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DEMONSTRATION OF SEMI-INTENSIVE POLYCULTURE
AND
INTEGRATED FISH-POULTRY FARMING
IN BANGLADESH

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ABSTRACT

Fish production through adopting semi-intensive polyculture and integrated fish-cum-poultry farming in three and four undrainable ponds respectively were demonstrated at different Fish Seed Multiplication Farms(FSMFs) of Department of Fisheries (DOF) in Bangladesh during 1990 - 1992.

Polyculture of Indian and exotic carps having different spatio-trophic habits were considered as stocking material. Stocking density varied from 7660 -12,473/ha in polyculture and that of 7,890 - 15,580 fingerlings per hectare in integrated fish-poultry system. Average weight of fingerlings at stocking ranged from 0.5 - 3500 g in polyculture and 2.0 - 157 g in Integrated fish-poultry system. Techniques of sequential harvesting and restocking of fish were practiced. Supplementary feed was applied for fish in polyculture system while no supplementary feed was applied for fish in integrated system except grass/duck weed for grass carps . In addition to base manuring, regular daily manuring was also done in polyculture system while in case of integrated farming no significant manure was given except base manuring during pond preparation.

Out of four, only chicken was reared with fish in three demonstration ponds. In the other pond, both chicken and ducks were reared together. Four different varieties of layer chicken (viz. Shaver cross hybrid, ISA Brown hybrid, White leg-horn and Phymee) and hybrid duck (Khaki-cambe11 X Local variety) were considered . Number of poultry ranged from 400 - 808/ha. Poultry birds were fed *ad libitum* with standard self made feed.

Net production of fish varied from 2941 - 4202 kg/ha/yr in polyculture and 3585 -4759 kg/ha/yr in integrated culture. Net return over operating costs varied from 63.29 - 96.51% and 15.75 - 22.47% in polyculture and integrated fish-poultry system respectively.

Combination of fish-chicken and fish-chicken-duck systems did not show notable differences in terms of fish production, profitability, etc. Shaver cross and ISA Brown chicken varieties laid eggs profitably. The egg laying rates of other chicken varieties and ducks were not profitable hence not recommended for fish-poultry integrated system.

Semi-intensive polyculture of fish has been found suitable technique of fish production for the rural fish farmers with less inputs and management efforts but good return.

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INTRODUCTION

In Bangladesh, there are about 1.5 million ponds of different sizes covering an area of about 146,955 hectares of land of which about 52% is under extensive fish culture (DoF 1991). Although, fish culture in ponds is not a new practice in the country, the rate of production of fish is still lying far below (1161 kg/ha/yr) than what it should be (Rahman 1989). Improper management and production techniques viz. high or low stocking, inadequate manuring and feeding etc. have been considered responsible for low production of fish.

As most of the farmers are poor and living in rural area, it is not possible for them to support the intensive technology of fish production which requires higher inputs supply. An appropriate intermediate technology for the farmers of Bangladesh, thus should be the semi-intensive culture technique that require moderate inputs and production management based mainly on proper stocking rate and ratio and adequate regular manuring with or without supplementary feeding.

Production of fish through semi-intensive polyculture or integrated fish farming by using animal or agricultural by-products in fish pond as manure and feed has appeared to be the most appropriate technique for rural farmers.

Scope of using cow dung in fish pond is limited in Bangladesh because of increased application of cow dung as fuel and as manure in crop lands. Chicken manure which is rich in nutrients is not yet properly utilized in the country.

In Noakhali area, production of fish through semi-intensive polyculture was observed to range from 2470 - 3700 kg/ha/yr (Ammen 1987). Several trials were conducted on integrated fish-cum-poultry farming system at Fisheries Research Institute (FRI), Mymensingh and a production of around 4500 kg/ha/yr of fish have been achieved (FRI, 1991).

The FAO/UNDP Project BGD/87/045 demonstrated the techniques of increasing fish production through semi-intensive polyculture and integrated fish-poultry farming at government farms. The objective of the trials was to standardize the generally applicable fish production techniques which the local fish farmers could adopt and practice by themselves.

MATERIALS AND METHODS

POLY CULTURE

Selection of ponds:

Two ponds were selected for demonstrating technique of polyculture of fish taking one pond at Faridpur FTEC and the other at Tongi FSMF. Two successive trials were done in the same pond at Faridpur FTEC in 1990 - 91 and in 1991 - 92. The ponds were perennial and retained an average water depth of about 3.0 m at Faridpur and 2.5 m at Tongi.

Pond preparation:

The ponds were dewatered by low-lift pumps prior to stocking with fish fingerlings in order to eradicate the unwanted fishes. After dewatering, the pond bottoms were exposed to sunlight for 3-4 days and then treated with lime 6250 -300 kg/ha. Base manuring was done with poultry drops/cow dung 91,500 - 2,000 kg/ha. The manure was spread evenly all over the pond bottom. Immediately after manuring, the ponds were

gradually filled in with water from adjacent ponds and/or from tube-well over a period of about 5-7 days.

Stocking:

The ponds were stocked with fish fingerlings after 5-7 days of base manuring when production of natural fish food organisms in sufficient quantity was observed in pond water. The objective of the first trial at Faridpur FTEC pond was to raise brood fish for the hatchery hence large size fish were stocked for that trail only.

Considering the diversified pond ecosystem, species of fishes were selected carefully ensuring maximum utilization of different trophic and spatial niches of ponds which are not competitive to each other for food and space. List of compatible stocked fish species 1s given in Table-I.

TABLE I: SELECTED SPECIES OF CARPS AND THEIR SPATIO-TROPHIC HABITS

Species	Spatio-trophic habits
Silver carp (<i>Hypophthalmichthys molitrix</i>)	Surface feeder - Phytoplanktophagous
Cat la (Cat la cat la)	Surface feeder - Zooplankton form the major diet
Grass carp (<i>Ctenopharyngodon idella</i>)	Surface/column feeder - Macrophyte feeder
Rui (<i>Labeo rohita</i>)	Predominantly column feeder - Plankton and organic debris form the major diet
Thai Sarpunti (<i>Puntius gonionotus</i>)	Column/bottom feeder - Plankton and soft aquatic weeds form the major diet
Mrigal (<i>Cirrhinus mrigala</i>)	Bottom feeder - Detritivore
Common/Mirror carp (<i>Cyprinus spp.</i>)	Bottom feeder - Omnivore

Stocking density varied from 7660 - 12473 fingerlings/ha. Fingerlings were collected from both the DOF Fish Seed Multiplication Farms (FSMF) and private fish nurseries. Average weight of stocked fish/fingerlings varied from 0.5 - 3500 g. Pond-w1se stocking details are given in Table II.

TABLE II: STOCKING DETAILS OF DEMONSTRATION PONDS FOR POLY CULTURE

Fish Farm	Pond Area (m ²)	Date	Species	No/Pond	No/ha	Avt. wt. (g)	Total wt.	
							Kg/pond	Kg/ha
1.Faridpur FTEC 1st Cycle	3,560	12/10/90	S.carp	620	1742	309	204	573
		12/10/90	Catla	20	56	3500	70	196
		12/10/90	Rui	420	180	150	63	177
		12/10/90	Mrigal	60	169	1150	69	194
		02/11/90	Catla	120	337	410	49	138
		02/11/90	G.carp	220	618	10	2	6
		02/11/90	M.carp	150	421	7	1	3
		02/11/90	C.carp	430	1208	142	61	171
		20/11/90	Mrigal	2400	6742	60	144	404
			Total	4440	12473		663	1862
2.Faridour FTEC 2nd Cycle	3,560	10/5/91	M.carp	797	2240	10	8	22
		01/6/91	Rui	278	780	45	12.5	35
		07/6/91	S.carp	1110	3120	1.2	1.3	4
		07/6/91	G.carp	214	600	10	2.1	6
		10/7/91	Catla	338	950	30	10.1	28
			Total	2737	7690		34.0	95
3. Tongi FSMF	2,670	26/1/91	Catla	307	1150	0.5	0.15	0.6
		26/4/91	Sarputi	139	520	1.0	0.14	0.5
		26/4/91	Magur	37	140	0.5	0.02	0.1
		01/5/91	G.carp	184	690	11.0	2.0	7.6
		01/5/91	S.carp	689	2580	1.5	1.0	3.9
		01/5/91	C.carp	689	2580	1.5	1.0	3.9
			Total	2045	7660		4.3	16.6

Manuring:

The ponds were regularly manured with poultry drops/cow dung @ 50 -80 kg/ha/day in between 9 - 11'0 clock in the morning. The manure was spread over the water from all sides of the ponds. Inorganic fertilizer (Urea and TSP) was applied in small quantity from time to time.

Feeding:

Supplementary feed was applied in all the three trials with mustard oil cake(50%) and rice bran (50%) or wheat bran(50%) @ 1 -2% body weight of fish except plankton feeding silver carp, catla and macrophyte feeding grass carp. Green grass and/or duck weed was also applied in ponds for grass carp.

Harvesting and marketing:

Large size fish (around 500 g) were partially harvested after 3/4 months of stocking. The ponds were again re-stocked with fingerlings of same species in almost same numbers. The first trial at Faridpur FTEC pond was completed in six months hence all the fish were harvested in six months time. The second trial at the same pond at Faridpur was continued for one year. The pond at Tongi was harvested in ten months culture period. A portion of harvested fish was re stocked in other ponds of the farms for induced spawning and the rest was sold to local markets.

INTEGRATED FISH-POULTRY SYSTEM

Fish sub-system:

Selection of ponds:

In selecting demonstration ponds for integrated fish-poultry farming, following main criteria were considered:

- medium sized ponds suitable for carp production that ranges from 1090m² - 4000m²;
- having facilities for periodic water replenishment as well as dewatering;
- retains water round the year;
- fish seeds and other production inputs, poultry feed ingredients and medicines are locally available;
- having good demonstration value and training facilities.

Considering the aforesaid criteria, following 4 ponds were selected at 4 DOF FSMFs located at 4 different parts of the country (Table -III).

TABLE-III: SELECTED FARM PONDS FOR INTEGRATED FISH CULTURE DEMONSTRATION

Farm Name	Pond size (m ₂)	Av. depth (m)	Type of integration
1. Tongi FSMF	1335	2.0	Carp and layer chicken
2. Faridpur FTEC	1090	2.5	Carp and layer chicken
3. Natore FSMF	2500	3.0	Carp and layer chicken
4. Karbala FSMF	4000	2.5	Carp and layer chicken and duck

Pond preparation:

In all the 4 ponds unwanted fishes were eradicated by complete dewatering by means of low-lift pumps. After dewatering, pond bottoms were exposed to sunlight for 3-4 days and then treated with lime @300 kg/ha. Base manuring was done after 4-5 days of liming with dry poultry drops/cow dung @1500-2000 kg/ha. The manure was spread at a time evenly all over the pond bottom. Application of inorganic manure was avoided. Immediately after manuring, pond was gradually filled in with water from adjacent pond and/or from tube-well over a period of about 5-7 days.

Stocking:

Stocking of ponds with fingerlings was done after 5-7 days of base manuring when observed that natural fish food organisms (phyto and zooplankton) were produced in the pond water in sufficient quantity.

Stocking density of fish varied from 7890 - 15580 fingerlings/ha. Fish fingerlings were collected from both DoF's FSMF and private fish nurseries. Average weight of fingerlings varied from 2.0 - 157 g. Details of pond-wise stocking rates and ratios of 4 demonstration ponds are shown in Table-IV.

TABLE - IV: STOCKING DETAILS AT DIFFERENT CULTURE/DEMONSTRATION PONDS

Farms Name and Culture System	Pond Area (m ²)	Stocking details of fingerlings						
		Date	Species	Number		Av. wt. (g)	Total wt (kg)	
				Pond	Hectare		Pond	Hectare
1. Tongi FSMF Fish-chicken integrated culture	1,335	11-Nov-90	S.carp	200	1498	45.0	9.00	67.40
		11-Nov-90	Catla	140	1,049	70.0	9.80	73.40
		11-Nov-90	Rui	220	1,648	29.0	6.40	47.80
		11-Nov-90	Sarputi	170	1,273	10.0	1.70	12.70
		11-Nov-90	C.carp	270	2022	45.0	12.15	91.00
		13-Dec-90	Mrigal	280	2,097	30.0	8.40	62.90
		22-Apr-91	Sarputi	210	1,573	19.0	4.00	29.90
		20-May-91	G.carp	70	524	12.0	0.84	6.30
		20-May-91	S.carp	150	1124	12.0	1.80	13.50
		13-Jun-91	Magur	40	300	20.0	0.80	6.00
		22-Jul-91	S.carp	330	2472	25.0	8.20	61.30
			Total	2,080	15,580		63.09	472.20
2. Faridpur, FTEC Fish-chicken Integrated culture	1,090	04-Jun-91	S.carp	360	3,303	11.0	3.96	36.30
		04-Jun-91	M.carp	280	2569	8.0	2.24	20.50
		04-Jun-91	G.carp	80	734	10.0	0.80	7.30
		10-Jul-91	Catla	40	367	30.0	1.20	11.00
		23-Dec-91	S.carp	100	917	10.0	1.00	9.17
			Total	660	7,890		9.20	84.27
3. Natore, FSMF Fish-chicken integrated culture	2,500	05-Apr-91	S.carp	875	3,500	2.5	2.18	8.70
		05-Apr-91	Catla	235	940	30.0	7.05	28.20
		05-Apr-91	G.carp	250	1,000	14.0	3.50	14.00
		05-Apr-91	C/M.carp	775	3,100	6.9	5.35	21.40
		08-Jun-91	S.carp	700	2,800	2.0	1.40	5.60
			Total	2,835	11,340		19.46	77.90
4. Karbala FSMF Fish-chicken-duck integrated culture	4,000	02-Nov-90	S.carp	2,200	5,500	40.0	88.00	220.00
		02-Nov-90	G.carp	300	750	90.0	27.00	67.50
		02-Nov-90	Rui	500	1,250	9.0	4.50	11.30
		02-Nov-90	Mrigal	800	2,000	12.0	9.60	24.00
		02-Nov-90	C.carp	500	1,250	23.0	11.50	29.00
		07-Jun-91	S.carp	610	1,525	157.0	95.80	239.50
			Total	4,910.00	12,275		236.40	591.30

Manuring:

Besides base manuring during pond preparation, no additional manure was applied to ponds throughout the culture period as the purpose of regular continuous manuring was done by the poultry birds (chicken and ducks) housed above the pond water. However, some additional manure in the form of compost was given to support high density of fish at Karbala FSMF (pond no.4). Some cow dung was also added to Natore pond from time to time as the number of birds in that pond was not adequate to manure the pond optimally.

Feeding:

Application of supplementary feed for fish was avoided throughout the culture period as the poultry drops and spilled food from poultry house provided feed for the fish in pond. However, in all the 4 ponds grass and duck weed (*Lemna minor*) were provided for feeding the grass carp.

Water management:

Although the ponds received continued poultry drops on a regular basis from the poultry shed made above the pond, the water quality apparently did not show any problem that might cause distress to fish. As such no attempt was undertaken to change or recirculate water. However, in Tongi pond, periodic replenishment of water had to be made because of high seepage rate.

Sampling:

With a view to monitor the growth rate, health condition and survival of fish, regular sampling was done on a monthly basis by seine net. Fish weight was taken by standard spring balance.

Harvesting and marketing:

Partial harvesting of large-size fishes started after 3-4 months of stocking when they reached around 500 g. Immediately after partial harvesting, ponds were restocked with fingerlings of same species. Culture period of fish was fixed for 1 year. Final harvesting of fish was done at the end of a year by seine net with gradual dewatering of ponds over the period 3 -5 days. Fish were sold at local markets.

Poultry Sub-system

Poultry varieties

Three different varieties of layer chicken (viz. Shaver cross hybrid, ISA Brown hybrid and Phymee (Pakistani)) were kept in three different demonstration ponds. In another demonstration pond both ducks (Khaki-campbell x Bangladeshi local variety) and chicken (White leg-horn) were kept together in separate houses.

Chicken and ducks were purchased from government and private poultry farms at different ages (Table-V).

TABLE-V: INFORMATION ON POULTRY BIRDS FOR DEMONSTRATION PONDS

Farm Name	Pond Size (m ²)	Poultry variety	Number		Date of Stocking	Age (day)	Price (Tk/pc)	Source of Poultry
			Pond	Ha				
1.Tongi, FSMF	1335	Shaver cross hybrid chicken	108	808	8/11/90	1	20.00	Biman Poultry Complex, Shavar, Dhaka
2.Faridpur, FTEC	1090	ISA Brown hybrid chicken	57	523	4/6/91	130	100.00	Silver carp Limited, Faridpur
3.Natore, FSMF	2500	Phyomee chicken (Pakistani)	100	400	5/4/91	100	50.00	Govt. poultry Farm Pabna
4. Karba1a, FSMF	4000	White leghorn chicken, and Khaki-campbell x local variety duck	109 144	272 375	24/10/90 30/10/90	100 84	50.00 25.00	Govt. poultry farm, Pabna and central duck breeding farm, Narayangonj

The day-old chicks were kept in a separate brooding confinement and were incubated with electric bulbs (one 100 watt bulb/100 chicks) for 2-3 weeks. The chicks were then shifted to poultry houses on the pond. For other ponds, adult birds were purchased from different sources and placed directly in the houses on ponds.

Poultry house:

Chicken and duck houses were made up of locally available cheap materials. Two types of houses were made (a) floor, wall and the roof made up of bamboo material at Faridpur FTEC and Karbala FSMF, (b) bamboo wall and floor with tin roof at Tongi and Natore FSMF. Chicken houses were built above the pond water in all the 4 places- At Karbala, the duck house was built on the dyke instead of above the pond water but a feeding platform for duck was made above the pond water. Usually the ducks were found to gather on the platform most of the time for food and rest. The size of the house was determined at 2-3 sq. ft. for a chicken and 3 sq.ft. for a duck.

Poultry feed:

The chicken and ducks were fed with recommended feed twice a day, in the morning between 8-9 am and in the afternoon between 4-5 pm. (Table-VI). The feed was given in suitable poultry feeders. Clean water was always kept in the house in self-drinker. Feed ingredients were purchased from markets and then properly mixed at the farm.

TABLE VI: COMPOSITION OF CHICKEN AND DUCK FEED.

Feed Ingredients.	Chicken			Duck layer (%)
	Starter 0–6 weeks (%)	Grower 7–18 weeks (%)	Layer 19–74 weeks (%)	
Broken wheat	50.25	52.25	43.75	40.0
Rice polish	22.0	25.0	25.0	25.0
Wheat bran	-	-	-	5.0
Till oil cake	10.0	11.0	12.0	12.0
Fish meal	17.0	10.0	11.0	10.0
Oyster shell	-	1.0	7.5	7.25
Salt	0.5	0.5	0.5	0.5
Embavit (vit. + min.premix)	0.25	0.25	0.25	0.25

Confinement:

Chicken were always kept confined in the house except for an hour in the afternoon where they were allowed to go out on the dykes for eating grasses almost everyday. Ducks were allowed to forage in the pond during day time. The pond was fenced by bamboo slats across the pond dykes so that the ducks could not go out to neighboring ponds or fields.

Egg collection:

In the chicken houses, wooden egg laying boxes (30 cm X 30 cm X 30 cm) were placed for lying eggs. Ducks laid eggs on the floor. Chicken eggs were collected twice a day in the morning and afternoon. Duck eggs were collected once - in the morning.

Disease prevention:

Both ducks and chicken were vaccinated in proper dosage as per the recommendation and dewormed when needed.

RESULTS

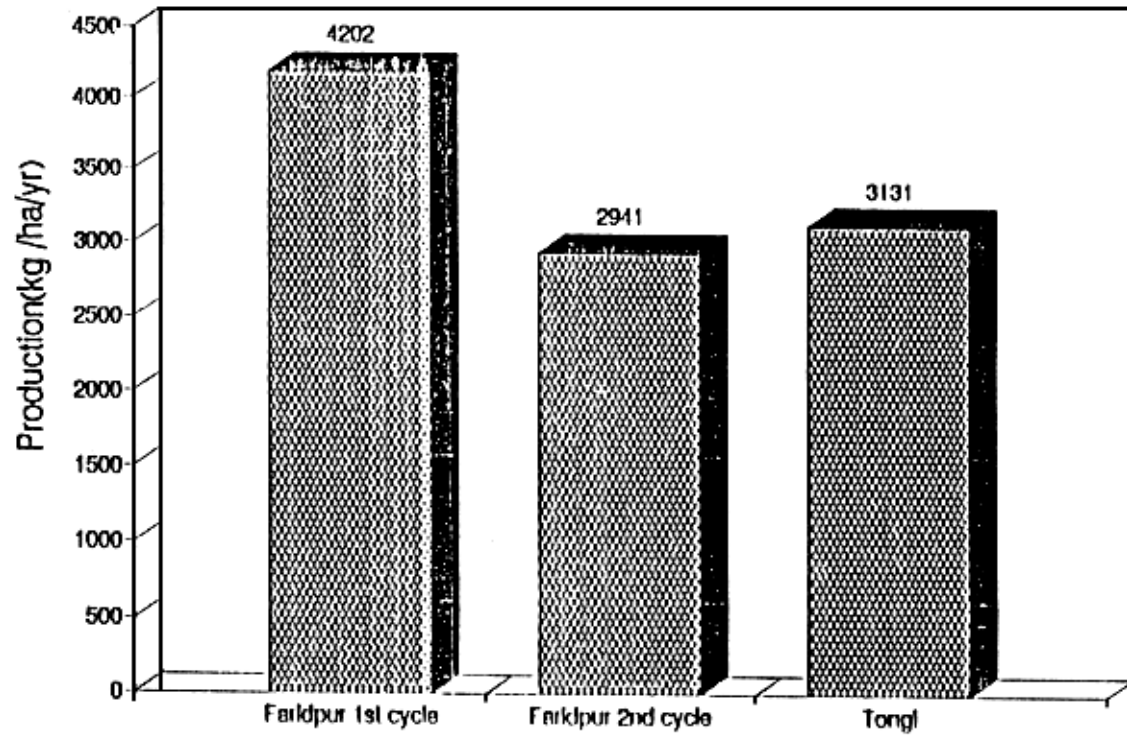
Result on the production of fish obtained in three trials of semi-intensive polyculture at Faridpur FTEC and Tongi FSMF are presented in Table VII and graphically in Fig. 1. Net production of fish varied from a minimum of 2941 kg/ha/yr in the second trial at Faridpur to a maximum 4202 kg/ha/yr in the first trial in the same pond at Faridpur FTEC.

Results on the production of fish in integrated polyculture obtained in four farm ponds at Tongi FSMF, Faridpur FTEC, Natore FSMF and Karbala FSMF are presented separately in Table VIII, IX, X and XI respectively and graphically in Fig. 2. The maximum net production of 4759 kg/ha/yr was obtained in integrated fish-chicken system in pond No. 3 at Natore FSMF and the minimum net production of 3585 kg/ha/yr was obtained in fish-chicken integrated system in pond No. 2 at Faridpur FTEC.

Average survival of fish in ponds, at the end of culture period varied from a minimum of 78.93% at Tongi FSMF(pond 3) to a maximum of 86.94% in the first trial at Faridpur FTEC (pond 1) in polyculture system and that in integrated system varied from a minimum of 61.74% at Faridpur FTEC (pond 2) to a maximum of 87.55% at Tongi FSMF(pond 1).

TABLE - VII: PRODUCTION DETAILS OF POLYCULTURE PONDS

Fish Farm	Pond area (m ²)	Date of harvest	Species	Fish harvested (No)	Survival (%)	Av wt (g)	Gross total wt (kg)		Net total wt kg/ha	Culture period (month)	Estimated Net Production t/ha/yr	
							Pond	Hectare				
1. Faridpur FTEC 1st cycle	3560	11-Apr-91	S carp	601	96.93	979	588.00	1652	1,079.00	6		
			Catla	18	90.00	4835	87.00	244	48.00			
			Rui	396	94.28	265	105.00	295	118.00			
			Mrigal	58	96.68	1417	82.00	230	36.00			
			Calls	111	91.66	704	78.00	219	81.00			
			G carp	136	61.61	213	29.00	82	76.00			
			M carp	88	58.66	230	20.00	56	53.00			
			C carp	107	94.65	387	157.00	441	270.00			
			Mrigal	2348	97.83	113	265.00	744	340.00			
			Total	4163	86.94		1,411.00	3963	2,101.00			4202
2, Faridpur FTEC 2nd cycle	3560	01-Jun-92	S carp	799	72.00	750	599.00	1683	1,679.00	12		
			Catla	318	94.00	440	140.00	393	365.00			
			Rui	267	96.00	490	131.00	368	333.00			
			G carp	191	89.00	460	92.00	258	252.00			
			M carp	611	76.00	195	119.00	334	312.00			
			Total	2,186	85.40		1,081.00	3036	2,941.00			2941
			3. Tongi FSMF	2670	29-Feb-92	S carp	613	88.90	608			373.00
Catla	276	89.90				192	53.00	199	198.40			
G carp	165	89.60				813	134.00	502	494.40			
Sarputi	58	41.70				185	11.00	41	40.50			
C carp	569	82.50				202	115.00	431	427.10			
Magur	30	81.00				490	15.00	56	55.90			
Total	1711	78.93					701.00	2626	2,609.40	3131		



Ponds
Fig 1. Fish Production in Polyculture System

TABLE-VIII: HARVESTING RECORD OF POND-1 (TONGI FSMF)

Date	Silver carp		Catla		Rui		Grass carp		Sarputi		Mrigal		Common carp		Magur		Total	
	No	kg	No	kg	No	kg	No	kg	No	kg	No	kg	No	kg	No	kg	No	kg
22-Apr-91	113	78.0							62	9.5							175	87.5
06-May-91	38	27.4															38	27.4
22-May-91	1	1.0	4	2.0					30	5.0			4	2.0			39	10.0
13-Jun-91			2	1.0					20	5.0			1	0.6			23	6.6
30-Jun-91	2	1.5	5	2.0					9	2.0							16	5.5
22-Jul-91			9	4.5					13	2.8	21	5.5	9	4.4	3	0.5	55	17.7
06-Aug-91	100	38.0	30	10.6							31	7.2					161	55.8
21-Aug-91			2	0.8					4	1.4	6	1.2	1	0.4			13	3.8
10-Oct-91	357	108.0	62	18.0	196	66.0	23	10.0	199	27.0	199	56.0	239	98.0	26	13.0	1301	396.0
Total	611	253.9	114	38.9	196	66.0	23	10.0	337	52.7	257	69.9	254	105.4	29	13.5	1821	610.3
Av.wt.(g)	416		341		337		435		156		272		415		464		335.1	
Survival (%)	89.85		81.43		89.1		32.86		88.68		91.78		94		72.5		87.55	

Pond area: 1335 m²

Culture period: 335 days

Gross fish production: 610.25 kg/bigha/11 months (4,571 kg/ha/11 months; 4987 kg/ha/yr)

Net fish production: 547.11 kg/bigha/11 months (4098 kg/ha/11 months: 4471 kg/ha/yr)

TABLE - IX : HARVESTING RECORD OF POND-2 (FARIDPUR FTEC)

Date	Silver carp		Catla		Grass carp		Mirror carp		Total	
	No	kg	No	kg	No	kg	No	kg	No	kg
04-Oct-91							12	5.00	12	5.00
29-Nov-91	176	107.00					22	11.00	198	118.00
01-Jun-92	202	159.00	11	14.00	37	36.00	71	68.00	321	277.00
Total	378	266.00	11	14.00	37	36.00	105	84.00	531	400.00
Av.wt.(g)		704		1273		973		800		753.30
Survival (%)		82.12		2750		4625		3750		61.74

Pond area: 1090 m²
 Culture period: 362 days
 Gross fish production: 400 kg/pond/yr. (3670 kg/ha/yr.)
 Net fish production 390 kg/pond/yr. (3585 kg/ha/yr.)

TABLE - X : HARVESTING RECORD OF POND-3 (NATORE FSMF)

Date	Silver carp		Catla		Grass carp		Mirror carp		Misc. Fish	Total	
	No	kg	No	kg	No	kg	No	kg	kg	No	kg
07-Jun-91	610	96.00								610	96.00
07-Nov-91	89	73.00	90	73.00	51	33.00				230	179.00
14-Nov-91	140	93.00	35	25.00	116	49.00			4	291	171.00
18-Dec-91	377	90.00	22	18.00	51	26.00	131	37.00	9	581	180.00
19-Dec-91	113	28.00	2	2.00	2	2.00	278	81.00	6	395	119.00
20-Dec-91	118	25.00					223	64.00	48	341	137.00
Total	1447	405.00	149	118.00	220	110.00	632	182.00	67	2448	882.00
Av.wt.(g)	280		792		500		288			333.00	
Survival (%)	91.87		63.40		88.00		81.50			86.35	

Pond area : 2500 m²

Culture period: 259 days

Gross fish production: 882 kg/pond/8.7 months (3.528 kg/ha/8.7 months; 4866 kg/ha/yr)

Net fish production 862.5 kg/pond/8.7 months (3,450 kg/ha/8.7 months; 4759 kg/ha/yr)

TABLE - XI: HARVESTING RECORD OF POND-4 (KARBALA FSMF)

Date	Silver carp		Grass carp		Rui		Mrigal		Common carp		Total	
	No	kg	No	kg	No	kg	No	kg	No	kg	No	kg
16-Mar-91	61	35.32									61	35.32
22-Mar-91	27	15.00									27	15.00
07-Apr-91	403	184.20							1	0.70	404	184.90
23-Apr-91	529	240.00	23	10.00							552	250.00
15-May-31	120	62.40									120	62.40
05-Jun-91	308	207.00			3	1.00	3	1.00	3	1.00	317	210.00
02-Jul-91	108	104.30					1	0.30	3	2.80	112	107.40
14-Jul-91	5	5.00	83	44.00	20	8.50	15	4.50			123	62.00
8-13-Nov-91	968	571.40	52	43.00	220	126.40	710	274.20	473	144.30	2423	1159.30
Total	2529	1424.62	158	97.00	243	135.90	729	280.00	480	148.80	4139	2086.32
Av.wt.(g)		563		614		560		384		310		504.06
Survival (%)		96.89		52.67		48.60		91.12		96.00		34.29

Pond area : 4000 m²
 Culture period: 367 days
 Gross fish production: 2086 kg/pond/year (5215 kg/ha/yr)
 Net fish production 1850 kg/pond/year (4625 kg/ha/yr)

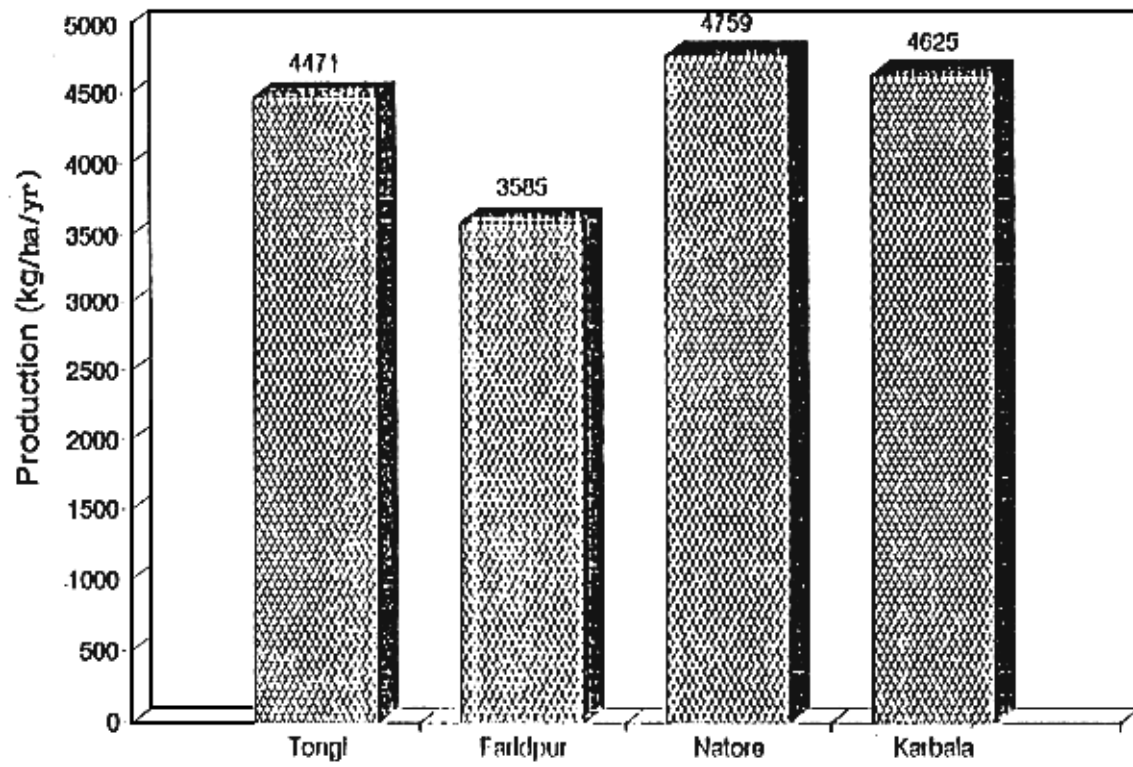


Fig. 2. Fish Production in Integrated Fish-Poultry System

TABLE XII: TOTAL OPERATING COSTS INCURRED IN POLYCULTURE SYSTEM

Farm Name	Pond Area (m ²)	Dewatering		Lime		Fish Seed		Manure		Feed		Labour		Pond rental Tk.	Interest on operating capital (12%)	Total cost Tk.
		Ltr	Tk	kg	Tk	No.	Tk	kg	Tk	kg	Tk	hrs.	Tk			
1. Faridpur FTEC 1st cycle	3560	75	1050	750	300	4440	16011	3500	990	1050	4230	300	1200	3115	1614	23510
2. Faridpur FTEC 2nd cycle	3560	80	1 120	100	500	2737	1380	9000	2700	1000	3650	625	2500	5340	2063	19253
3. Tongi FSMF	2670	55	700	30	400	2045	615	7500	2250	900	4050	350	1400	4000	1610	15025

In polyculture system, species-wise survival rate varied from a minimum of 58.66% (M. carp) to a maximum of 97.83% (Mrigal) in the first trial at Faridpur FTEC pond and that of 72% (Silver carp) to 96% (Rui) in second trial at Faridpur FTEC pond, 41.7% (Sharputi) to 89.9% (Catla) at Tongi FSMF pond (Table VII). Species-Wise survival rate varied from a minimum of 32.86% (Grass carp) to a maximum of 94% (Common carp) at Tongi FSMF and that of 27.5% (Catla) to 82.12% (Silver carp) at Faridpur FTEC, 63.4% (Catla) to 91.87% (Silver carp) at Natore FSMF and 48.6% (Grass carp) to 96.89% (Silver carp) at Karbala FSMF (Table VIII, IX, X & XI).

Details of cost of production of fish and cost-benefit analyses in polyculture system have been worked out and are presented in Table XII and XIII respectively. The costs of production of fish and poultry and cost-benefit analyses of integrated fish-poultry farming at four demonstration ponds have also been worked out and are presented in Table XIV and XV.

Poultry sub-system did not show profitable performance by itself at all the four demonstration ponds. However, the extent of loss of poultry sub-system was minimal at Tongi FSMF than that of other farm ponds. Income from fish sub-system covered the loss of poultry sub-system.

TABLE XIII: COST-BENEFIT ANALYSES OF POLYCULTURE SYSTEM

Farm name	Pond area (m ²)	Total operating cost (Tk/pond)	Gross fish yield (kg/pond)	Income from fish (Tk/pond)	Net income (Tk/pond)	Return over operating cost (%)
Faridpur FTEC	3560	28,510	1411	49,385	20,875	73.22
Faridpur FTEC	3560	19,253	1081	37,835	18,582	96.51
Tongi FSMF	2670	15,025	701	24,535	9,510	63.29

Sale price of fish : Tk. 35 per kg

TABLE XIV : TOTAL OPERATING COSTS IN INTEGRATED FISH PRODUCTION SYSTEM

Farms Name and Culture System	Pond Area m ²	Fish sub-system										Poultry sub-system										Labours		Pond Rental Tk	Interest on working capital (12%)	Total Cost Tk	
		Dewatering		Lime		Fish seed		Manare		Fish Total Tk	Chicken noise Tk	Duck house Tk	Chicken		Duck		Chicken feed		Duck feed		Medicine & others Tk	Poultry Total Tk.	hrs.				Tk
		Ltr	Tk	Kg	Tk	No	Tk	Kg	Tk				No	Poultry Total Tk.	No	Tk	Kg	Tk	Kg	Tk							
1. Toagi FSMF Eish-chicken integrated system	1,335	76	1,140	40	220	2,080	832	200	60	2,252	1,500	-	107	2,140	-	-	3,441	29,250	-	-	200	3,090	730	2,190	2,000	4,744	44,276
2. Faridpur, FTEC Fish-Chicken integrated system	1,090	35	504	30	450	860	412	200	50	1,126	800	-	57	5,700	-	-	2,290	19,465	-	-	160	25,145	375	1,125	1,635	3,604	33,635
3. Natore FSMF Fish-chicken integrated system	2,500	58	312	65	360	2,335	1,126	3,000	1,500	3,798	1,500	-	100	5,000	-	-	2,681	22,789	-	-	309	29,689	520	1,560	3,125	4,531	42,753
4.. Karbala, SMF Fish-Chicken-Duck integrated system	4,000	165	2,475	120	600	4,910	3,437	450	113	6,625	1,000	850	109	5,450	144	3,600	3,565	30,302	5,037	42,315	500	84,517	912	2,736	6,000	11,985	111,363

TABLE XV: COST-BENEFIT ANALYSIS OF INTEGRATED CARP POLYCULTURE

Farm Name and Culture System	Pond area m ²	Cost of Fish sub-system (Tk.)					Cost of Poultry sub-system (Tk.)							
		Dewatering	Lime	Fish Seed	Manure	Fish Total	Chicken house	Duck house	Chicken	Duck	Chicken feed	Duck feed	Medicine and others	Poultry Total
1. Tongi FSMF Fish-chicken chicken integrated System	1335	1140	220	832	60	2252	1500	0	2140	0	29250	0	200	33090
2. Faridpur, FTEC Fish-Chicken integrated System	1090	504	150	412	90	126	800		5700		19465		180	26145
3. Natore FSMF Fish-chicken integrated System	2500	912	360	1125	1500	3799	1600		5000		22789		300	29689
4. Karbala FSMF Fish-Chicken-Duck integrated system	4000	2475	600	3437	113	6625	1000	850	5450	3600	30302	4285	500	94517

Farm Name and Culture System	Labours	Pond Rental	Interest on working capital	Total operati cost	Income from fish		Income from Poultry						Total Income Tk.	Net Return Tk.	Return over Operating cost (%)			
					Gross fish Production	Income from fish	Chicken egg		Duck egg		Value of chicken					Value of duck		Total Tk.
							(kg)	(Tk)	No	Tk	No.	Tk.				No.	Tk.	
1. Tongi FSMF Fish-chicken chicken integrated System	2190	2000	4744	44276	610	21350	9670	24175	0	0	87	8700	0	0	32875	54225	9949	22.47
2. Faridpur, FTEC Fish-Chicken integrated System	1125	1635	3694	33635	400	16000	10646	21292			48	3360			24552	40552	6917	20.56
3. Natore FSMF Fish-chicken integrated System	1560	3125	4551	42753	882	26460	9583	19166			81	4375			23541	50001	7246	16.95
4. Karbala FSMF Fish-Chicken-Duck integrated system	2736	6000	11955	11853	2086	73010	10557	21114	12188	24375	93	5580	135	5400	56470	129480	17617	15.75

Sale price: Fish: Tk. 16–40 per kg
 Egg: Tk.2–2.50 per egg
 Chicken: Tk.60–100 per chicken
 Duck: Tk. 40 per duck

DISCUSSION AND CONCLUSION

Production as well as growth of fish in the integrated fish-poultry systems were found better than those of polyculture system. Highest growth of fish in integrated system was observed at Faridpur FTEC which might be due to lower stocking density of fish (7890/ha) than that of other ponds (11,340 - 15,580/ha) (Table XVI). However, the fish in both the cases, reached marketable size of around 400 g within the period of 3-5 months from stocking. This fast growth rate facilitated practicing partial harvesting and restocking of fish during the culture period.

Net production of fish in semi-intensive polyculture system varied from 2941-4202 kg/ha/yr which has the relevance to the findings of 2470 - 3700 kg/ha/yr in Noakhali area (Ameen 1987).

Production rates of carps in both fish-chicken and fish-chicken-duck systems were found encouraging. Net production of fish varied from 3585 to 4759 kg/ha/yr. This figure is similar to the result of 4500 kg fish/ha/yr in fish-chicken integrated system at FRI (FRI 1991) and 3543 - 4323 kg/ha/yr in integrated fish-duck farming in India (Jhingran & Sharma 1980). Production figure did not show any notable differences between fish-chicken and fish-chicken-duck systems, or higher and lower poultry densities either (Table XVI).

TABLE XVI: RELATIONSHIP BETWEEN FISH PRODUCTION AND STOCKING DENSITIES OF FISH AND POULTRY

Farms Name	Density of poultry (No./ha)	Fish at stocking			Gross av.wt (g)	Gross survival (%)	Net fish yield kg/ha	Culture period (month)	Esti. fish yield (kg/ha /yr)
		No/ha	kg/ha	Av.wt.(g)					
Tongi FSMF	Chicken 808	15580	472.2	30.3	335	87.55	4098	11	4471
Faridpur FTEC	Chicken 523	7890	84.27	10.7	753	61.74	3585	12	3585
Natore FSMF	Chicken 400	11340	73.7	6.9	333	86.35	3450	8.7	4759
Karbala FSMF	Chicken 272 Duck 375	12276	591.3	48.2	504	84.29	4625	12	4625

Higher density of poultry at Tongi FSMF than that of other ponds did not contribute to higher production of fish. However, better production rate of fish has been observed in pond with low stocking density of fish and chicken at Faridpur FTEC (pond 2) and Natore FSMF (pond 3) than those of two ponds at Tongi FSMF (pond 1) and Karbala FSMF(pond 4) with higher stocking of chicken and fish (Table XVI).

Lower production of fish (3585 kg/ha/yr) at Faridpur FTEC was due to low survival (61.7 %) resulting from predation and poaching of fish. It was reported that the surface feeding catla (*Catla catla*) became the easy victim of fishing eagle hence resulted very low survivality(27.5%).

The chicken and duck systems at Karbala FSMF committed loss, which was mainly due to low laying capacity of chicken and duck associated with improper management. Although the chicken sub-system at Tongi FSMF showed better performance in terms of egg laying rate, the system could not make profit by itself. This was due to starting with day-old chick. The laying period was only 6 months out of 11 months fish culture period.

It is obvious that the chicken variety (Shaver cross hybrid) at Tongi FSMF would have made profit by itself if they were reared for 1 year effective laying period.

Although net production of fish was found less in polyculture system, the net return over operating cost was found higher (63.29 - 96.51%) than that of integrated fish-poultry system (15.75% - 22.47%). The low return from fish-poultry system was due to loss/poor return in poultry sub-system, though return from fish sub-system covered the loss. The net return over operating costs was found higher in Tongi (22.47%) than that of other ponds at Faridpur, Natore and Karbala (Table VX). This was due to better laying rate of chicken and higher price of eggs at Tongi FSMF because of its nearness to Dhaka. The loss or profit, in integrated fish-poultry system, is thus primarily dependent on the poultry sub-system i.e. good layer variety, improved management and good marketing outlet.

All sorts of fish was observed feeding directly on poultry drops/spilled feed from poultry house above the pond. Common/mirror carp and grass carp were found under the poultry house in search of food in most of the time. Delmendo (1980) mentioned that about 70-92% of nutrients (N,P,K) from the feeds fed to animal are recovered in their excreta. In addition, waste poultry feed mixed with the excreta make a good protein rich feed for fish.

The study revealed that a good return from integrated fish-poultry system could be obtained under proper management of the sub-systems which include optimum stocking density of fast growing compatible fish species (6500 - 7500 fingerlings/ha), Shaver cross or ISA Brown layer chicken variety (500 - 600 birds/ha), partial harvesting and restocking and proper management. Phyomee and White leg-horn chicken and duck is not recommended for integrated fish-poultry system because of their low laying rate. However, if the duck is introduced, the size of fish fingerlings should be larger than 10 cm in order to escape from duck predation.

The management of poultry sub-system needs special attention hence general fish farmers are not competent enough to handle the sensitive poultry system. Alternatively, the poultry raisers, profitably operating poultry birds at their capacity, could easily integrate the fish sub-system with poultry and thus could make better use of resources with substantial income.

The study eventually revealed that the technique of low-cost semi-intensive polyculture would be the best option of fish production for the rural fish farmers than that of high-cost and sensitive technique of integrated fish-poultry farming system.

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