Project ID -778

Competitive Research Grant

Sub-Project Completion Report

on

Fine Tuning of Short Cycle Culture of Shrimp *Penaeus monodon* in Rotation with Tilapia in the Coastal Ghers

Project Duration

May 2017 to September 2018

Bangladesh Fisheries Research Institute
Brackishwater station, Paikgacha, Khulna

Submitted to

Project Implementation Unit-BARC, NATP - 2
Bangladesh Agricultural Research Council
Farmgate. Dhaka-1215

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Edited and Published by:

Project Implementation Unit
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Acknowledgement
The execution of CRG sub-project has successfully been completed by [Bangladesh Fisheries Institute, Brackishwater Station, Paikgacha, Khulna] using the research grant of USAID Trust Fund and GoB through Ministry of Agriculture. We would like to thank to the World Bank for arranging the grant fund and supervising the CRGs by BARC. It is worthwhile to mention the cooperation and quick responses of PIU-BARC, NATP 2, in respect of field implementation of the sub-project in multiple sites. Preparing the project completion report required to contact a number of persons for collection of information and processing of research data. Without the help of those persons, the preparation of this document could not be made possible. All of them, who made it possible, deserve thanks. Our thanks are due to the Director PIU-BARC, NATP 2 and his team who extended their whole hearted support to prepare this document. We hope this publication would be helpful to the agricultural scientists of the country for designing their future research projects in order to generate technology as well as increase production and productivity for sustainable food and nutrition security in Bangladesh. It would also assist the policy makers of the agricultural sub-sectors for setting their future research directions.

Published in: September 2018

Printed by:

Acronyms

ABW	Average Body Weight
APHA	American Public Health Association
BCR	Benefit Cost Ratio
BFRI	Bangladesh Fisheries Research Institute
CaO_2	Calcium Oxide
cm	Centimeter
DoC	Days of Culture
DoF	Department of Fisheries
EMS	Early Mortality Syndrome
et. al.	Et alia(L), and Others
FCR	Feed Conversion Ratio
g	Gram
GIFT	Genetically Improved Farmed Tilapia
ha	Hectare
kg	Kilogram
L	Liter
mg	Milligram
PL	Post Larvae
ppm	Parts Per Million
ppt	Parts Per Thousand
SGR	Specific Growth Rate
SPF	Specific Pathogen Free
T	Treatment
TSP	Triple Super Phosphate

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Executive Summary

To develop a year round affordable and production increasing culture technology for coastal Shrimp farmers, Shrimp (*Penaeus monodon*) was cultured during high salinity period (10-18 ppt) with 5 nos/m^2 stocking density for the period of 60 days of culture as short cycle pattern and Tilapia culture was practiced during low salinity period (0-5 ppt) with 4/m^2 stocking density for the period 90 and 120 days of culture incorporating crop rotation and crop diversification technique**.** The culture trial was performed in on station and on farm culture ponds for further validation of the previous research findings of Bangladesh Fisheries Research Institute, Brackishwater Station, Paikgacha, Khulna.

The experiments were conducted in six on-station and six on-farm ponds of 0.1 ha each. In short cycle, for 60 days Shrimp culture all the ponds were prepared as per methodology and stocked with good quality Specific Pathogen Free (SPF) Shrimp post larvae (PL). After 60 days of culture, the highest average body weight, production, net benefit and benefit cost ratio (BCR) of Shrimp were found 18.20g, 797 kg/ha/crop, 157906 BDT and 1.59 respectively in on-station ponds where as 17.28 gm, 713 kg/ha/crop and 120629 BDT and 1.43 respectively in on-farm ponds.

After harvesting, Shrimp ponds were prepared and Tilapia fingerlings were stocked for 90 and 120 days of culture period. The average body weight (ABW) was 196g after 120 days of culture and 149g after 90 days of culture period in on-station. In farmers' ponds the highest average weight of Tilapia was found 181g in 120 days of culture and 138g in 90 days of culture period. The highest average production of Tilapia was found 5838 kg/ha/crop with a survival rate of 76% in 120 days of culture and 5041 kg/ha/crop with a survival rate of 84% in 90 days of culture in on station. In on-farm ponds the highest average production of Tilapia was 5456 kg/ha/crop with a survival rate of 75% in 120 days of culture and 4306 kg/ha/crop with a survival rate of 78% in 90 days of culture period. Which implies a good production and average survival rates were high (>80%) in all the treatments of 90 days of culture period. The highest net benefit was BDT 165900/ha/crop with benefit cost ratio (BCR) of 1.35 was found in treatment one of on-station ponds in 120 days of culture followed by treatment two with 90 days of culture, BDT 76435/ha/crop with BCR of 1.20. The highest net benefit was Tk. 146800/ha/crop with benefit cost ratio (BCR) was 1.32 in 120 days of culture and net benefit was BDT 29180 in 90 days of culture. Results of on station were found somewhat lower in on-farm ponds.

However, traditional shrimp farmers of the coastal regions can be adapted with this diversified short term culture technology pattern of shrimp (60 days during high salinity period) alternate with GIFT (Genetically Improved Farmed Tilapia) during low salinity period. This ensures lower management cost with higher production of shrimp and tilapia.

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. Title of the CRG sub-project: **Fine Tuning of Short Cycle Culture of Shrimp *Penaeus monodon* in Rotation with Tilapia in the Coastal Ghers**
2. Implementing organization: Bangladesh Fisheries Research Institute, Brackishwater Station, Paikgacha, Khulna
3. Name and full address with phone, cell and E-mail of PI/Co-PI (s):

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4. Sub-project budget (Tk):

4.1 Total: **40,00,000.00**
4.2 Revised (if any): None

5. Duration of the sub-project:

5.1 Start date (based on LoA signed) : 8 May 2017

5.2 End date : 30 September 2018

6. Justification of undertaking the sub-project:

In Bangladesh, Shrimp culture has grown by leaps and bounds and turned the sector as a vainglorious industry. Shrimp sector has a lion share in foreign exchange earnings as well as employment generation and livelihood improvement of the peoples directly or indirectly involved with the sector. Four potential penaeid species are available for the coastal aquaculture of which, *Penaeus monodon* is the single species contributed more than 90% of total farmed Shrimp production of the country.

Shrimp aquaculture industry in Bangladesh is running with some major hurdles of disease outbreak and pollution of culture water due to lack of proper water management system in coastal *ghers*. Poor water quality management in combination with stocking of poor quality seed and improper feeding has been pointed out as the reasons for disease outbreak and low production rate. Average production rate of Shrimp is very low and would not be more than 200 kg/ha. About 2,17,000 ha of the coastal Shrimp *ghers* remained under-utilized. Sometimes the Shrimp farmers became penniless due to outbreak of disease and therefore looking for scientific and technological intervention for increasing per unit production than traditional systems. Shrimp farming in Bangladesh is mostly traditional in nature with the average production ranging between 280 to 350 kg per hectare (DoF, 2014).

Since, Shrimp is one of the most important export earning commodities, it is important to consider a production increasing culture technology that would be affordable particularly for marginal to medium farmers. In these circumstances, periodic culture of Shrimp with finfish on rotational basis such as short term (60 days) Shrimp culture of diversified cropping pattern along with little interventions of feeding and water management would save the farmers from disease outbreak and will promote per unit production and total farm out puts as well. Beside this, marginal Shrimp farmer could utilize their 1st crop return in their second short cycle crop as their investment capacity is limited to run the long cycle pattern. Indeed the marginal to medium farmer would be surely benefited economically by utilizing their *ghers* through year round aquaculture during low to high salinity period.

Crop rotation in aquaculture is the successive culture of different species in the same culture area within a particular cropping season where one crop directly or indirectly influence other crop in terms of uplifting productivity, disease reduction by keeping a healthy sanitary environment. Continuous culture of Shrimp over the past few years might have caused the increase of Shrimp-pathogenic *Vibrio harveyi* in the culture systems and related environments. Although, many of the farms might have employed thorough pond preparation techniques, these bacteria would have passed over into succeeding cultures as they are protected by the biofilms. Bacterial biofilms are notably resistant to drying and disinfection (Paclibare *et al*., 1998). Karunasagar *et al*. (1996) found that *Vibrio harveyi* can survive in sediments that are treated with high doses of disinfectants. Because of the difficulty in reducing the concentration of pathogenic bacteria in Shrimp ponds by conventional chemical disinfection, other effective means such as biological control should be explored. Single crop production over the year in the same field may reduce the fertility of the soil and accumulate harmful nutrients in the pond bottom. Cultivable land reduction, seasonal inundation and disease problems can be minimized by adopting fish paddy crop rotation (Roy *et al*., 2013).

Crop rotation in Shrimp aquaculture is worth exploring and may prove feasible in view of the recent findings on the host specificity/preference of certain strains of *Vibrio harveyi*. Liuxy *et al*. (1996) found differences in the pathogenicity of *Vibrio harveyi* isolated from penaeid and non-penaeid sources. Some research programs by Bangladesh Fisheries Research Institute (BFRI) on increasing *gher* productivity using concurrent culture (Saha *et al.,* 2012; Islam *et al.,* 2015), crop rotation and crop diversification (Shofiquzzoha *et al.,* 2009) have already been implemented with tremendous success in production and disease control. The findings of some of the researches are also encouraging for production of GIFT during low saline period (Khatun and Saha, 2017) as an alternate crop. Thus evidently proven to increase total farm output with minimal intensification of technologies that is affordable by the marginal and medium farmers. Introduction of some technological interventions through diversified cropping system and crop rotation followed by modification in *gher* area, culture period, stocking density and other inputs would surely up rise production as well as profitability. If traditional Shrimp farmers can be impetuously accustomed with diversified cropping pattern ensuring lower management cost with higher production rate, Bangladesh could successfully ensure a sustainable production in near future up to maximum level. Considering all above, this project was proposed to implement the short term culture of Shrimp (60 days during high salinity period) alternate with GIFT (Genetically Improved Farmed Tilapia) during low salinity period incorporating crop rotation and crop diversification technology.

7. Sub-project goal:

Increasing productivity of *gher* fishery through harmonization of crop rotation and diversified short cycle cropping patterns.

8. Sub-project objective (s):

i. To increase the productivity of coastal *ghers* through year round aquaculture

ii. To demonstrate short cycle Shrimp culture system in rotation with Tilapia in the farmers' *gher*

9. Implementing location (s): The sub-project will be implemented in potential Shrimp farming area in southwest coastal region of Bangladesh named Paikgacha upazila of Khulna district and Brackishwater station of BFRI, Paikgacha, Khulna.

10. Methodology in brief:

10.1 Experimental design:

The experiment was conducted in six on-farm ponds of Paikgacha Upazilla, Khulna and six on-station ponds of Bangladesh Fisheries Research Institute, Brackishwater Station, Paikgacha, Khulna. Area of ponds were 0.1 ha each following the design as given in Table 2. The experiment was provided with two treatments (T) and 3 replications of each. In treatment-1 (T1), short term (60 days) Shrimp culture with double cropping pattern; in treatment-2 (T2), short term (60 days) Shrimp culture with double cropping pattern alternate with GIFT culture (90-120 days during low saline period). The farmer's ponds were selected in two different areas of Paikgacha Upazila as Table 1.

Table 1. Farmers name and locations of the ghers/ponds

Farmers name	**Location of *ghers***
Md. Abdul Momin	Goroikhali, Paikgacha, Khulna
Md. Abdur Rahim	Sorol, Bandikhati, Paikgacha

Table 2. Experimental design (On-farm and On-station)

Treatment	**Treatment description**	**Salinity**	**Culture period**	**Replication**	**Density**	**GIFT density**
T1	Culture of Shrimp	High salinity (10-18 ppt)	Short cycle (60 days)	3	$5/m^2$	-
T2	Culture of Shrimp	High salinity (10-18 ppt)	Short cycle (60 days)		$5/m^2$	-
	Alternate culture of GIFT	Low salinity (0-5 ppt)	90-120 days		-	$4/m^2$

10.2 Pond preparation and pre-stocking management:

Initially all the on-station and on-farm ponds were completely drained out and re-excavated to remove the bottom sludge/fouled layer, renovation of dykes and then allowed to sun dry for 7-10 days to increase the oxidation capacity of hydrogen sulphide and to eliminate other obnoxious gases. For short term (10-15 days) in-pond nursery of Shrimp post larvae, about 10% area of each pond receiving the respective treatments was enclosed with nylon net fastened with bamboo frame. The entire pond areas were fenced by blue net as biosecurity measure to prevent entry of virus/disease carrier species. Liming (Quick lime: dolomite 1:1) @ 250 kg/ha of soil was done and then filled with tidal water from Shibsha river up to a depth of 1m by filtration with small mesh size filter net and then treated with bleaching @ 60 ppm to kill all animalcules.

Pond drying and nursery preparation

Liming of pond bottom

Organic fertilizers, such as fermented mixtures of molasses, rice bran and yeast were spread across the ponds at a ratio given in Table 3 to develop colour of water and to prevent penetration of sunlight. After 2-3 days of molasses application, mustard oil-cakes were applied in liquid state @ 60 kg/ha and then fertilized with urea and TSP @ 2.5 and 3.0 ppm, respectively for quick development of colour of water and production of plankton. However, major inputs applied in this experiment are furnished in Table 3.

Table 3. Major interventions followed in the experimental ponds

Key features	**Doses/application**
Liming of soil	250 Kg/ha (Quick lime: dolomite 3:1)
Chlorination	@ 20 ppm
Urea+TSP	25+30 (Kg/ha)
Fermented Molasses mixture (Molasses: rice bran: yeast)	140:35:0.6 kg/ha.
PL (Post Larvae)	
In-pond nursing	PCR tested PL
Dolomite (water)	15 days
Feed	@ 15 ppm (Monthly basis)
Pond depth	CP feed
Zeolite	1 Meter (Minimum)
	@ 4 ppm (3rd & 4th month of culture)

After fertilization required quantity of SPF post larvae (PL) were procured exclusively from commercial hatchery and acclimatized with the pond water and stocked slowly as per mentioned design to the in-pond nursery during the late evening period.

Chlorination in on-station pond

Acclimatization of Shrimp PL

10.3 Post-stocking management and monitoring of growth and water quality parameters:

In the nursery the stocked PL were fed with CP nursery feed manufactured by India. In the nursery the stocked PL were fed with CP nursery feed. After 10 days, the juveniles were released to the whole pond by up-folding the nylon net of the nursery enclosure. In the grow-out ponds, the Shrimps were fed with CP grow-out Shrimp feed depending on the biomass of Shrimp and the growth and

well-being of Shrimp was monitored at weekly interval and feeds were adjusted according to CP Shrimp feed manual.

Chlorination in farmer's pond

Sampling of Shrimp in farmer's pond

The feeding frequency was 4 times per day as in the morning at 6.00 am., 11.00 .m., 6.00 pm. and 10.00 pm. respectively. The ingredient of the feed includes Fish meal, Wheat flour, Soybean meal, Fish oil, Phospholipid, Vitamins and Minerals etc. The compositions of CP Shrimp feed applied are given below in Table 4.

Table 4. Nutritional composition of CP feed applied during the culture period

Composition	**Minimum Percentage (%)**
Crude protein	38
Fat	5
Moisture	12
Fibre	4

During the grow out period the water quality parameters *viz*., temperature, transparency, salinity, pH, free carbon dioxide, alkalinity were monitored and recorded at 7 days interval and dissolved oxygen was monitored frequently following standard methods as mentioned by APHA (2005).

10.4 Shrimp health monitoring:

Shrimp growth and health condition was monitored weekly, growth and biomass were estimated and feed was adjusted. Ponds were treated with lime @20 ppm at 15 days of intervals. After 60 days of culture, Shrimp was harvested and prepared accordingly. GIFT was stocked according to the design in the short cycled ponds. Shrimp was fed with CP Shrimp feed while GIFT (Genetically Improved Farmed Tilapia) was fed with quality Tilapia floating feeds. After 120 days GIFT was harvested. Data was collected on growth, food conversion ratio (FCR), survival, Shrimp production, GIFT production, total production, production cost and farm gate sales for each of the treatment ponds/ghers.

10.5 Data analysis and reporting:

Collected data were plotted in MS excels and analyzed using SPSS.

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11. Results and discussion:
Information/data of Shrimp culture:

In short culture cycle, SPF Shrimp PL were used and cultured for 60 days. The growth performances of Shrimp in different ponds are shown in Table 5-6. After 60 days of culture, average body weight, production, net benefit and benefit cost ratio (BCR) were found 18.20g and 17.43 gm, 796.5 kg/ha/crop and 733.6 kg/ha/crop, 157906 BDT and 1.59 respectively in on-station ponds whereas 17.23 gm and 17.28 gm, 712.5 kg/ha/crop and 707.9 kg/ha/crop, 120629 BDT and 1.43 respectively in on-farm ponds.

These results were higher than previous results found in different experiment on this station. Saha *et.al*. 2016 found 748 kg/ha/crop in sixty days Shrimp culture with stocking density of 5 m^2 in Brackishwater station of BFRI. Washim *et.al*. 2016 also reported 561 kg/ha/crop in sixty three days culture of SPF Shrimp in Brackishwater station pond of BFRI with same density. Washim and Rahman 2017 found highest production 702 kg/ha/crop in stocking density of 5 m^2 in Brackishwater station of BFRI in sixty days culture

The water quality parameters are furnished in Table 7. All the physicochemical parameters were found congenial for Shrimp culture. Although there were some fluctuations in salinity level due to location of ponds near to upstream and down-stream.

Table 5. Production performance of Shrimp culture in on-station ponds in 60 days

Treatment	Crop(s)	Replications	ABW (g)	Survival (%)	Production (Kg/ha/crop)	FCR
T1	1st short cycle	R1	18.70	88.40	826.5	1.21
		R2	18.30	84.70	775.0	1.24
		R3	17.60	89.55	788.0	1.26
		Average	**18.20**	**87.55**	**796.5**	**1.24**
T2	1st short cycle	R1	16.70	91.70	765.7	1.31
		R2	17.50	81.60	714.0	1.34
		R3	18.10	79.69	721.2	1.37
		Average	**17.43**	**84.33**	**733.6**	**1.34**

Table 6. Production performance of Shrimp culture in on-farm ponds in 60 days

Treatment	Crop(s)	Replications	ABW (g)	Survival (%)	Production (Kg/ha/crop)	FCR
T1	1st short cycle	R1	17.10	82.90	708.80	1.35
		R2	16.90	85.70	724.17	1.31
		R3	17.70	79.60	704.46	1.47
		Average	**17.23**	**82.72**	**712.5**	**1.38**
T1	1st short	R1	16.98	84.54	717.74	1.37

	cycle	R2	17.45	81.65	703.41	1.41
		R3	17.42	80.66	702.55	1.44
		Average	**17.28**	**82.28**	**707.90**	**1.41**

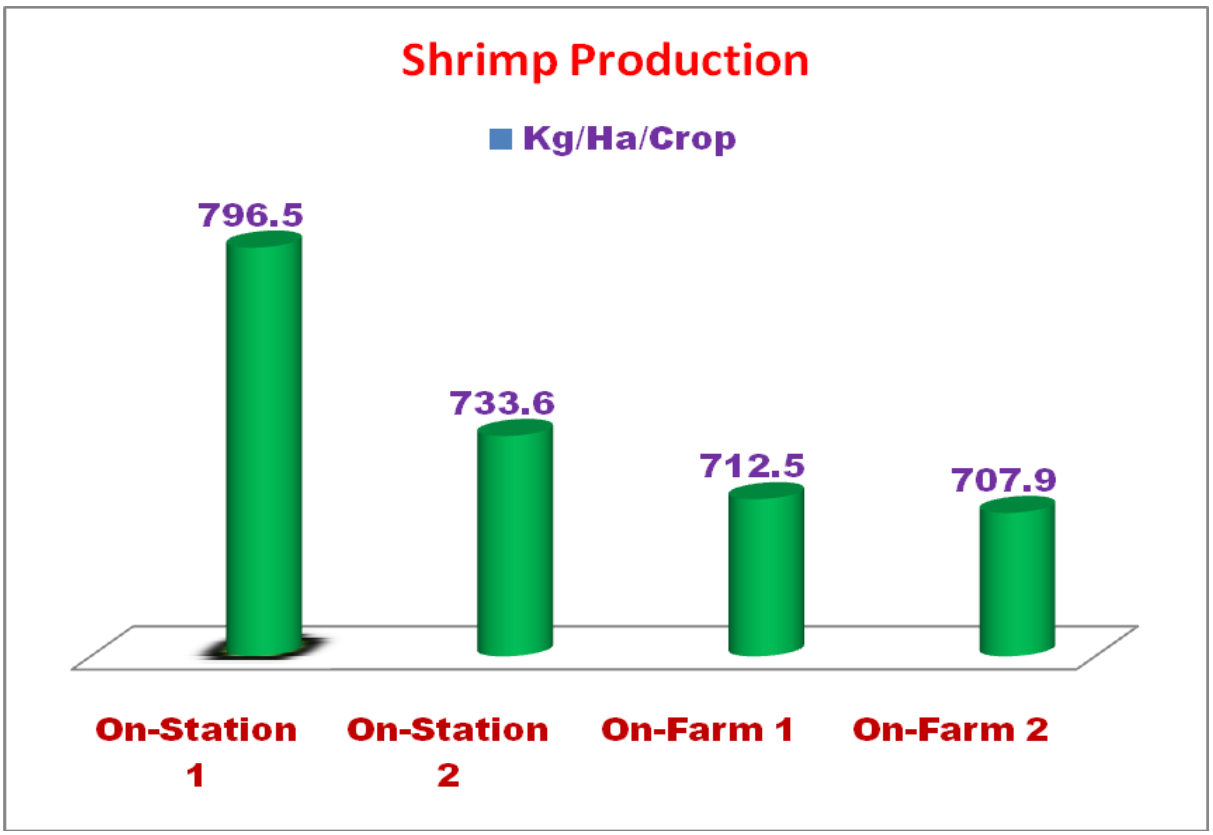

Figure 1. Production performance of on-station and on-farm Shrimp Culture

Table 7. Hydrographical parameters of Shrimp culture

Parameters	**On-station**		**On-farm**	
	T1	**T2**	**T1**	**T2**
Temperatures (°C)	27.5-30.5	27.4-31.0	29.2-34	28.4-32
Salinity (ppt)	12-17	12-17	13-21	13-21
Transparency (cm)	35-50	36-44	25-30	26-30
pH	7.8.-8.6	8.2-9.0	8.1-8.9	8.3-9.0
Alkalinity (mg/l)	122-140	104-122	155-180	110-140
Morning DO (mg/l)	4.5-6.8	3.8-5.8	4.3-6.2	4.0-6.6

Table 8. Cost of production and economic returns of Shrimp culture from 1ha ponds for 60 days of culture.

Components	On-station		On-farm	
Treatments	**T_1**	**T_2**	**T_1**	**T_2**
Days of culture	**60**	**60**	**60**	**60**
Expenditure	**Taka**	**Taka**	**Taka**	**Taka**
Pond lease	13000	13000	13000	13000
Bleach+Lime+Fertilizer	12000	12000	12000	12000
Shrimp PL	6000	6000	6000	6000
Feed	128396	127793	127823	129758
Labour	48000	48000	48000	48000
Miscellaneous	5000	5000	5000	5000
A, Total cost	212396	211793	211823	213758
Income	**Taka**	**Taka**	**Taka**	**Taka**
B. Gross return	334530	308112	299250	297318
Net benefit (B-A)	122134	96319	87427	83560
BCR	**1.58**	**1.45**	**1.41**	**1.39**

Price of Shrimp = Taka 420/ kg with ABW 17.2 –18. 2 g cultured for 60 days.

Information/data of Tilapia culture

Pond preparation and fry stocking:

After complete preparation of ponds, all the on-station and on-farm ponds were stocked with Tilapia fry again to fulfill the remnant experimental design. To continue Tilapia culture all the ponds were drained out completely for sun drying again and aquatic weeds were removed manually then treated with lime (CaO @ 250 kg/ha). A temporary in-pond nursery (25 m^2) was prepared at one corner in each of the ponds by erecting nylon net fastened in bamboo frame. One week after liming the on-station ponds were filled with tidal water of 13 ppt and farmers ponds were filled with 16 and 14 ppt tidal water from river Shibsha up to a depth of 1 meter after filtering through nylon net. Water of the ponds was treated with rotenone @ 2 ppm to kill unwanted and predatory fishes. Dolomite @ 20 ppm was applied to each pond to increase buffering capacity of the ponds. After three days, ponds were fertilized with urea and TSP @ 2.5 ppm and 3.0 ppm respectively. TSP was soaked overnight, and then urea and TSP were dissolved together and spread manually on pond water surface in the morning.

Tilapia fry in oxygenated bag

Conditioning of Tilapia fry in farmers ponds

After growth of sufficient plankton, male monosex Tilapia fry with mean initial weight of 0.50±5g were procured from commercial hatchery and stocked uniformly to the in-pond nursery of each pond. The procured fries were produced and transported in freshwater. Before stocking, fries were acclimatized to the pond water gradually for one hour.

Releasing Tilapia fry in farmers ponds

Supply of feed to farmer

Feeding trial:

In the nursery, the stocked fries of Tilapia were fed with commercial nursery feed (containing 35% protein) @ 20% of total Tilapia biomass. After 15 days of nursing, fishes were released to the whole pond by up-folding the nylon net of the nursery. At this stage, fishes were fed with commercial floating crumble feed *eg.* Mega Feed. The feed was applied @ 10% of the body weight of fishes at the beginning of the experiment then feeding rate was gradually reduced to 3.0% at the end of the culture period.

Application of feed by farmer **Measuring water quality in farmers ponds**

Growth and well-being of fishes were monitored weekly and feed was adjusted accordingly. Daily diet was fed thrice a day. The feed ingredient includes Fish meal, Maize, Meat & bone meal, Wheat flour, Soybean meal, Rice polish, Mustard oil cake, Salt, D.C.P and Vitamin-Mineral premix etc. However the nutritional compositions of Mega feed applied in the experiment are given below in Table 9.

Table 9. Nutritional elements of Mega feed applied during the culture period

Composition	Minimum Percentage (%)
Crude protein	28
Fat	3
Moisture	12
Fibre	8
Ash	20
Glucose	37
Calcium	1.9
Phosphorus	0.5

Monitoring of physicochemical parameters, growth and harvesting:

Water quality parameters and fish health were monitored after every 7 days interval. Water quality parameters *viz.,* temperature, depth, salinity, pH, transparency and total alkalinity were determined on a weekly basis but dissolved oxygen (DO) was determined frequently following standard methods (APHA 1992).

Sampling of Tilapia **Harvested Tilapia**

All the Tilapia in on-station and on-farm ponds covering 90 and 120 DOC were successfully harvested by seine netting and finally draining out ponds then growth, production and economics were estimated. Water quality parameters and growth performance of Tilapia culture ponds in terms of initial weight, final weight, specific growth rate, feed conversion ratio, survival rate and total production and the economic status have been illustrated in Table 10 to 12 respectively.

Table 10. Production performance of Tilapia culture in on-station ponds in 60 days

Treatment	Culture Period	Replications	ABW (g)	Survival (%)	Production (Kg/ha/crop)	FCR
T1	120 days	R1	218	72	6105	1.26
		R2	180	80	5712	1.21
		R3	191	76	5696	1.25
		Average	**196**	**76**	**5838**	**1.20**
T2	90 days	R1	152	82	5051	1.07
		R2	146	80	4672	1.16
		R3	150	90	5400	1.00
		Average	**149**	**84**	**5041**	**1.08**

Table 11. Production performance of Tilapia culture in on-farm ponds.

Treatment	Culture Period	Replications	ABW (g)	Survival (%)	Production (Kg/ha/crop)	FCR
T1	120 days	R1	181	75	5430	1.22
		R2	178	73	5198	1.28
		R3	184	78	5741	1.16
		Average	**181**	**75**	**5456**	**1.20**
T1	90 days	R1	142	78	4430	1.22
		R2	137	80	4384	1.23
		R3	135	76	4104	1.30
		Average	**138**	**78**	**4306**	**1.25**

Average weight of Tilapia ranged from 180-218 g in 120 DOC and production was 5696-6105 kg/ha/crop with a survival of 72-80% in 120 DOC in on station ponds. While in 90 DOC average weight was 146-152g and production was 4672-5400 kg/ha/crop with a survival of 80-90%. Net benefit 165900 BDT was highest in T1 (120 DOC) and BCR was found highest (1.35) in on-station ponds. In 90 days culture net benefit was 76435 BDT and BCR was 1.20.

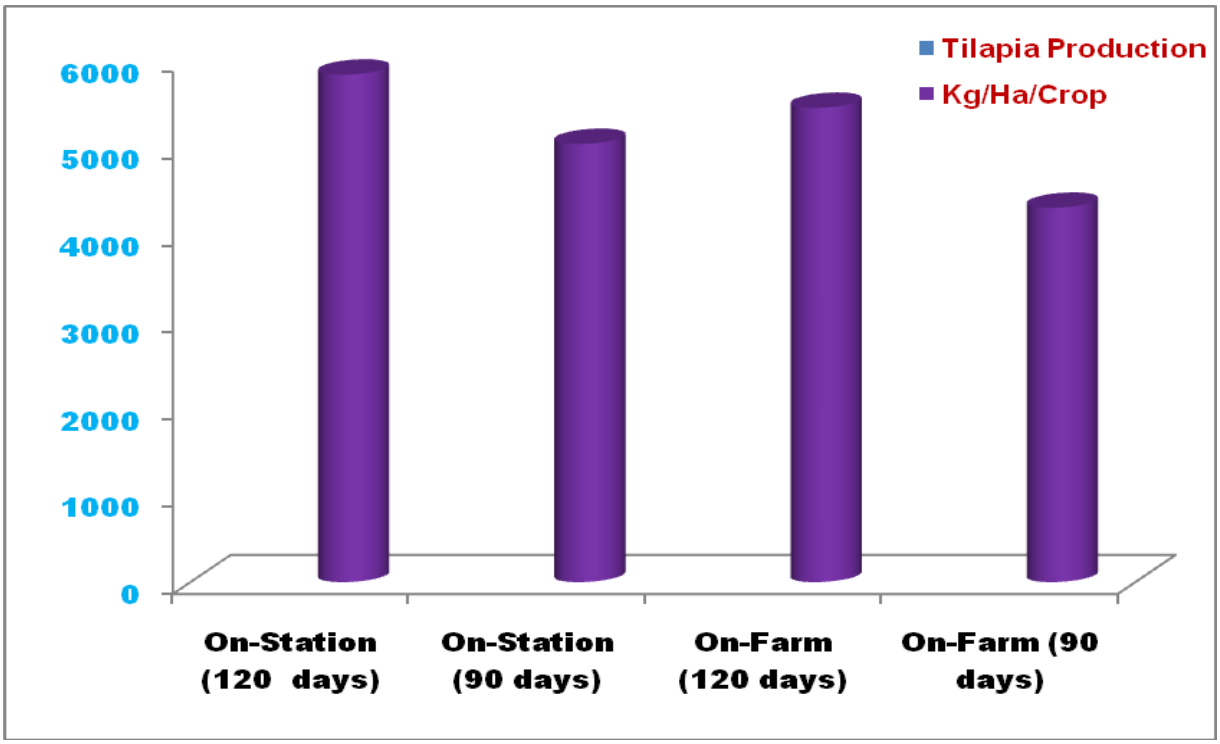

Figure 2. Production performance of on-station and on-farm Tilapia culture

In farmers ponds weight of Tilapia ranged from 178-184 g in 120 DOC and production was 5198-5456 kg/ha/crop with a survival of 73-78%. Whereas in 90 DOC of Tilapia average weight found was 135-142g and production recorded was 4104-4430 kg/ha/crop with a survival of 76-80%. Net benefit 146800 BDT was highest in T1 (120 DOC) and BCR was found highest (1.32) and in 90 days culture net benefit was 29180 BDT and BCR was 1.08. This shows lower than on-station ponds.

Table 12. Hydrographical parameters in different treatment of Tilapia culture

Parameters	On-station		On-farm	
	T1	T2	T1	T2
Temperatures (°C)	28.0-30.4	27.8-30.0	27.5-30.0	27.0-29.5
Salinity (ppt)	3-13	4-13	7-16	5-14
Transparency (cm)	35-50	36-44	25-40	20-35
pH	7.6.-8.6	8.2-8.8	7.9-8.4	8.0-9.0
Alkalinity (mg/l)	127-156	104-122	134-190	115-138
Morning DO (mg/l)	3.5-6.5	3.6-6.0	3.4-6.2	3.5-6.5

All the recorded physical and chemical properties of water in different treatment were within the permissible levels required for the optimal growth of Tilapia.

Economic and return analysis of Tilapia culture:

Table 13. Cost of production and economic returns of Tilapia culture from 1ha ponds for 90 days of culture and 120 days of culture.

Components	**On-station**		**On-farm**	
Treatments	**T_1**	**T_2**	**T_1**	**T_2**
Days of culture	**120**	**90**	**120**	**90**
Expenditure	**Taka**	**Taka**	**Taka**	**Taka**
Pond lease	13000	13000	13000	13000
Lime+Fertilizer	8000	6000	8000	6000
Fry	4000	4000	4000	4000
Feed	350280	277255	327360	258360
Labour	96000	72000	96000	72000
Miscellaneous	5000	5000	5000	5000
A. Total Expenditure	**464580**	**365555**	**356560**	**346660**
Income	**Taka**	**Taka**	**Taka**	**Taka**
B. Gross return	642180	453690	600160	387540
Net benefit (B-A)	**165900**	**76435**	**146800**	**29180**
BCR	**1.35**	**1.20**	**1.32**	**1.08**

Price of Tilapia fish = Taka 110/ kg with ABW 200 g cultured for 120 days.

Price of Tilapia fish = Taka 90/ kg with ABW 140-150 g cultured for 90 days.

12. Research highlight/findings:

- Year round aquaculture achieved through culture of Shrimp in high salinity and culture of Tilapia in low salinity period.
- In short cycle Shrimp culture (60 days) Shrimp production was found 734–797 kg/ha/crop in on station ponds. Net benefit of BDT 122134/ha/crop and BCR was 1.58. This production was better than previous experimental result of BFRI.
- In short cycle Shrimp culture (60 days) Shrimp production was found 708-713 kg/ha in on farmers ponds. Net benefit of BDT 87427/ha/crop BCR was 1.41 in on-farm ponds.
- Average body weight of Shrimp was 17.4-18.2 g in on-station ponds. Average body weight of Shrimp 17.2- 17.3 g in on-farm ponds.
- Feed conversion ratio (FCR) in on station was 1.24-1.34. FCR in on farm was recorded 1.38-1.41.
- Highest average yield in 120 days culture of Tilapia was 5838 kg/ha/crop in on-station pond with a net benefit of BDT 165900/ha and BCR was 1.35
- Highest average yield in 90 days culture of Tilapia was 5041 kg/ha/crop in on-station pond with a net benefit of BDT 76435/ha/crop and BCR was 1.20.

- ❖ Highest average yield in 120 days culture of Tilapia was 5456 kg/ha/crop in on-farm pond with a net benefit of BDT 146800/ha and BCR was 1.35
- ❖ In on farm highest average yield in 90 days culture of Tilapia was 4471 kg/ha/crop with a net benefit of BDT 34130/ha/crop and BCR was 1.09.

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
(a) Office equipment	8	270000	8	249100	-
(b) Lab & field equipment	10	210000	10	198716	-
(c) Other capital items	-	-	-	-	-

2. Establishment/renovation facilities: N/A

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
-	-	-	-	-	
-	-	-	-	-	
-	-	-	-	-	
-	-	-	-	-	

3. Training/study tour/ seminar/workshop/conference organized:

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	55	05	60	01 days	Culture of Shrimp in rotation with Tilapia in coastal gher
(b) Workshop	-	-	-	-	-

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	239320	235000	234692	308	99.87	-
B. Field research/lab expenses and supplies	2490885	2345191	2344671	520	99.98	-
C. Operating expenses	262614	240500	240204	296	99.88	-
D. Vehicle hire and fuel, oil & maintenance	263567	211100	210356	744	99.65	-
E. Training/workshop/ seminar etc.	132000	128100	128080	20	99.98	-
F. Publications and printing	70000	0	0	0	0.00	-
G. Miscellaneous	61614	50107	50072	35	99.93	-
H. Capital expenses	480000	467000	466816	184	99.96	-
TOTAL	**4000000**	**3676998**	**3674891**	**2107**	99.94	-

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
To increase the productivity of coastal *ghers* through year round aquaculture	Year round culture successfully performed through culture of Shrimp during high salinity period and Tilapia culture in low salinity period	Highest average Shrimp (*Penaeus* monodon) production was found 797 kg/ha/crop in on station ponds. Average Tilapia highest production was 5838 kg/ha/crop for 120 DOC and 5041 kg/ha in 90 DOC in on station ponds	Farmers received training on short cycle Shrimp culture with alternate culture of Tilapia.
To demonstrate short cycle Shrimp culture system in rotation with Tilapia in the farmers' *gher*	Shrimp culture was practiced in on farmers ponds with 5 nos/m^2 stocking densities for 60 days as short cycle. Tilapia culture was practiced for 90-120 days with 4 nos/m^2.	Highest average Shrimp (*Penaeus* monodon) production was found 713 kg/ha/crop in on farm ponds. Average Tilapia highest production was 5456 kg/ha/crop for 120 DOC and 4306 kg/ha in 90 DOC in farmer ponds.	Allied farmers nearby on farm culture demonstration area were motivated to adopt the technology.

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.	✓		
Journal publication	✓		
Information development		✓	
Other publications, if any	✓		

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

Short cycle culture of Shrimps with alternate culture of Tilapia

ii. **Generation of new knowledge that help in developing more technology in future**

Need to stock specific pathogen free (SPF) Shrimp PL

iii. Technology transferred that help increased agricultural productivity and farmers' income

Adoption of these technologies through training, developing awareness, published paper, leaflet, booklet etc.

iv. Policy Support

Traditional Shrimp farming in coastal zone can be substituted by adopting Shrimp-Tilapia alternate culture practice, moreover this theme can be applied for other

G. Information regarding Desk and Field Monitoring

i) Desk Monitoring

1. CRG Sub- Project Implementation Progress Workshop/Seminar held in BARC, Farmgate Dhaka on 21 December 2017. Found satisfactory
2. CRG Sub-Project Final output Workshop held in BARC, Farmgate Dhaka on 19-20 September 2018. Found satisfactory

ii) Field Monitoring

Monitoring team	Date(s) of visit	Total visit till date (No.)	Remarks
Technical Division, BARC 1. Dr. Md. Monirul Islam, Director (Nutrition), BARC, Dhaka	13 February 2018	1	Satisfactory
PIU-BARC, NATP-2 1. Mr. Dipok Kumar, PIU-BARC, NATP-2, Dhaka 2. Munshi Mamunur Rahman, PIU-BARC, NATP-2, Dhaka	8 April 2018	1	Satisfactory
Internal Monitoring 1. Dr. Md. Enamul Hoq, PSO, BFRI 2. Dr. Anuradha Bhadra, PSO, BFRI	22-23 June 2018	1	Satisfactory
Others Visitors: 1. Dr. Md. Yahia Mahmud, DG, BFRI. 2. Mr. Asim Kumar Bala, Joint Secretary, MoFL, Dhaka 3. Mr. Muhamadullah, Deputy Secretary of MoFL, Dhaka	22-23 June 2018	1	Satisfactory

H. Lesson Learned

i. Sudden change of temperature causes mass mortality of Shrimp.

I. Challenges

i. Unavailability of quality SPF Shrimp PL in peak time.
ii. Sudden outbreak of Shrimp disease is alarming.

Signature of the Principal Investigator
Date …….
Seal

Counter signature of the Head of the organization/authorized representative
Date ……..
Seal

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Appendix 1. Training of Farmers:

Training courses were done for sixty farmers about the short cycle Shrimp culture and alternate culture of Tilapia. Among the trainees fifty five were male and five were female.

Project Activity

POND PREPARATION

SHRIMP PL STOCKING

SHRIMP SAMPLING

SHRIMP SAMPLING

FIELD MONITORING

FIELD MONITORING

SHRIMP PRODUCTION

TILAPIA STOCKING

TILAPIA PRODUCTION

FARMERS TRAINING

FARMERS TRAINING

FARMERS TRAINING