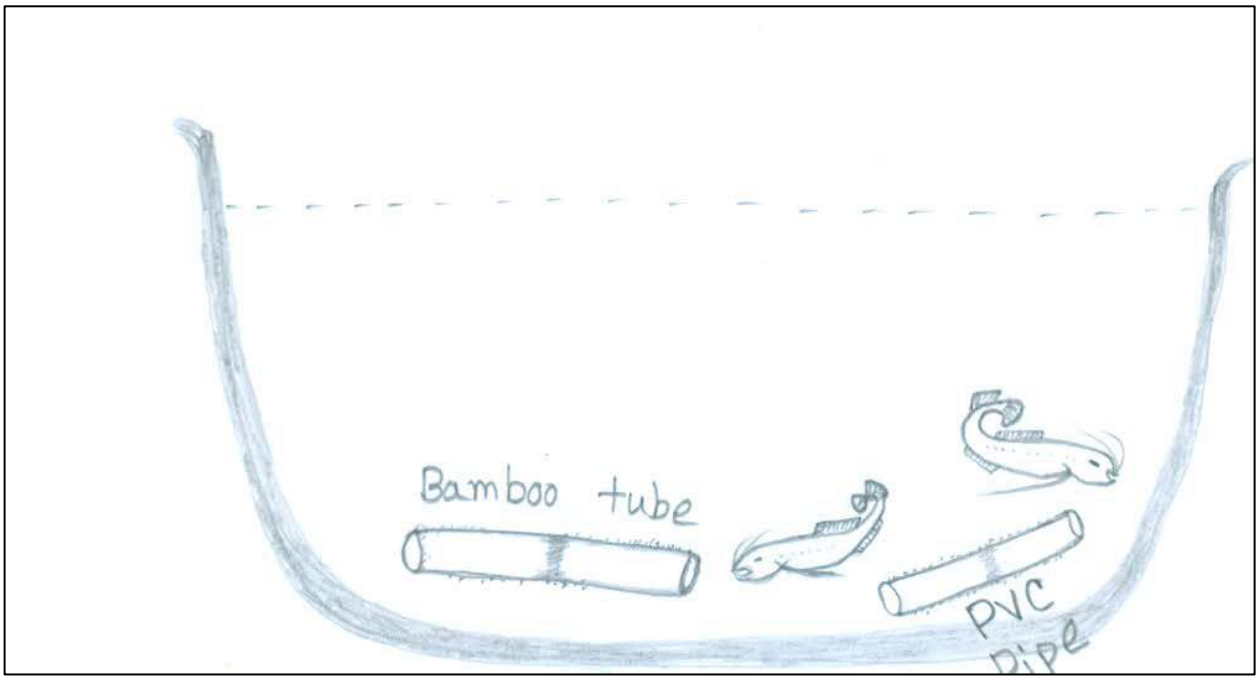
- Which materials attracted which fish? Was there a difference between organic and non-organic structures?
- How many fish were in each hole? What difference did size make?
- Are fish territorial over holes? Do fish fight over holes?
- Why are fish using hole? Are they using it for food, shelter, or breeding?
- Compare the differences between fish that use holes and the ones that don’t? Can you see notable differences between these fish?
- Have you used holes before? Is it a way to easily trap fish such as shing? What is your experience with holes?
- What kind of structures do you have in you pond? What other environments and structures do fish use? What other artificial structures could we create?

- Do you notice that various fish use various depths, structures, that they have different breeding preferences, and food preferences? (This knowledge will be used in the next experiments as well).

Conclusion:

Farmers have now learned about the many different structures in ponds and the diversity of fish that use various structures. Farmers have learned that different structures are preferred by different fish and that depth in the pond as well as size of structures plays a role. Different fish also create their own structures by making holes, although artificial holes may also be provided. At this point farmers have created an ideal type pond environment in an aquarium where they have added various fish and structures. They may also add zooplankton and phytoplankton as they have already learned about this before, and as such they can begin feeding fish. Farmers will be asked to maintain the artificial pond for 3 weeks and monitor the various behaviors of fish, especially in terms of feeding, breeding (season dependent), and shelter. This aquarium will be used in the next experiments as well.

Diagram 9



WEEK 10

Farmers must maintain the aquarium. If there is no electricity to run the aerator and filter, the pond water may have to be replaced after a week. Try to refrain from putting soil in the pond. Smaller stones and pebbles that are cleaned can be used. PAR 10 also utilized some homestead ponds to view depth. This may also depend on the clarity of water.

PAR 10: What roles does depth in a pond play on fish behaviour?

Summary:

Whilst the aquarium can be used to show how some fish may prefer to shelter in holes at the bottom of the pond, and that some organisms are found in the benthos whilst others are found on floating structures, the aquarium does not necessarily give an accurate account of how depth plays a role in fish behaviour in a pond. Farmers will use the periscope and observe various depths in a household pond and note which fish mostly reside in which levels. Farmers will identify this by looking at fish behaviour and looking at the difference between bottom feeders, surface feeders, and column feeders. The latter will also be demonstrated by showing the mouthing structure of the different kinds of fish. The PAR will end with a game where farmers place pictures of fish in a cross-section diagram of a pond.

Materials:

- Periscope
- Magnifying glass
- Katla, mrigel, rui fish.
- Diagram of pond
- Fish picture cards
- Pins

Process:

This PAR will start with a demonstration from some of the farmers. First the aquarium will be used to summarize what has been learned in previous PARs about different fish preferring different structures and therefore at which depth they may be found in a pond. Then, the facilitator will use three different fish to show why some fish have different shaped mouths and teeth that adapt them to the various levels of the pond. Farmers will then be asked to take note of how different depths foster niche environments for various fish.

Farmers will use a periscope to monitor these differences in one deep pond, a middle depth pond, and a shallow pond. Farmers will make observations. Farmers will then be given picture cards of various fish and be asked to place, with a pin, where the fish belongs in 1 sqm diagram of a cross section of a pond, showing various levels. This pond cross-section has been used throughout the entire PAR process. Now faciltiatrs will mark the three different depths, surface, middle, and bottom.

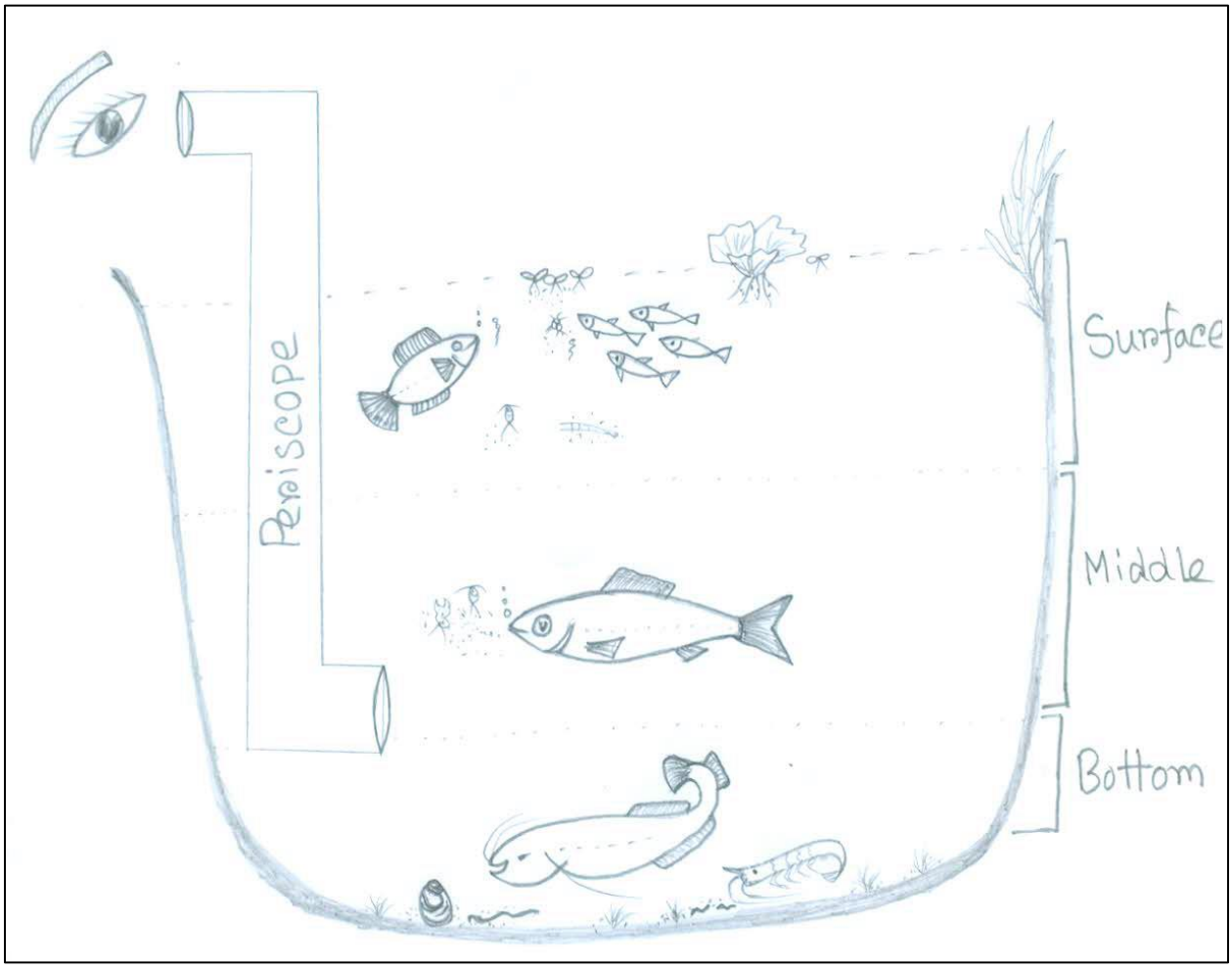
Design

- Farmers will first make observations in the aquarium and compare what they have already learned before to determine where some fish may be found in a pond.
- Facilitators will also demonstrate the structure of a fish's moth using katla, mrigel, and rui fish. The structure of the mouth determines which fish is found where in the pond – the katla fish is a surface feeder with a top lip, the Mrigel is a bottom feeder with a bottom lip, and the Rui is a middle level feeder. Whilst this may not be true for all fish (as there are also column feeders), farmers can use the aquarium (or their ponds) to catch various fish and identify their mouths. They can then match their knowledge of where fish live with further observations.
- Farmers will then locate three ponds of various depths. A periscope will be used to try and monitor the different levels of a pond and make further observation on which fish are found there and for what purpose.
- Finally farmers will be asked to use their knowledge with picture cards of various fish, where they will place them on a cross section diagram of a pond. On this diagram farmers have already added various pictures of organisms from previous experiments. They are now adding the fish and in the next PAR they will add arrows to draw the final food chain in a pond.

Data collection:

Fish	Level	What does a fish do there
shing	bottom	Feed and take shelter
plankton	Top and bottom	Come up to surface for sunlight and go to bottom in the evening
Tilapia	All three	Tilpia follow various foods at different levels
mola	surface	
Khorsula	surface	

Diagram 10



Analysis:

- What does your food chain look like now? Are you able to locate various organisms and fish around a pond based on structure, depth, and feeding habits?
- How deep is your pond? What types of organisms and fish do you have in your pond?
- Do you notice a difference between deeper ponds in the village, and shallower ponds?
- What is the reason for the depth of your pond? Is it too time consuming to dig deeper ponds? Are you concerned that children may fall in for instance?

Conclusion:

Farmers have from the beginning started building their food chain. Now they have a better understanding of where certain fishy may be found in different levels of a pond, based on what type of feeder they are, and based on where certain organisms may be found (which they learned in previous experiments). Farmers now utilize this knowledge to think about depth in their own ponds.

WEEK 11

The entire PAR process has almost built up to PAR 11. Farmers have been adding picture cards to a cross-section diagram of a pond from day one, as they learn about various plants, organisms, and fish. Farmers will use the ideal type aquarium and start discussions and finally use all their knowledge to construct a pond food web.

PAR 11: What is the food chain in a pond?

Summary:

Farmers have already learned about the plankton and benthos food chains, as well as different. But they have not yet illustrated the entire food chain as one system. An aquarium will be set up will different fish species, different habitats and fertile water to allow the fish to begin to establish themselves according to habitats and food chains. A mixture of fish will be provided. Different components such as various structures can be added over a couple of weeks. Famers relate this to their ponds and habitats and finally finish their food web chart form PAR 1.

Materials:

- Aquarium
- Picture cards of fish
- 1 sqm cross section diagram of a pond

Process:

Farmers will be asked to incorporate all the knowledge that they have learned so far in constructing a food chain in an artificial pond. An aquarium will be used to demonstrate a pond ecosystem. Farmers will provide the water, structure, and food that various fish require At this point they have already used a few structures such as holes in an aquarium. They will be asked to complete an ideal type pond environment and food web. By doing this farmers will monitor the food chain and ecosystem in a pond. This will be demonstrated through a game where farmers will be given card of various organisms and animals that live in a pond. The cross section diagram of a pond will be used (the same one as in PAR 1) and farmers will be asked to place the fish on the drawing on where they might be found in a pond. After this they will be asked to draw arrows that show the food chain. They will apply this in the maintenance of their aquarium for one more week until the PAR ends in week 12.

Design

- Farmers use the aquarium as a starting point to make observations and discuss observations in their own ponds
- Farmers begin to add various components into their aquarium to create an ideal type pond environment and food web.
- They fill out the data sheet below to begin connecting the various organisms and fish in a food web.
- Farmers have throughout the entire PAR process been building a cross-section diagram of a pond, adding various components to it such as phytoplankton, benthos, floating structure and depth. They will complete the diagram with picture cards of fish.

Data collection:

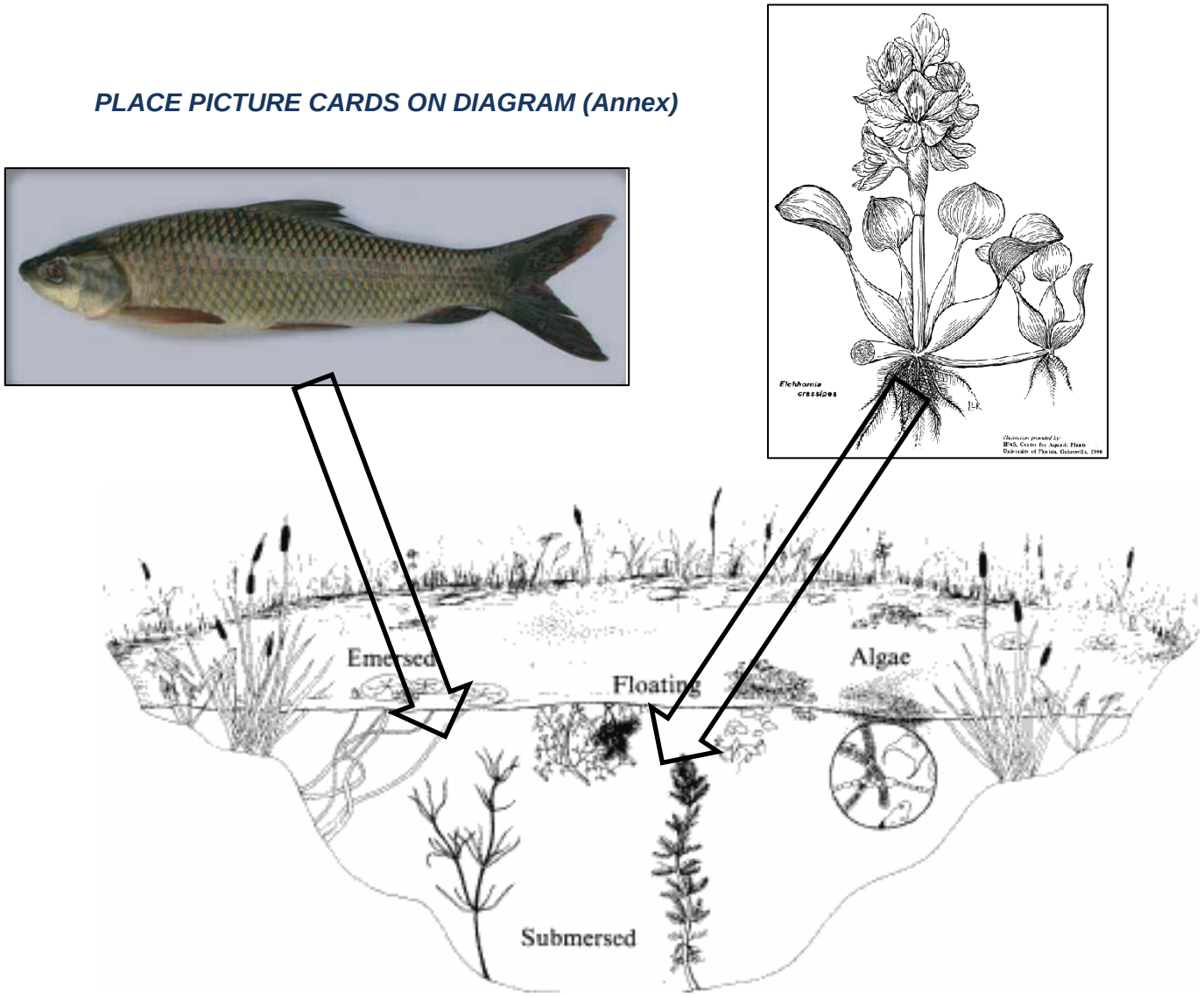
What type of food		What type of fish	What level
Phyto plankton		Mola, puti, darkina, silver barb,	surface
Snails		Shrimp, pangash, black carp,	All levels on structure
Fry, fingerling of all fishes, mola, darkina etc.	Pangash, boal, snakehead		

Analysis:

- What is the entire food chain of a pond? How does the food chain look like in your pond?
- Which species of fish or plants do you have in your pond, and which ones do you not have and why?
- What happens to the food chain if you remove certain plants or predatory fish? How does it change the food chain, and how does this impact on the pond?
- Which fish would you introduce in your pond to have a healthy food chain? Which ones would you take out?

Example of how to do the cross-section diagram of pond and use picture cards:

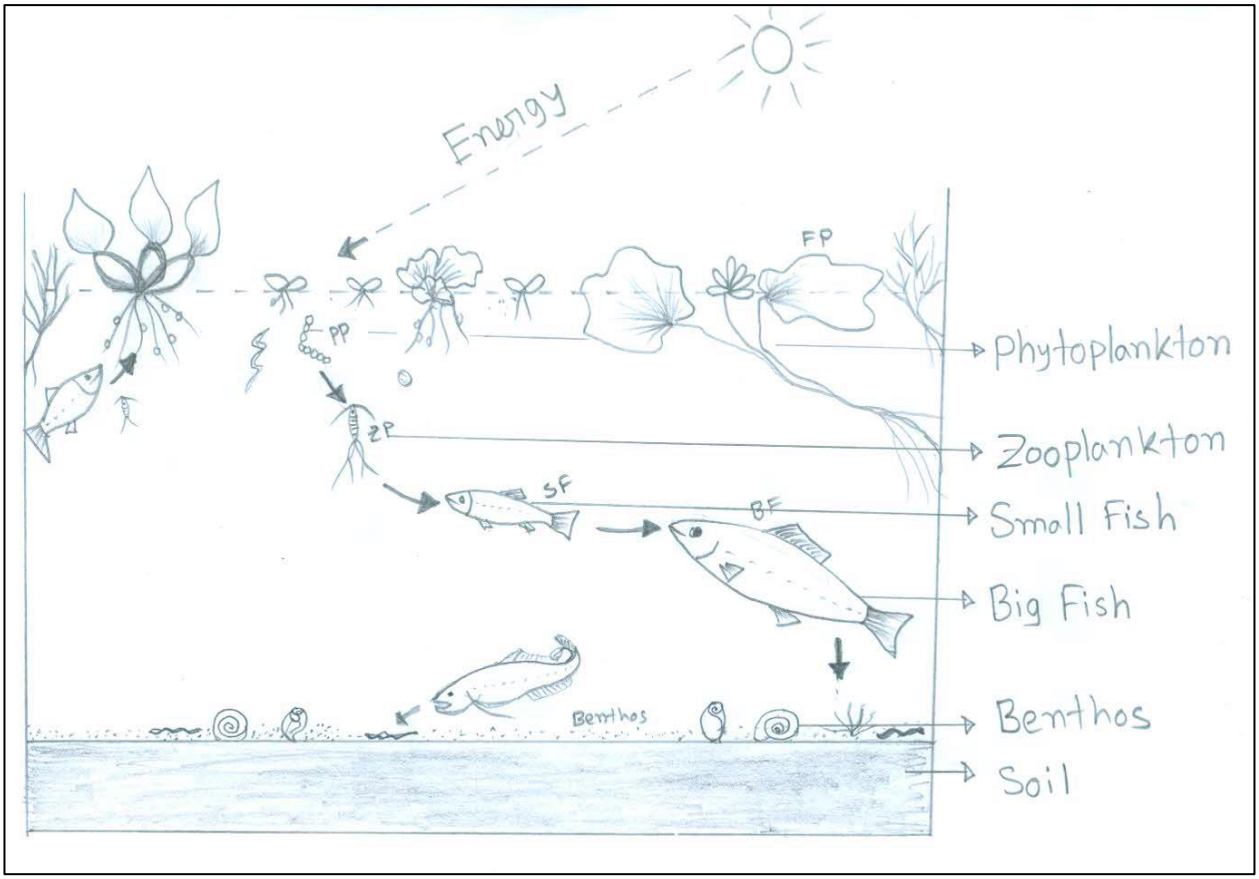
PLACE PICTURE CARDS ON DIAGRAM (Annex)



Conclusion:

Farmers have been building the food chain throughout most of the 12 weeks of the PAR process. Farmers have started with sunlight and phytoplankton, moving to zooplankton and periphyton, through to where various organisms and fish can be found. Finally they have created the ideal fish food chain habitat and they are asked to relate these observations to their individual homestead ponds.

Diagram 11



WEEK 12

Farmers dismantle the aquarium after a final thoughts and discussion period about how to replicate what they created in the aquarium in their ponds. Farmers finally sit down and together create a reproduction calendar for all 16 fish introduced by EcoPond. The session will end with

a discussion on the next phase of the EcoPond research which is how farmers will work with WorldFish to put in practice what they have learned in their ponds

PAR 12 - What is the reproductive cycle for various fish?

Summary:

The WorldFish Eco-ponds team works with around 16 different types of fishes in the ponds. Farmers may already know where and how certain fish breed. Since the winter seasons is coming and few fish will breed and spawn, a discussion will ensue to discuss fish breeding habits of various fish. Using a calendar from January to December, participants will be asked in a game situation to complete the stages of reproduction for 16 fish with the winners getting a prize. Farmers will name the stages and provide evidence from their observations on where some fish may deposit eggs, or where they may spawn etc.

Materials:

- 1 sqm calendar
- Markers and color pencils

Process:

Facilitators will research whether certain species of fish may be observed breeding or spawning during the winter months. If it is possible observations of these fish can be used. Some eggs or fry can even be collected and looked at under a magnifying glass. If this turns out to be difficult, a calendar will be used with 12 months on the x axis and the names and pictures (from picture cards in previous experiments) of 16 fish on the y axis. Farmers will provide 5 stages of fish reproduction, namely Breeding - Eggs – Fry – Fingerling – Adult. Farmers will colors to mark stages on calendar for 16 pond fish.

Design

- If observations are available (perhaps even farmers will know how to observe breeding habits and reproductive stages, then fry and eggs can be collected using a scalpel or hand net and looked at under a magnifying glass or microscope. Farmers would then make observations such as where are eggs deposited, where do fish hatch, how long till a fry becomes an adult etc. This can be done for al the fish found in people's ponds.
- Depending on the season, if this first step proves to difficult, a game situation can be created. Farmers will mark a calendar (found below) and they will mark the reproductive cycles of fish from "eggs – fingerling – adult" on the calendar of 16 different fish with colored pencils. They will also put how many reproductive cycles can some fish have in a year calendar, tilapia for instance are known to have up to 3 cycles and mola 2.

Data collection:

- See the datasheet on next page

Analysis:

- It is important to understand the reproductive cycle of fish and how they correspond to the seasons in order to cultivate and produce fish. Compare your knowledge with the knowledge that is provided by the facilitator?
- How does the calendar you created compare to what you have been doing when feeding and harvesting fish?
- When is it important to allow fish to breed?
- How many times can some fish reproduce? How many cycles? Why is this?
- Are ponds the most favorable habitat for these fish? Where else might you find them breeding?

Conclusion:

This PAR aims to end the 12 week PAR programme for farmers and facilitators. This specific PAR has shown the many different breeding patterns of fish, especially how they may look like on a calendar. This is compared to farmers' knowledge.

2nd Report

Appendix 1: Fish stocking, harvest, consumption and expenses for fish production in small homestead ponds by women in 2015

Table 1.Fish consumption by household during October to November'2015 in the communities Sajiara and Bahirakra in Dumuria

Upazilla	**Village**	**Total farmer Started fish consumption**	**Fish consumption (g)**
Dumuria	Sajiara	Women-01	6500
		Women-02	500
		Women-03	4450
		Women -04	2600
	Total consumption of 4 households with ponds		14050
	Mean fish consumption (g/household)		3512
	Bahirakra	Women -01	1000
		Women -02	7750
		Women -03	960
		Women -04	1750
	Total fish consumption by 4 households		11460
	Mean fish consumption (g/household) consumption		2865

Table 2. Stocking by women involved in fish production in their small homestead ponds during October to November 2015 in Gangarampur and Sukhdara community in Botiaghata

Gangarampur Farmer name	**Fish stocked (g)**	**Sukhdara** Farmer name	**Fish stocked (g)**
1.Anita Mohaldar	4000	Archona Mondol	3000
2.Bijoli Roy	2000	Basonti Roy	2500
3.Gouri Roy	4500	Chanda Roy	1300
4.Hemlata Kobiraj	3350	Chandona Sarker	3000
5.Lipi Begum	4000	Dipali Mondol	950
6.Mira Mondol	5000	Hira Roy	2600
7.Monila Begum	2900	Kajol Mondol	1000
8.Promadini Kobiraj	1750	Konika Mondol	1200
9.Puspo Sarker	1700	Lucky Mondol	2450
10.Rima Mondol	8100	Nilu Mondol	1450
11.Shongkori Kobiraj	1800	Provati Sarker	3550
12.Shova Kobiraj	7800	Rekha Mondol	900
13.Suchitra Kobiraj	2000	Rinku Gain	3150
14Toma Kobiraj	2500	Torulata Sarker	2200
15.Trilata	2850	Tumpa Mondol	2700
Total	54250		31950
Mean	3616		2130

Table 2. Fish harvest by households during October to November 2015 in Gangarampur and Sukhdara community in Botiaghata

Gangarampur Farmer name	Fish harvest for household consumption (g)	Sukhdara Farmer name	Fish harvested for household consumption (g)
Anita Mohaldar	5390	Archona Mondol	3150
Bijoli Roy	1427	Basonti Roy	2380
Gouri Roy	2100	Chanda Roy	2850
Hemlata Kobiraj	2630	Chandona Sarker	2070
Lipi Begum	2130	Dipali Mondol	3210
Mira Mondol	4610	Hira Roy	5960
Monila Begum	1310	Kajol Mondol	0
Promadini Kobiraj	1050	Konika Mondol	0
Puspo Sarker	3180	Lucky Mondol	0
Rima Mondol	3260	Nilu Mondol	2190
Shongkori Kobiraj	1630	Provati Sarker	7850
Shova Kobiraj	3670	Rekha Mondol	0
Suchitra Kobiraj	1860	Rinku Gain	0
Toma Kobiraj	1330	Torulata Sarker	3180
Trilata	0	Tumpa Mondol	480
Total	35577		33320
Mean (g/hh)	2372		2221

Note: Of total 15 women with ponds in Gangarampur except one all of them started harvest of fish to use for household consumption. In Sukhdara of total 15 women 10 of them started harvest of fish for household consumption.

Table 3. Total expenses of stocking of fish and habitat uses in ponds by women in communities in Dumuria in 2015

Community	Pond type	Pond Number	Fish Stock (g)	Average stocking (g)	Stocking cost (BDT)	Habitat cost (BDT)	Total expenditure (BDT)	Average expenditure
Sajiara	Seasonal	04	6150	1537	960	0	960	240
	Perennial	05	17000	3400	3030	0	3030	606
Bahirakra	Seasonal	05	4250	850	625	95	720	144
	Perennial	03	26150	8717	4600	30	4630	1543

Table 4. Total expenses of stocking of fish and habitat uses in ponds by women in communities in Dumuria in 2015

Community	Pond type	Pond Number	Fish Stock (g)	Average stocking (g)	Stocking cost (BDT)	Habitat cost (BDT)	Total expenditure (BDT)	Average expenditure
Sajiara	Seasonal	04	6150	1537	960	0	960	240
	Perennial	05	17000	3400	3030	0	3030	606
Bahirakra	Seasonal	05	4250	850	625	95	720	144
	Perennial	03	26150	8717	4600	30	4630	1543

Report 2 Appendix 2: Questionnaire for Women Empowerment in Agricultural Index (WEAI)

1. **Name of the women:**

2. **Location of the household**

Para:	Village:	Union :
Upazila:	District:	Division:

3. **Demography of the household**

Name of HH Members	Sex Man=1 Woman=2	Relationship with women	Age	Marital Status	Education	Occupation	
						Primary	Secondary
3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8

Code: Household Demography

3.5 Marital Status	**3.6 Education**
Unmarried=1 Married=2 Others =3	Illiterate =1, Can signed =2, Primary =3 Secondary =4 Higher secondary=5 Graduate =6 Above=7

4. Production Input and Autonomy

4.1	Who take decision in fish stocking?	Self =1 Partner/spouse =2 Jointly =3 Others HH members- =4 Other non HH members=5 Not Applicable=6

4.2	Who contact the sources?	Self =1 Partner/spouse =2 Jointly =3 Others HH members- =4 Other non HH members=5 Not Applicable=6
4.3	Who take the decision that what types of habitat use in your ditch?	Self =1 Partner/spouse =2 Jointly =3 Others HH members- =4 Other non HH members=5 Not Applicable=6

4.4 Who decide what types of feed, fertilizer and harvesting gear used in the ditch?

Activity	Type	Source	Time	Who take decision? Self=1, Partner/spouse=2, jointly =3, Other HH member=4, Other non-household member=5, Not Applicable=6
Feed				
Fertilizer				
Harvesting Gear				

4.5 How do you manage the ditch?

Activity	Do you participate in activity? Yes=1, No=2	How much decisions you can take about this activity? Take all decision=1, partly take some decisions=2 No decision made= 3
Habitat placement		
Vegetable case on (What)		
Feeding		
Fertilizer		
Flash flood and restocking		
Fish Mortality		
Time to Harvest		
Labor		

4.6 Role in other agricultural activity

Activity	Do you or anyone in your household currently engage? Yes=1, No=2	How much decisions you can take about this activity? Take all decision=1, partly take some decisions=2 (next Colum) No decision made= 3	In which part of these activities do you take decision?
Fish Culture (pond and gher, commercial)			
Cash crop farming			
Vegetable			
Poultry and duck rearing (duck and chicken, pigeon)			
Livestock			
Fruit trees			

5. <u>Access to Resources</u>

Item	Have you or anyone in your household currently have any Item? Yes=1, No=2	How many of item does your household have? (number)	Who owns most of the item? Self=1, Partner/spouse=2, Other HH member=3, Other non-household member=4, Not Applicable=5	(In case of selling) Most of the time who decides which item to be sell? Self=1, Partner/spouse=2, Other HH member=3, Other non-household member=4, Not Applicable=5	Most of the time who decide to mortgage or rent out of the item? Self=1, Partner/spouse=2, Other HH member=3, Other non-household member=4, Not Applicable=5	Who can take decisions regarding a new purchase of item? Self=1, Partner/spouse=2, Other HH member=3, Other non-household member=4, Not Applicable=5
5.1	5.2	5.3	5.4	5.5	5.6	5.7
Agricultural Land						
Homestead Land						
Big Fruit trees						
Ditches						

Ponds						
Ghers						
Livestock						
Poultry						
Farm equipment (non-mechanized: hand tools, animal-drawn plows)						
Farm equipment (mechanized: tractor-plough, power tiller, treadle						
Means of transportation (bicycle, van motorcycle)						

5.8	If you owns, any resource, how did you get it?	From her parents=1 Form her husband= 2 Buy her own name=3 From other relatives=4 From the govt./NGO/other organization=5
5.9	Do you have savings?	Yes= 1, No=1
5.10	If yes, where do you save?	Bank =1, Samity/group =2 In the house = 3 Others=4
5.11	Do you invest any money?	Yes=1. No=2
5.12	If yes, How and where do you invest?	
5.13	Have you or anyone in your household taken any loans or borrowed cash/in-kind?	Yes =1, no=2
5.14	If yes, What are lending sources?	NGO=1 Friends or relatives=2 Money lender =3 Formal lender(bank/financial institution)=4 Others=5
5.15	Who made the decision to lending?	Self=1 Spouse= 2 Jointly=3 Other HH members=. 4 Not Applicable=5

5.16	Who makes the decision about what to do with the money/ item borrowed from]?	Self=1 Spouse= 2 Jointly=3 Other HH members=. 4 Not Applicable=5
5.17	Who repay the loan?	Self=1 Spouse= 2 Jointly=3 Other HH members=. 4 Not Applicable=5

6. Control over Income

6.1	What are your own sources of income?	Crop =1, vegetable=2, Poultry=3, livestock =4, Fish culture= 5, Gher=6 Fruit = 7 0ther non- farm activities= 8 (specify), No other sources = 9
6.2	Do you have control over your own income?	Yes=1, No=1
6.3	How do you spend your income?	Personal=1, household expenditure =2 Children's education=3 agricultural equipment =4, Aquaculture equipment=5,others=6
6.4	Do you have any share of household income?	Yes=1 no=2 Do not know =3
6.5	What proportion of your income spends in household purchase?	
6.6	What decision-making do you participate in?	
6.7	What decision-making do your husband/any other family members usually control?	
6.8	What constraints do you face to participate in decision making process?	

7. Leadership

7.1	Do you the member of any group?	Yes=1 No=2
7.2	If yes, In which group do you belong?	Cooperative =1 NGO credit samity=1 Water user's group=3 Local Group=4 Association=5 Network=6 Learning center based group= 7 Others= 8 (Specify)

7.3	Which position do you belong?	President=1 Vice president=2 Secretary =3 Cashier= 4 General member=5
7.4	Do you feel comfortable speaking up in concerning your knowledge on natural feed, habitat and species related work?	Yes comfortably=1 Yes, but with difficulty=2 No, not at all comfortable=3
7.5	Do you feel comfortable speaking up in public to help decide on infrastructure (like small wells, roads, water supplies) to be built in your community?	Yes comfortably=1 Yes, but with difficulty=2 No, not at all comfortable=3
7.6	Do you feel comfortable speaking up in public to protest the misbehavior of the community people?	Yes comfortably=1 Yes, but with difficulty=2 No, not at all comfortable=3
7.7	What are your family's reactions about your activity and how are they reacting	
7.8	Is there any evidence that others community people come to you to learn the technology/science?	Yes=1 No=2
7.9	Do you have any access to agriculture related information and technology?	Yes=1 No=2
7.10	If yes, what type of information you have access and how?	
7.11	If no, what barriers kept you from getting access to agricultural information and technology?	

Self Esteem

(Strongly disagree =1, Disagree =2, neither disagree nor Agree =3, Agree=4, Very agree=5)

7.12	You can express your opinion Independently	1	2	3	4	5
7.13	You have clear understanding on your activity	1	2	3	4	5
7.14	You have ability to take quick decision	1	2	3	4	5
7.15	You have interest for innovation	1	2	3	4	5
7.16	You have willing to research work presentation	1	2	3	4	5
7.17	You have ability to share knowledge to others	1	2	3	4	5
7.18	You have capacity to solve problem	1	2	3	4	5
7.19	You have an freedom on mobility	1	2	3	4	5

7.20	You are able to mobilize the people	1	2	3	4	5

8. Time Allocation

8.1 How do you spend your time?

Morning	**Activities**
5-7 am	
7-9 am	
9-12 am	
Afternoon	
12-2 pm	
2-6 pm	
Evening	
6-8 PM	
8-10 Pm	
Night	
10 pm -Onwards	

8.2	How are you satisfied with the time you have to yourself to do things?	Strongly dissatisfied =1 Dissatisfied =2 Neither dissatisfied nor Satisfied =3 Satisfied=4 Very satisfied=5
8.3	How satisfied are you with your available time for leisure activities like visiting neighbors, watching TV or listening to the radio?	Strongly dissatisfied =1 Dissatisfied =2 Neither dissatisfied nor Satisfied =3 Satisfied=4 Very satisfied=5

Annex 3 Questionnaire for Gender Parity Index (GPI)

1. **Name of the men:**
2. **Name of the wife:**

3. Production Input and Autonomy

No	Activities	Do you take decision?	Why?
3.1	Stocking of species for the ditch		
3.2	Contact the sources		

3.3	Types of habitat use the ditch		
3.4	Types of Feed		
3.5	Fertilizer		
3.6	Harvesting Gear and time to harvest		
3.7	Flash flood and restocking		
3.8	Labour		

4. Role in other agricultural activity

Activity	In which area do you take decision?	Why?
Fish Culture (pond and gher; commercial)		
Cash crop farming		

Vegetable		
Poultry and duck rearing (duck and chicken, pigeon),		
Livestock		
Fruit trees		

5, <u>Access to Resources</u>

<u>5.1 Please tick the following resources:</u>

Agricultural Land	Homestead Land	Big Fruit trees	Ponds	Ghers	Livestock	Farm equipment (non-mechanized:

						hand tools, animal-drawn plows)
Farm equipment (mechanized: tractor-plough, power tiller, treadle	Means of transportation (bicycle, van motorcycle,)		Savings			

5.2	From where do you get the resource?	Buy myself=1 From my parents=2 From my in-laws=3 From my wife=4 From other family members= 5
5.3	Do you have savings?	Yes= 1, No=1
5.4	If yes, where do you save?	Bank =1, Samity/group =2, in the house = 3, Others=4
5.5	Do you invest any money?	Yes=1, No=2
5.6	If yes, How and where do you invest?	
5.7	Have you or anyone in your household taken any loans or borrowed cash/in-kind?	Yes =1, No=2,
5.8	If yes, What are lending sources?	NGO=1 Friends or relatives=2 Money lender =3 Formal lender (bank/financial institution)=4 Others=5
5.9	Who made the decision to borrow?	Self=1 Spouse= 2 Jointly=3 Other HH members=4 Not Applicable=5

5.10	Who makes the decision about what to do with the money/ item borrowed from]?	Self=1 Spouse= 2 Jointly=3 Other HH members=4 Not Applicable=5
5.11	Who repay the loan?	Self=1 Spouse= 2 Jointly=3 Other HH members=4 Not Applicable=5

6. Control over Income

6.1	What are your own sources of income?	Crop =1, vegetable=2, Poultry=3, livestock =4, Fish culture= 5, Gher=6 Fruit = 7 0ther non- farm activities= 8 (specify), No other sources = 9	
6.2	Do you have control over your own income?	Yes=1, No=1	
6.3	If no, who control?		
6.4	How do you spend your income?	Personal=1, household expenditure =2 Children's education=3 agricultural equipment =4, Aquaculture equipment=5,others=6	
6.5	What proportion of your income spends in household purchase?		

6.6	What decision-making do you participate in?				
6.7	How frequently do you talk to your wife about problems you are facing in your life?				
6.8	How do you enjoy the following activities? (Not enjoy=1, Enjoy =2, Greatly enjoy=3, Not applicable)				
	Caring for or spending time with children	1	2	3	4
	Travelling	1	2	3	4
	Going to cultural events (religious occasion, Jari gan, village fair, marriage)	1	2	3	4
	Having meals together	1	2	3	4
	Watching TV together	1	2	3	4
	Cooking together	1	2	3	4
	Food and clothing	1	2	3	4
	Large investments such as buying a land, or a van, shop, or a household appliance	1	2	3	4

7. Leadership

7.1	Do you the member of any group?	Yes=1 No=2
7.2	If yes, In which group do you belong?	Cooperative =1 NGO credit samity=2 Water user's group=3 Local Group=4 Association=5 Network=6 Learning center based group= 7 Others= 8 (Specify)

7.3	Which position do you belong?	President=1 Vice president=2 Secretary =3 Cashier= 4 General member=5
7.4	What are your family's reactions about your wife's activity and how are they react?	
7.5	Do you have any access to agriculture related information and technology?	Yes=1 No=2
7.6	Do your wife has access to agriculture related information and technology? How?	
7.7	If no, what barriers kept you wives from getting access to agricultural information and technology?	

Self Esteem

(Strongly disagree =1, Disagree =2, neither disagree nor Agree =3, Agree=4, Very agree=5)

7.8	You feel that your wife has clear understanding on her activity	1	2	3	4	5
7.9	Your wife has ability to take quick decision	1	2	3	4	5
7.10	Your wife has interest for innovation	1	2	3	4	5
7.11	Your wife has ability to share knowledge to others	1	2	3	4	5
7.12	She has the capacity to solve problem	1	2	3	4	5
7.13	She has an freedom on mobility	1	2	3	4	5

7.14	She has the ability to mobilize the people	1	2	3	4	5

8. Time Allocation

8.1 How do you spend your time?

Morning	**Activities**
5-7 am	
7-9 am	
9-12 am	
Afternoon	
12-2 pm	
2-6 pm	
Evening	
6-8 PM	
8-10 Pm	
Night	
10 pm -Onwards	

8.2	How are you satisfied with the time you have to yourself to do things?	Strongly dissatisfied =1 Dissatisfied =2 Neither dissatisfied nor Satisfied =3 Satisfied=4 Very satisfied=5
8.3	How satisfied are you with your available time for leisure activities like visiting neighbors, watching TV or listening to the radio?	Strongly dissatisfied =1 Dissatisfied =2 Neither dissatisfied nor Satisfied =3 Satisfied=4 Very satisfied=5

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