Government of the People's Republic of Bangladesh
National Agricultural Technology Program – Phase II Project
NATP-2

Study on Aquaculture Technology Demonstration and Adoption Under DoF Component of NATP-2

(Component 3: Supporting Fisheries Development)

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Project Implementation Unit
National Agricultural Technology Program – Phase II Project
NATP-2

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Executive sumary

The main objective of this study was to evaluate the efficacy of the demonstrated technology, identify potential technologies, perceive the extent of technology adoption and estimate the productivity of adopted farmers' ponds. The data were collected from all 270 Upazillas for all demonstrations implemented so far and for adopted farmers. A total of 23535 demonstrations of eight major technologies were established till 2019-20. The demonstration farmers include 14.26% females. Carp polyculture was the most demonstrated technology covering 84.59% of the total demonstration, followed by monosex tilapia (8.64%), pangas monoculture (1.28%), nursery (1.23%), carp-galda mixed culture (1.05%) etc.. The demonstration occupied a 5011 ha water area in which the highest area was covered by carp polyculture (86.3%), followed by monosex tilapia (7.5), pangas monoculture (1.4%) carp-galda mixed culture (1.1%). The highest BCR was found for pabda-gulsha mixed culture technology (2.02), followed by shing-magur mixed culture (2.01), carp-galda mixed culture (1.80), shing monoculture (1.76), carp polyculture (1.61) etc. The yield in the demonstrated pond is higher than that of the adoption pond. The average yield of demonstration ponds was 56.30%, 50.14%, 47.63%, 43.29%, 42.0%, 41.62%, 26.44% and 23.92% higher compared to previous years' yield of koi monoculture, carp polyculture, pabda gulsha mixed culture, shing-magur mixed culture, pangas monoculture, monosex tilapia, carp-galda mixed culture and shing mono culture, respectively. As a consequence of demonstration and other interventions, 63,736 CIG farmers and 101541 non-CIG farmers adopted the technology. Females occupied 30.47% CIG adopters and 28.7% non-CIG adopters. The most adopted technology by the farmers was carp polyculture (86.75%), followed by monosex tilapia (5.25), carp-golda mixed culture (3.28), shing and magur mixed culture (1.40) and pangas monoculture (1.14%). The average pond productivity in CIG-adopter pond was 4.14, 4.82, 4.88 and 4.94 MT/ha in 2017-18, 2018-19, 2019-20 and 2020-21, respectively, which was consistent with the result farmwork. Three potential technologies, such as Pabda-gulsa mixed culture, shing-magur mixed culture and carp-galda mixed culture, which showed higher BCR in demonstration pond, may be promoted in the future.

A. Analysis of Aquaculture Technology Demonstration

1. Background

The fisheries development component was aimed to increase fisheries productivity through technology transfer, establish market linkage and increase farm income, with a particular focus on small, marginal and female farmers. To achieve the component objective, the project has scaled up Good Aquaculture Practices (GAP) for the production systems through the demonstration of particular aquaculture technologies with the participation of CIG farmers.

The purposes of technology demonstration are technology validation, scaling-up and transfer. The process includes: appropriate technology identification, training on the selected technology, setup of demonstrations, organize field-days, adoption & diffusion of demonstrated technology, etc. Lack of knowledge on aquaculture was identified as one of the most important problems while preparing micro plans. A demonstration is the best method for the dissemination of new technology. Therefore, demonstrations were established on various technologies to disseminate modern aquaculture-related information to the fish farmers.

NATP-2 provided adequate extension and technical advisory support and training for the CIGs for participatory demonstration and adoption of proven low-cost, productivity-enhancing technologies for rapid dissemination of these technologies to the farmers. A total of 23535 demonstrations of nine (09) major technologies was established in the project area up to 2019-`20. As the consequence 63736 CIG farmers have adopted these technologies so far.

2. Objective of this study

(i) To evaluate the efficacy of the demonstrated technology; and

(ii) To identify potential technologies that can be promoted in the future.

3. Methodology

Data of demonstration of aquaculture technology were collected through administration of a data collection format (Annex-I). Data from all Upazilla from all demonstrations were collected as hardcopy by mail and softcopy by e-mail. Data of 2017-18, 2018-19 and 2019-20 were scrutinized for reliability and validity and omission and commission. Validated demonstration data were analyzed by Excel and SPSS.

4. Description of major aquaculture technology demonstrated

A brief description of the major aquaculture technology demonstrated is given below:

1. Carp Polyculture (CPC): Culture of Rui, Catla, Mrigal, Silver carp, Mirror carp, Common carp, Grass carp, Thai sarpunti etc. together. For fry of 250-400 gram weight, the stocking density of 16-21/decimal is followed. Regular feeding practice is followed on the basis of body weight of fish.
2. Monosex Tilapia (MST): Stocking of fry of 5-10 gram weight having a density of 200-250/decimal. Regular feeding practice is followed on the basis of the bodyweight of fish.
3. Pangas Monoculture (PMC): Stocking of fry of 100-gram weight having the density of 250-300/decimal. The feeding rate varied on the basis of gain in bodyweight of fish.
4. Shing Monoculture (SMC): Stocking fry of 0.5-1g weight having the density of 1000-1200 per decimal.
5. Koi Monoculture (KMC): Stocking fry of 0.5-1g weight having the density of 1000-1500 per decimal.
6. Shing and Magur Mixed culture (SMMC): Shing: Stocking fry of about 0.5g weight having the density of 800-1000 per decimal, and Magur: 0.5g weight with 100-150 fingerlings per decimal.
7. Carp-Galda Mixed Culture (CGMC): Culture of Rui, Catla, Silver carp, Mirror carp, Common carp, Grass carp along with Galda. Regular feeding practice is followed on the basis of body weight of fish, Golda 50-100 PL per decimal and 10 carp per decimal.
8. Pabda-Gulsha mixed culture (PGMC): Fry size of 3.5 cm/ 0.5-0.6g. Gulsha: 700-800 fries per decimal. Pabda: 700-800 weight per decimal.
9. Others (O): Culture of a combination of fishes other than above is termed as `Others' demonstration technology.
10. Nursery (CN): Collection of hatchlings from the government farm/private farm and rearing in the nursing pond and supply fingerlings to the pond owners.
    A number of fry per gram fertilized egg 1gm: Carp-400 fries per gram.
    The stocking rate is 25-30 gm fertilized egg per decimal.

5. Result and discussion of aquaculture demonstration technology

5.1. Number of demonstrations established and female participation:

As per DPP, there was a provision of establishing 23535 demonstrations over the project period. A total of 23535 demonstrations has already been established till 2019-20. The number of participants including females involved in the establishment of the demonstration is shown in Table 1. The data indicated that about 14.26% of females were involved in the demonstration established over the years. The geographic distribution of female participation in demonstration is shown in Annexure-IV & V.

Table 1. Number of demonstrations established and female participation over the years

Technology	Number of participants in demonstration							
	2017-2018		2018-2019		2019-2020		Total	
	All	Female	All	Female	All	Female	All	Female
1. Carp polyculture	11035	1399	4384	705	4486	821	19905	2925
2. Monosex Tilapia culture	1233	128	473	60	328	51	2034	239
3. Pangas monoculture	203	17	49	5	50	8	302	30
4. Nursery	176	24	66	8	47	7	289	39
5. Carp-Galda mixed culture	115	12	66	5	65	8	246	25
6. Pabda Gulsha mixed culture	133	21	77	11	4	1	214	33
7. Shing monoculture	105	9	8	1	55	6	168	16
8. Shing Magur mixed culture	54	11	72	8	21	1	147	20
9. Koi monoculture	41	5	20	4	18	5	79	14
10. Others	84	9	67	6	0	0	151	15
Total	13179	1635	5282	813	5074	908	23535	3356
% of female participant	12.41		15.39		17.90		14.26	

5.2. Major demonstrated technologies

Figure 1 shows that the Carp polyculture was the most demonstrated technology covering 84.59% of the total demonstration over the years, followed by monosex tilapia (8.64%), pangas monoculture (1.28%), nursery (1.23%), carp-galda mixed culture (1.05%) etc. Carp polyculture and monosex tilapia are well-known, easy to implement by the farmers and require less adaptation to adopt. These fishes are very popular and common fish food in Bangladesh and contributes about 62.39% of the total aquaculture production (DoF, 2019) .

Besides, these fishes are less susceptible to disease and have a stable market price. That is why people have taken these as the popular demonstration technology.

5.3. Geographic distribution of demonstrated technology

The geographic distribution of demonstrated technology is shown in **Table 2**. The data depicted that carp polyculture was the most demonstrated technology in all divisions sharing from 61.8% in Barishal to 91.3% in the Rajshahi division. About 30%, 11.2% and 10.2% demonstration of monosex tilapia technology was established in the Barishal division, Rangpur division and Chattogram divisions, respectively, which are higher among the divisions. Large number of seasonal ponds in these regions may be the reason for getting popular with this short cycled fish (Ahamed et. al., 2017; Hossen et. al., 2020). On the other hand, the Rajshahi division has become a model of `Carp Fattening' technology. So, the highest portion of demonstration (91.3%) of carp polyculture was established in the Rajshahi division.

Table 2. Number of technology demonstrated in different regions

Technology	Number of technology demonstration in different regions																Total
	Dhaka		Rajshahi		Chattogram		Khulna		Barishal		Sylhet		Rangpur		Mymensingh		
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	
1. Carp polycultures	5152	85.3	3656	91.3	3276	85.8	2684	81.9	340	61.8	1108	82.1	1591	84.3	2098	80.7	19905
2. Monosex Tilapia culture	569	9.4	133	3.3	389	10.2	242	7.4	166	30.2	206	15.3	211	11.2	118	4.5	2034
3. Pangas monoculture	91	1.5	27	0.7	31	0.8	70	2.1	27	4.9	4	0.3	3	0.2	49	1.9	302
4. Nursery	53	0.9	56	1.4	64	1.7	16	0.5	1	0.2	11	0.8	23	1.2	64	2.5	289
5. Carp-Galda mixed culture	2	0.1	3	0.1	0	0.0	226	6.9	13	2.4	0	0	2	0.1	0	0	246
6. Pabda Gulsha mixed Culture	58	1.0	45	1.1	4	0.1	8	0.2	0	0	1	0.1	19	1.0	79	3.0	214
7. Shing monoculture	27	0.5	18	0.5	4	0.1	11	0.3	0	0	0	0	3	0.2	105	4.0	168
8. Shing Magur mixed Culture	19	0.3	42	1.1	18	0.5	16	0.5	0	0	0	0	13	0.7	39	1.5	147
9. Koi monoculture	34	0.6	5	0.1	2	0.1	4	0.1	3	0.6	0	0	10	0.5	21	0.8	79
10. Others	40	0.66	19	0.5	32	0.8	2	0.1	0	0	20	1.5	12	0.6	26	1.0	151
Total	6045	100	4004	100	3820	100	3279	100	550	100	1350	100	1887	100	2599	100	23535

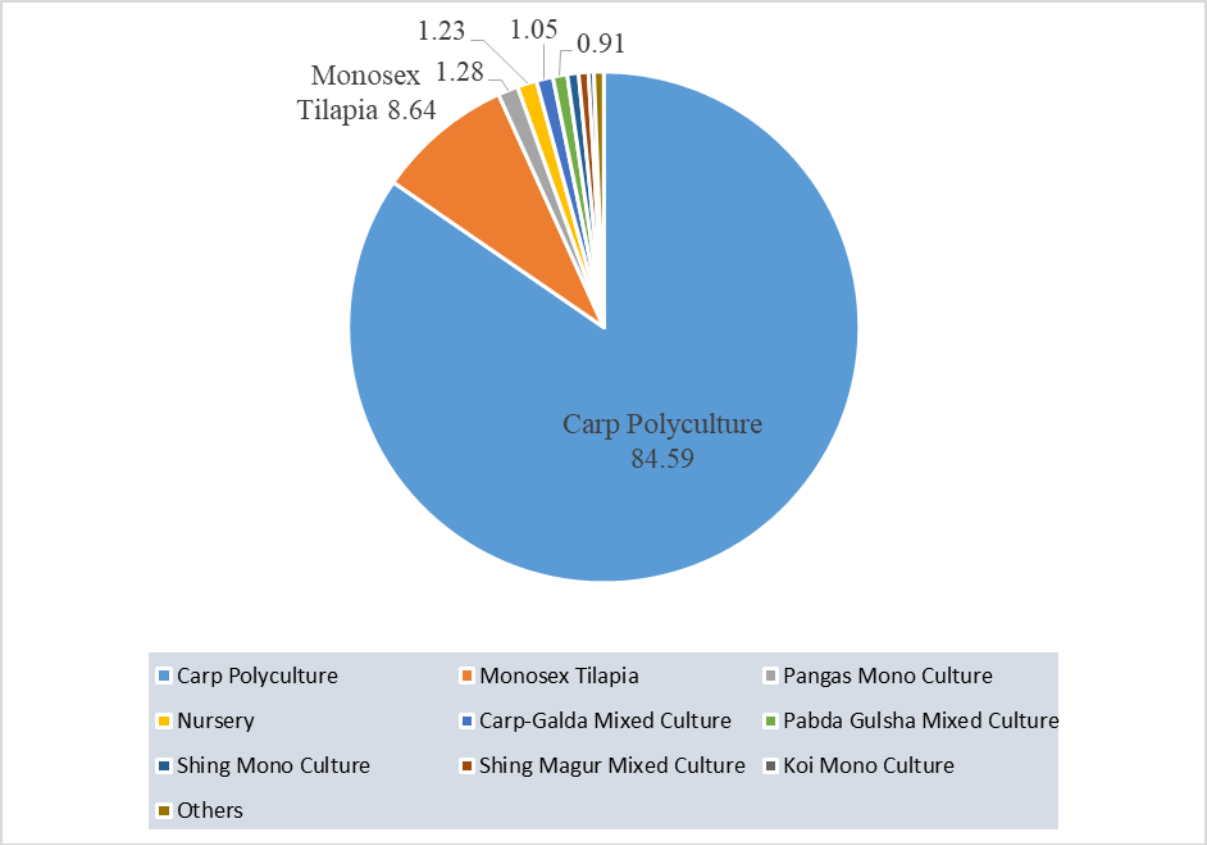

Figure 1. Major share of demonstrated technology

5.4. Water area occupied under the demonstration

The total 23535 demonstrations occupied a 5010.58 ha water area. The highest area was covered by carp polyculture (86.3%), followed by monosex tilapia (7.5), pangas monoculture (1.4%) carp-galda mixed culture (1.1%) etc. (Table 3). This result is consistent with the percent of demonstration established (Fig. 1).

Table 3. Demonstration technology and water area occupied in different regions

Technology	Water area occupied in different regions (ha)								Total	%
	Dhaka	Rajshahi	Chattogram	Khulna	Barishal	Sylhet	Rangpur	Mymensingh		
1. Carp polycultures	1138.29	812.59	724.87	569.97	69.77	241.12	324.48	443.24	4324.33	86.3
2. Monosex Tilapia culture	111.31	23.02	73.20	44.18	28.55	37.94	37.21	20.48	375.89	7.5
3. Pangas monoculture	21.37	5.96	6.83	16.45	5.74	1.06	0.57	10.46	68.44	1.4
4. Nursery	7.63	8.02	11.18	3.17	0.06	1.96	3.20	9.33	44.56	0.9
5. Carp-Galda mixed Culture	0.64	0.39	0	48.45	3.48	0	0.35	0	53.30	1.1
6. Pabda Gulsha mixed culture	11.24	9.18	0.86	1.48	0	0.24	3.70	14.87	41.56	0.8
7. Shing monoculture	6.07	3.23	0.60	1.85	0	0	0.39	17.70	29.85	0.6
8. Shing Magur mixed culture	4.14	8.84	4.20	3.21	0	0	1.98	7.43	29.81	0.6
9. Koi monoculture	6.67	1.11	0.45	0.68	0.59	0	1.75	4.03	15.27	0.3
10. Others	9.71	3.21	6.49	0.27	0	2.73	1.94	3.22	27.57	0.6
Total	1317.06	875.55	828.68	689.69	108.19	285.07	375.58	530.76	5010.58	100

5.5. Yield of Demonstrated Technologies over the years

The average yield of demonstrated aquaculture technologies is depicted in Fig. 2. Pangas monoculture recorded the highest yields (18525.90 kg/ha). Then, monosex tilapia and koi monoculture had higher yields than others which were 12162.42 kg/ha and 10329.71 kg/ha, respectively. Carp polyculture, which covered 84.59% of the demonstration had an average yield of 5416.26 kg/ha. The year-wise yield of demonstrated technologies is shown in Annexure-VI.

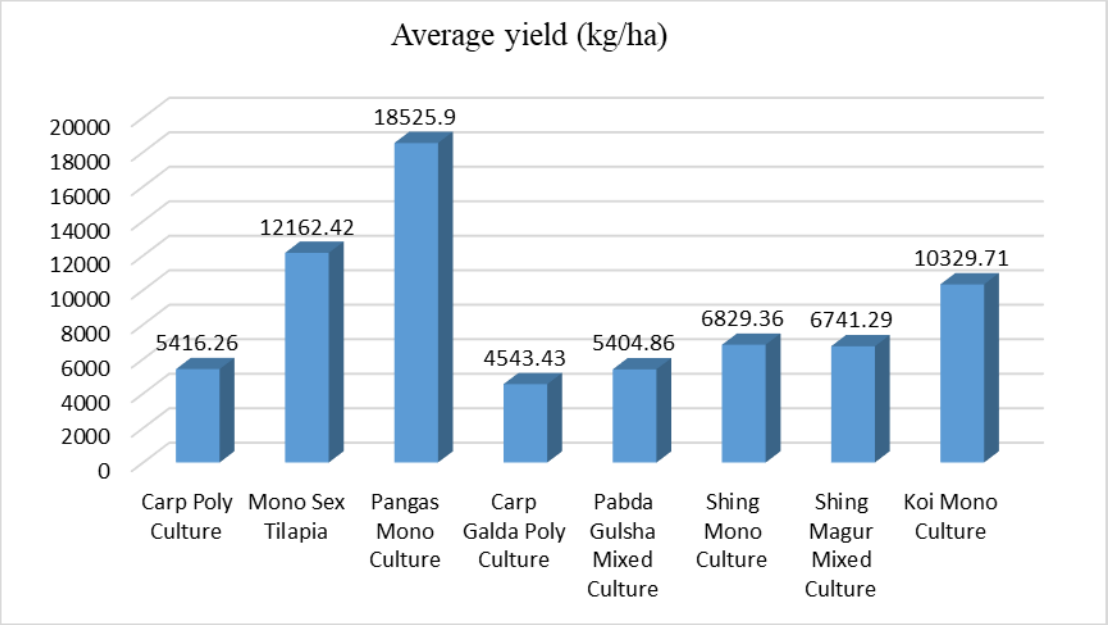

Figure 2. Average yield (kg/ha) of demonstrated technologies

Changes in yield before and after demonstration technologies over the years are shown in Table 4. The data exhibited that the mean yield change occurred from 23.29% to 56.30% depending on the culture technology. The highest mean yield change appeared for koi monoculture (56.30%), followed by carp polyculture (50.15%), pabda-gulsha mixed culture (50.33%), , shing-magur mixed culture (43.29%), pangas monoculture (41.99%), monosex tilapia (41.62%) etc.

Table 4. Changes in yield before and after demonstration technologies over the year

Technology	Yield (kg/ha)									
	2017-2018			2018-2019			2019-2020			Mean % change in yield
	Before Demo	After Demo	% change in yield	Before Demo	After Demo	% change in yield	Before Demo	After Demo	% change in yield	
1. Carp polycultures	3163	5086.43	60.81	3702	5522.1	49.17	4015	5640.24	40.48	50.15
2. Monosex Tilapia culture	7466	11414.3	52.88	9196	12279	33.53	9240	12794	38.46	41.62
3. Pangas monoculture	12507	18031.6	44.17	13262	18619.6	40.40	13384	18926.4	41.41	41.99
4. Carp-Galda mixed culture	*3163*	4479.88	41.63	*3702*	4640.25	25.34	*4015*	4510.17	12.33	26.44
5. Pabda Gulsha mixed culture	*3163*	5329.84	68.51	*3702*	5409.76	46.13	*4015*	5474.98	36.36	47.63
6. Shing monoculture	6495	8063.56	24.15	5507	6194.13	12.48	5536	6230.39	12.54	23.29
7. Shing Magur mixed culture	3427	5964.59	74.05	5507	7162.97	30.07	5643	7096.31	25.75	43.29

8. Koi Monoculture	5164	8188.44	58.57	7332	11858.6	61.74	7364	10942.1	48.59	56.30

5.6. Performance of demonstrated technologies

Productivity, as well as BCR (benefit-cost ratio), are the important characteristics of a technology that indicates relative yield, investment and return. BCR is a ratio used in a cost-benefit analysis to summarize the overall relationship between the relative costs and benefits of technology. The higher the BCR indicates higher profitability, in general. The result revealed that the highest BCR was found for pabda-gulsha mixed culture technology (2.02), followed by shing-magur mixed culture (2.01), carp-galda mixed culture (1.80), shing monoculture (1.76), carp polyculture (1.61) etc. **(Table 5)**. The general findings are that the higher-valued fish culture technology showed higher profitability except for carp-galda mixed culture. Although galda is the most valued fish, the production is comparatively lower than pabda-gulsha/shing-magur, which makes it comparatively less profitable. In addition, although Pungush monoculture exhibited higest yield, it showed lowest BCR. This may be happen due to higher market price of feed and comparatively lower price of pungush.

Table 5. Yield and BCR of the demonstrated technology over the years

Technology	**Average yield (kg/ha)**				**BCR (Average)**			
	2017-2018	2018-2019	2019-2020	Mean	2017-2018	2018-2019	2019-2020	Mean
1. Pabda Gulsha mixed culture	5330	5410	5475	5405	2.14	2.16	1.76	2.02
2. Shing Magur mixed culture	5965	7163	7096	6741	2.55	1.78	1.69	2.01
3. Carp-Galda mixed culture	4480	4640	4510	4543	1.82	1.8	1.78	1.80
4. Shing Monoculture	8064	6194.	6230	6829	1.9	1.78	1.61	1.76
5. Carp polyculture	5086	5522	5640	5416	1.65	1.61	1.56	1.61
6. Koi monoculture	8188	11859	10942	10330	1.82	1.38	1.31	1.50
7. Monosex Tilapia culture	11414	12279	12794	12162	1.52	1.48	1.46	1.49
8. Pangas monoculture	18032	18620	18926	18526	1.55	1.23	1.19	1.32

Performance of the demonstration technology established during 2017-`18, 2018-`19, 2019-`20 is shown in Annexure-VII, VIII and IX, respectively and the mean performance is shown in Table 6. The result showed that the unit yield was increased from 23.92% to 56.30% depending on the technology. The average yield of demonstration ponds were 56.30%, 50.14%, 47.63%, 43.29%, 42.0%, 41.62%, 26.44% and 23.92% higher compared to previous years' yield of koi monoculture, carp polyculture, pabda gulsha mixed culture, shing-magur mixed culture, pangas monoculture, monosex tilapia, carp-galda mixed culture and shing mono culture, culture, respectively.

Table 6. Mean Performance of the demonstration established

Parameters	Results (Average)							
	Carp polyculture	Monosex Tilapia culture	Pangas monoculture	Carp Golda mixed culture	Pabda Gulsha mixed culture	Shing monoculture	Singh Magur mixed culture	Koi monoculture
1. Demonstrated technology (no.)	19905	2034	302	246	214	168	147	79
2. Mean water area in decimal	56	46	55	54	47	44	49	49
3. Yield (Kg/ha)	5416	12162	18526	4543	5305	6829	6741	10329
4. Production cost (Tk/ha)	512072	888928	1221260	731203	742925	940554	909407	755773
5. Gross return (Tk/ha)	821173	1322543	1624462	1317567	1488565	1656549	1748407	1089205
6. Net return (Tk/ha)	309100	433615	403202	586363	745640	715995	839000	333432
7. Bebefit cost ratio (Tk/Tk)	1.61	1.49	1.32	1.80	2.02	1.76	2.01	1.50
8. Fish price (TK/kg)	151	109	88	290	281	245	260	105
9. Yield before demo. (kg/ha)	3627	8634	13051	3627	3627	5513	4859	6620
10. Change of yield (Kg/ha)	1789	3528	5475	917	1678	1317	1882	3710
11. Increase of yield (%)	50.14	41.62	42.00	26.44	47.63	23.92	43.29	56.30

B. Analysis of Technology Adoption

1. Background

Adoption of technology refers to the change of practice or change in the use of a technology that was introduced and/or promoted by the project. The term 'technology' includes a change in practices compared to currently used practices or technologies. The adoption of new aquaculture technology is the major driving force for increasing fish production and the rising income of small and marginal fish farmers. Adoption of technology usually takes place as a combined effect of technology demonstration, training, organization of field day, exchange visit, direct advocacy etc. NATP-2 implemented the above-mentioned program or activities to disseminate aquaculture technology. Demonstration of the technologies plays a key role in adopting the technology. NATP-2 promoted 8 different aquaculture technologies by establishing 23535 demonstrations in the CIG farmers' pond. As a consequence 63,736 CIG farmers and 101541 non-CIG farmers have adopted the technologies so far.

2. Methodology

Data of adoption and adopter farmers of CIG and non-CIG were collected through the administration of a data collection format (Annex-II and III). Filled in formats were collected from all Upazilas in hardcopy by mail and softcopy by e-mail. Data of 2017-18, 2018-19, 2019-20 and 2020-21 were scrutinized for reliability and validity and omission and commission. Validated demonstration data were analyzed by Excel and SPSS.

3. Objective of this study

(i) To perceive the extent of technology adoption;

(ii) To analyze the CIG-adopted farmers;

(iii) To estimate the productivity of adopted farmers' ponds.

4. Results and discussion of adopted technology

4.1. Major adopted technology

Table 6 shows the extent of technology adoption up to June 2021. The results indicated that the most adopted technology (86.75%) by the farmers was carp polyculture. The other major adopted technologies were monosex tilapia, carp-golda mixed culture, shing and magur

mixed culture, pangas monoculture etc. Many factors can affect the adoption of these technologies are (i) easy to implement by the farmers (ii) availability of seed (iii) less disease susceptibility and (iv) consumers' preference (v) relatively stable market price etc.

Carp polyculture and monosex tilapia were mostly demonstrated as well as mostly adopted technology. These two technologies are well-known, easy to implement by the farmers and require less adaptation to adopt. Carp-golda mixed culture has been adopted by the farmers probably because of the higher market price and availability of golda PL (post larvae) from the Government hatcheries. Shing Monoculture (0.01%) and Koi Monoculture (0.27%) are the two technologies that were poorly adopted probably because of the poor market price of koi, higher disease susceptibility and unstable seed supply for both technologies. It can also be mentioned that the three technologies had been well-adopted from the top five profitable demonstration technologies (Table 5 &Table 7).

Adoption of technology by CIG-farmers over the years is shown in **Annexure-X.**

Table 7. Extent of technology adoption (Up to June 2021)

Name of Technology	No. of CIG Adopter				% of total CIG Adopter
	Male	Female	% female	Total	
1. Carp polyculture	38558	16734	30.26	55292	86.75
2. Monosex Tilapia culture	2353	990	29.61	3343	5.25
3. Carp Golda mixed culture	1290	800	38.28	2090	3.28
4. Shing Magur mixed culture	656	238	26.62	894	1.40
5. Pangas monoculture	519	210	28.81	729	1.14
6. Pabda Gulsha mixed culture	217	99	31.33	316	0.50
7. Koi monoculture	139	32	18.71	171	0.27
8. Shing monoculture	3	3	50.00	6	0.01
9. Others	413	239	36.66	652	1.02
10. Nursery	170	73	30.04	243	0.38
Total	44318	19418	30.47	63736	100

4.2. Number of CIG adopter

Up to June 2021, out of 105,640 CIG members, 63736 (60.33%) have adopted improved aquaculture technologies. As per RDPP, 64% of CIG members of which 35% female are targeted to adopt the demonstrated technologies. **Table 7** shows the progress of adoption of the demonstrated technologies over the years. It is found that 60.33% of farmers have adopted the demonstrated technologies by this period among which 30.47% are female adopters. The number of CIG-adopters in different regions is shown in **Annexure-11.** Gender

composition in CIG adopters is shown in Table 9. Results indicate that about 30.47% member of the CIG adopter is female. Besides shing monoculture, which has a very small number of adopters and 50% female adopters, the higher number of adopters (38.28%) was found for Carp Galda mixed culture. Most of the adopters of the Carp Galda mixed culture are from the Khulna division, in which females are traditionally involved in aquaculture.

Of the 63736 CIG-adopters, 86.75% adopted improved management practices of carp polyculture, 5.25% adopted improved management practices of monosex tilapia and 3.28% adopted improved management practices of carp-golda mixed culture technology with a considerable number of the female adopters (**Table 7**). The modern fish culture technologies have been adopted as a combined effect of demonstration, field days and exposure visits etc., which was also implemented by the project.

Table 8. Progress of technology adoption among CIG members

Parameter	2017-`18	2018-`19	2019-`20	2020-`21	2021-`22	2022-`23
Total CIG Members	105640	105640	105640	105640	105640	105640
Target: Adopters (No.) 64% of CIG Members	23,875	41,833	55,884	63,595	67,610	67,610
Achievement: Total CIG Adopters (cumulative)	10250	42256	54520	63736	-	-
Cumulative % of CIG Member Adopters	9.70	40.00	51.61	60.33	-	-
No. of female adopter (cumulative)	2846	12314	16249	19418		
% of female adopter (cumulative) (target is 35%)	27.77	29.14	29.80	30.47	-	-

Table 9. Gender compositin in CIG adopter

Technonogy	Female	Male	Total	% Female
1. Carp polyculture	16734	38558	55292	30.26
2. Monosex Tilapia culture	990	2353	3343	29.61
3. Carp Galda mixed culture	800	1290	2090	38.28
4. Shing Magur mixed culture	238	656	894	26.62
5. Pangas monoculture	210	519	729	28.81
6. Pabda Gulsha mixed culture	99	217	316	31.33
7. Koi monoculture	32	139	171	18.71
8. Shing monoculture	3	3	6	50.00
9. Other	255	478	733	34.79
10. Nursery	57	105	162	35.19
Total:	19418	44318	63736	30.47

4.3. Water area occupied under adoption

Total water area occupied under different adopted technology by CIG adopter farmers up to 2020-`21 was 10801 ha (Table 8) which covers more than double the area than that of demonstration. The highest area was covered by carp polyculture (86.5%), followed by monosex tilapia (5.3%), carp-galda mixed culture (3.6%), shing and magur mixed culture (1.3) etc. This result is consistent with the percent of demonstration established (Fig. 1).

Table 10. Water area occupied under different adopted technology in different regions

Technology	Water area occupied in different regions (ha)								Total	%
	Dhaka	Rajshahi	Chattogram	Khulna	Barishal	Sylhet	Rangpur	Mymensingh		
1. Carp polyculture	2467.1	1686.9	1698.6	1117.5	111.5	567.5	763.8	933.4	9346	86.5
2. Monosex Tilapia culture	151.1	38.7	0	68.0	27.9	62.7	39.1	23.7	573	5.3
3. Carp Galda polyculture	2.9	0.0	0	277.2	22.7	19.8	0.0	48.8	391	3.6
4. Shing Magur mixedculture	32.6	16.3	0	7.2	0.0	1.1	12.2	40.0	142	1.3
5. Pangas monoculture	31.8	4.1	161.4	17.1	11.1	8.3	1.1	26.6	123	1.1
6. Pabda Gulsha mixed culture	2.3	1.6	19.9	17.9	0	3.6	3.7	22.0	53	0.5
7. Koi monoculture	12.8	5.2	32.7	5.0	1.8	0.0	0.4	2.1	27	0.3
8. Shing monoculture	0.0	0.3	0.0	0.0	0.0	0.0	0.0	1.3	2	0.0
9. Other	12.6	79.2	25.3	0.0	0.0	0.0	0.0	0.1	117	1.1
10. Nursery	1.1	4.0	16.5	1.3	0.0	0.0	2.7	2.4	28	0.3
Total:	2714.2	1836.3	1978.5	1511.4	175.0	662.9	822.8	1100.3	10801	100.0

4.4. Yield comparison between before and after adoption in different years

Among others, yield is the primary characteristic that attracts farmers to adopt a technology. The yield of different technologies in different years is shown in Table 11. The yield was increased from 9.9% for monosex tilapia to 32.9% for pabda-gulsha mixed culture. This change was lower than the changes of demonstration technologies which range from 23.9% for shing monoculture to 56.3% for koi monoculture (Table 4). In general, the yield in the demonstration pond is higher than that of the adoptor's pond. The reason may be that the

demonstration is implemented under the close supervision of the local Upazila Fisheries office. Besides, distortion of information may affect the yield of adopters pond.

Table 11. Yield comparison of adopted technologies before and after adoption in different years

Technology	2017-`18			2018-`19			2019-`20			2020-`21			Mean % Change
	Yield before adoption (kg/ha	Yield after adoption (kg/ha	% Change	Yield before adoption (kg/ha	Yield after adoption (kg/ha	% Change	Yield before adoption (kg/ha	Yield after adoption (kg/ha	% Change	Yield before adoption (kg/ha	Yield after adoption (kg/ha	% Change	
1. Carp polyculture	3126	3745	19.8	3568	4407	23.5	3784	4472	18.2	4094	4522	10.5	18.0
2. Monosex Tilapia culture	7410	8380	13.1	7832	8672	10.7	8110	8766	8.1	8230	8863	7.7	9.9
3. Carp Galda polyculture	3256	3867	18.8	3608	4014	11.3	3585	4378	22.1	3953	4392	11.1	15.8
4. Shing Magur mixed culture	3427	5278	54.0	5235	5563	6.3	5621	5843	3.9	5683	6342	11.6	18.9
5. Pangas monoculture	12530	16544	32.0	13647	17983	31.8	13431	16983	26.5	16062	17994	12.0	25.6
6. Pabda Gulsha mixed culture	3320	4967	49.6	3730	5032	34.9	4005	5278	31.8	4612	5312	15.2	32.9
7. Koi monoculture	5189	6946	33.9	6231	6693	7.4	6236	8596	37.9	6675	7644	14.5	23.4
8. Shing monoculture	5140	5693	10.8	5178	5983	15.6	5357	5896	10.1	0	0	0	9.10

4.5. Pond productivity in CIG adopter farmers' pond

The pond productivity of CIG adopter farmer's pond is shown in Table 12. The result exhibited that the average pond productivity was 4.14, 4.82, 4.88 and 4.94 MT/ha in 2017-18, 2018-19, 2019-20 and 2020-21, respectively, which was consistent with the result framework, in which the pond productivity was targeted as 3.4, 3.70, 4.10 and 4.4 in 2017-18, 2018-19, 2019-20 and 2020-21, respectively.

Table 12. Pond productivity in CIG adopter farmers pond over the year

Technology	2017-18			2018-19 (Cum.)			2019-20 (Cum.)			2020-21 (Cum.)		
	Water Area (ha)	Total Production (MT)	Unit Production (kg/ha)	Water Area (ha)	Total Production (MT)	Unit Production (kg/ha)	Water Area (ha)	Total Production (MT)	Unit Production (kg/ha)	Water Area (ha)	Total Production (MT)	Unit Production (kg/ha)
Carp polyculture	1563	5852	3745	6201	27334	4408	7991	35736	4472	9346	42263	4522
Monosex Tilapia culture	83	694	8380	384	3330	8672	490	4295	8766	572	5070	8863
Carp Galda polyculture	64	249	3867	278	1116	4014	355	1554	4378	391	1717	4392
Shing Magur mixed culture	16	85	5278	92	512	5563	127	742	5843	143	907	6341
Pangas monoculture	21	343	16544	83	1493	17983	105	1783	16983	124	2231	17994
Pabda Gulsha mixed culture	8	39	4967	40	201	5032	47	248	5278	53	282	5312
Koi monoculture	4	25	6946	17	114	6693	23	198	8596	27	206	7645
Shing Monoculture	1	3	5693	2	12	5983	2	12	5896	2	0	0
Total	1760	7290		7097	34111		9140	44568		10658	52675	
Average pond productivity MT/ha	4.12			4.82			4.88			4.94		

4.6. Non-CIG adopted farmers

The non-CIG farmers also adopted the technology promoted by NATP-2. A total of 101540 non-CIG farmers were listed as adopted farmers so far and the female percentage was 28.7 (Table 13). Although the non-CIG adopter farmers were not included in the target of result framework, the result indicated that a significant number of fish farmers adopted the aquaculture technology promoted by NATP-2, which will play a vital role in increasing national fish production.

Table 13. Gender composition of non-CIG adopter farmers up to 2020-21

Technonogy	Female	Male	Total	% Female
1. Carp Polyculture	24562	61973	86535	28.4
2. Monosex Tilapia culture	1910	4686	6596	28.9
3. Carp Galda mixed culture	1104	1920	3024	36.5
4. Shing Magur mixed culture	225	662	887	25.4
5. Pangas monoculture	482	1297	1779	27.1
6. Pabda Gulsha mixed culture	214	401	615	34.8
7. Koi monoculture	63	134	197	31.9
8. Shing monoculture	163	410	573	28.4
9. Other	409	780	1189	34.4
10. Nursery	39	106	145	26.9
Total:	29171	72369	101540	28.7

Conclusion

Demonstration, as well as adoption technologies, increases the yield of fish. As the demonstration was implemented with the close supervision of the local Upazila offices, the yield in the demonstrated pond is higher than that of the adoption pond. Three potential technologies, such as Pabda-gulsa mixed culture, shing-magur mixed culture and carp-galda mixed culture, which showed higher BCR in demonstration pond, may be promoted in the future.

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Annexure (I to XI)

1. Annexure-I: Data collection form for demonstration result

No	Union	Name of CIG	Name of the farmer	Water area (decimal)	Technology demonstrated	Number of fingerling stocked	Culture Duration (Days)	Total production (kg)	Total cost (Tk)	Total income (Tk)	Yield before demo. (kg) of the similar technology	Culture technology before demo
1.												
2.												

2. Annexure-II: Datacollection form for CIG adopter

Year	Name of the adopter farmers	Gender (Male/Female)	Address	Name of the technology adopted	Water area of the adopted farmer (ha)	Before adoption		After adoption	
						Total production (kg) for similar technology	Unit Production (kg/ha)	Total production (kg)	Unit Production (kg/ha)

3. Annexure-III: Data collection form for non-CIG adopter

Sl. No.	FY	Name of the adopter farmers	Gender (Male/Female)	Address	Name of the technology adopted

4. Annexure-IV: Female participation in demonstration in different regions

Technology	Dhaka			Rajshahi			Chattogram			Khulna		
	F	Total	% F	F	Total	% F	F	Total	% F	F	Total	% F
1. Carp Polyculture	4567	14765	31	3068	9592	32	2390	8930	27	2236	6687	33
2. Monosex Tilapia	250	923	27	83	233	36	216	819	26	152	401	38
3. Pangas Monoculture	50	217	23	4	22	18	32	123	26	35	94	37
4. Nursery	11	18	61	0	0	0	40	107	37	591	1509	39
5. Carp-Galda Mixed Culture	4	14	29	0	6	0	0	7	0	48	113	42
6. Pabda Gulsha Mixed Culture	0	0	0	0	1	0	0	0	0	0	0	0
7. Shing Monoculture	53	201	26	26	107	24	53	190	28	20	42	48
8. Shing Magur Mixed Culture	21	87	24	4	32	13	0	0	0	3	29	10
9. Koi Monoculture	40	92	43	199	560	36	16	80	20	0	0	0
10. Others	0	8	0	9	23	39	39	86	45	3	9	33
Total	4996	16325	30.60	3393	10576	32.08	2786	10342	26.94	3088	8884	34.76

5. Annexure-V: Female participation in demonstration in different regions (Cont'd)

Technology	Barishal			Sylhet			Rangpur			Mymensingh			Grant Total		
	F	Total	% F	F	Total	% F	F	Total	% F	F	Total	% F	F	Total	% F
1. Carp Polyculture	401	953	42	901	3465	26	1489	4970	30	1682	5930	28	16734	55292	30.26
2. Monosex Tilapia	84	221	38	76	347	22	80	252	32	49	147	33	990	3343	29.61
3. Pangas Monoculture	33	80	41	15	37	41	2	9	22	39	147	27	210	729	28.81
4. Nursery	27	81	33	36	111	32	0	0	0	95	264	36	800	2090	38.28
5. Carp-Galda Mixed Culture	0	0	0	5	12	42	6	22	27	36	142	25	99	316	31.33
6. Pabda Gulsha Mixed Culture	0	0	0	0	0	0	0	0	0	3	5	60	3	6	50.00
7. Shing Monoculture	0	0	0	0	8	0	23	75	31	63	271	23	238	894	26.62
8. Shing Magur Mixed	3	6	50	0	0	0	0	3	0	1	14	7	32	171	18.71

Culture															
9. Koi Monoculture	0	0	0	0	0	0	0	0	0	0	1	0	255	733	34.79
10. Others	0	0	0	0	0	0	4	18	22	2	18	11	57	162	35.19
Total	548	1341	40.8	1033	3980	25.9	1604	5349	29.9	1970	6939	28.4	19418	63736	30.5

6. Annexure-VI: Year-wise yield of demonstrated technologies

Technology	Average yield (kg/ha)			
	2017-2018	**2018-2019**	**2019-2020**	**Mean**
Carp Poly Culture	5086.43	5522.10	5640.24	5416.26
Mono Sex Tilapia	11414.25	12279.04	12793.97	**12162.42**
Pangas Mono Culture	18031.64	18619.64	18926.41	**18525.90**
Carp Galda Poly Culture	4479.88	4640.25	4510.17	4543.43
Pabda Gulsha Mixed Culture	5329.84	5409.76	5474.98	5404.86
Shing Mono Culture	8063.56	6194.13	6230.39	6829.36
Shing Magur Mixed Culture	5964.59	7162.97	7096.31	6741.29
Koi Mono Culture	8188.44	11858.64	10942.05	**10329.71**
Other	8464.19	4758.56	-	6611.37

7. Annexure-VII: Annexure Performance of the demonstration established in 2017-18

Parameters	Results (Average)							
	Carp Polyculture	Monosex Tilapia	Pangas Monoculture	Carp Golda Mixed culture	Pabda Gulsha Mixed culture	Shing Monoculture	Singh Magur Mixed Culture	Koi Monoculture
1. Demonstrated technology (no.)	11035	1233	203	115	133	105	54	41
2. Average water area in decimal	49	46	57	53	47	46	47	46
3. Yield (Kg/ha)	5086	11414	18032	4480	5330	8064	5965	8188
4. Production cost (Tk/ha)	448269	883988	1304451	712500	709360	924451	619060	449320
5. Gross return (Tk/ha)	738812	1347243	2019584	1299200	1519050	1757952	1580725	818800
6. Net return (Tk/ha)	290543	463255	715133	586700	809690	833501	961665	369480

7. Bebefit cost ratio (Tk/Tk)	1.65	1.52	1.55	1.82	2.14	1.9	2.55	1.82
8. Fish price (TK/kg)	145	118	112	290	285	218	265	100
9. Yield before demo. (kg/ha)	3163	7466	12507	3163	3163	5495	3427	5164
10. Change of yield (Kg/ha)	1923	3948	5525	1317	2167	2569	2538	3024
11. Increase of yield (%)	60.8	52.88	44.18	41.64	68.51	46.75	74.06	58.56

8. Annexure-VIII: Performance of the demonstration established in 2018-`19

Parameters	Results (Average)							
	Carp Polyculture	Monosex Tilapia	Pangas Monoculture	Carp Golda Mixed culture	Pabda Gulsha Mixed culture	Shing Monoculture	Singh Magur Mixed Culture	Koi Monoculture
1. Demonstrated technology (no.)	4384	473	49	66	77	8	72	20
2. Average water area in decimal	64	46	55	59	49	48	54	48
3. Yield (Kg/ha)	5522	12279	18620	4640	5110	6194	7163	11859
4. Production cost (Tk/ha)	525093	861737	1133103	746260	666250	889290	1028217	899640
5. Gross return (Tk/ha)	844866	1277016	1396500	1345600	1441020	1585664	1833728	1245195
6. Net return (Tk/ha)	319773	415279	263397	599340	774770	696374	805511	345555
7. Bebefit cost ratio (Tk/Tk)	1.61	1.48	1.23	1.8	2.16	1.78	1.78	1.38
8. Fish price (TK/kg)	153	104	75	290	282	256	256	105
9. Yield before demo. (kg/ha)	3702	9196	13262	3702	3702	5507	5507	7332
10. Change of yield (Kg/ha)	1820	3083	5358	938	1408	687	1656	4527
11. Increase of yield (%)	49.16	33.53	40.4	25.34	38.03	12.48	30.07	61.74

9. Annexure-IX: Performance of the demonstration established in 2019-`20

Parameters	Results (Average)							
	Carp Polyculture	Monosex Tilapia	Pangas Monoculture	Carp Golda Mixed culture	Pabda Gulsha Mixed culture	Shing Monoculture	Singh Magur Mixed Culture	Koi Monoculture
1. Demonstrated technology (no.)	4486	328	50	65	4	55	21	18
2. Average water area in decimal	55	45	52	49	45	38	45	52
3. Yield (Kg/ha)	5640	12794	18926	4510	5475	6230	7096	10942
4. Production cost (Tk/ha)	562855	921058	1226225	734850	853165	1007921	1080943	918360
5. Gross return (Tk/ha)	879840	1343370	1457302	1307900	1505625	1626030	1830768	1203620
6. Net return (Tk/ha)	316985	422312	231077	573050	652460	618109	749825	285260
7. Bebefit cost ratio (Tk/Tk)	1.56	1.46	1.19	1.78	1.76	1.61	1.69	1.31
8. Fish price (TK/kg)	156	105	77	290	*275*	261	258	110
9. Yield before demo. (kg/ha)	4015	9240	13384	4015	4015	5536	5643	7364
10. Change of yield (Kg/ha)	1625	3554	5542	495	1460	694	1453	3578
11. Increase of yield (%)	40.47	38.46	41.41	12.33	36.36	12.54	25.75	48.59

10. Annexure-X: Adoption of technology by CIG-farmers over the years

Technology	Number of CIG-adopted farmers									
	2017-18		2018-19		2019-20		2020-21		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
1. Carp Polyculture	9039	88.19	27502	85.93	10591	86.36	8160	88.53	55292	86.75
2. Monosex Tilapia	465	4.54	1764	5.51	626	5.10	488	5.29	3343	5.25
3. Carp Golda Mixed Culture	322	3.14	1159	3.62	412	3.36	197	2.14	2090	3.28
4. Shing and Magur Mixed Culture	106	1.03	460	1.44	231	1.88	97	1.05	894	1.40
5. Pangas Monoculture	107	1.04	375	1.17	141	1.15	106	1.15	729	1.14
6. Pabda Gulsha Mixed Culture	52	0.51	182	0.57	40	0.33	42	0.46	316	0.50
7. Koi Monoculture	21	0.20	83	0.26	40	0.33	27	0.29	171	0.27
8. Shing Monoculture	2	0.02	3	0.01	1	0.01	0	0.00	6	0.01
9. Others	109	1.06	384	1.20	147	1.20	93	1.01	733	1.15
10. Nursery	27	0.26	93	0.29	35	0.29	7	0.08	162	0.25
Total CIG Adopters	10250	100	32005	100	12264	100	9217	100	63736	100

11. Annexure-XI: Geographic distribution of CIG-adopters in different regions

Technology	Number of CIG-adopters in different regions								Total
	Dhaka	Rajshahi	Chittagong	Khulna	Barisal	Sylhet	Rangpur	Mymensingh	
1. Carp Polyculture	14765	9592	8930	6687	953	3465	4970	5930	55292
2. Monosex Tilapia	923	233	819	401	221	347	252	147	3343
3. Carp Galda Polyculture	18	0	107	1509	81	111	0	264	2090
4. Shing and Magur Mixed Culture	201	107	190	42	0	8	75	271	894
5. Pangas Monoculture	217	22	123	94	80	37	9	147	729
6. Pabda Gulsha Mixed Culture	14	6	7	113	0	12	22	142	316
7. Koi Monoculture	87	32	0	29	6	0	3	14	171
8. Shing Monoculture	0	1	0	0	0	0	0	5	6
9. Other	92	560	80	0	0	0	0	1	733
10. Nursery	8	23	86	9	0	0	18	18	162
Total :	16325	10576	10342	8884	1341	3980	5349	6939	63736