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Nutrient mass balance for improved traditional coastal shrimp ponds of Bangladesh

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Abstract – Three category of tidal water exchange system depended ponds have been selected for the experiments which were canal connected, river connected and pond connected pond. Present study was undertaken to estimate the nutrient balance into the coastal shrimp ponds of Cox's Bazar coastal region. It was found that mineral fertilizer, organic fertilizer, feed, fish and shrimp fry, water supply and rainfall are the nutrient input and crop product (fish, shrimp, crab), crop residues, denitrification, water discharge and sedimentation are the nutrient output for shrimp pond. Estimation of overall nutrient mass balance per hector basis indicates that fertilizer was the highest nutrient contributor as followed by the supplementary feed into the experimental ponds. The total inputs of nitrogen and phosphorus were 78.87 $kgha^{-1}cycle^{-1}$ and 42.85 $kgha^{-1}cycle^{-1}$ respectively. Among the input only 34.6 % of nitrogen and 7.20 % of phosphorus were removed as harvested shrimp, fish and crab. A large portion, 38.58 % of N and 91.38 % of P were remained in the sediments and unaccounted for. From the investigation on nutrient balance for 3 categories of shrimp ponds it was concluded that Reuse water or pond connected pond system for coastal shrimp ponds should not be practiced anywhere in Bangladesh.

Key Words : Mass balance, shrimp ponds, Nutrients, tidal water exchange system, reuse water, Bangladesh.

Introduction

A mass balance model for a water body is useful to help understand the relationship between the loadings of a pollutant and the levels in the water, biota, and sediments. Mass balance (also called a material balance) is an accounting of material entering and leaving a system. Fundamental to the balance is the conservation of mass principle, i.e. that matter can not disappear or be created. Mass balances are used, for example, to design chemical reactors, analyze alternative processes to produce chemicals, in pollution dispersion models, etc. In environmental monitoring the term budget calculations is used to describe mass balance equations where they are used to evaluate the monitoring data comparing input and output data (Wikipedia, 2006).

The direct discharge of waste nutrients from shrimp farms into adjacent waters has raised global concerns regarding adverse environmental impacts from such practices (Naylor *et al.*, 2000). In addition to environmental issues, the discharge of untreated pond effluents represents an economic loss of costly nutrients, thereby reducing farm profitability (Smith *et al.*, 2002).

One of the major challenges faced by shrimp farming is to become environmental concerns and improves economic efficiency by developing and implementing management strategies to reduce nutrient wastes. This approach should include improvements in feed formulations and feed management along with improved design and management of effluent treatment systems (Jackson *et al.*, 2003).

Several studies on nutrient mass balances in shrimp ponds have shown that the major source of nutrient input (e.g., nitrogen and phosphorus) is the formulated feed (Briggs and Funge-Smith, 1994; Martin *et al.*, 1998; Teichert-Coddington *et al.*, 2000; Jackson *et al.*, 2003). Other studies have revealed that feeding strategy can have a significant impact on pond water quality and hence growth, health and survival of the shrimp, as well as the efficiency of feed utilization (Burford and Williams, 2001; Smith et al., 2002). The establishment of nutrient mass balance budgets for different shrimp farming strategies is a basic step for the quantitative understanding of food utilization efficiency, water quality and biogeochemical processes (Thakur and Lin, 2003).

Shrimp culture is expected to continue to play an important role in ensuring food security and poverty alleviation, particularly for the rural poor. The urban population will be benefited from the improvement in processing, value adding, and marketing of the shrimp industry as a whole. Incidence like "EU ban on Bangladeshi shrimp" should not happen again and most importantly, this industry is operating under capacity and can increase the productivity up to five times than the current capacity. A majority of workers in the processing industries are women. The shrimp industry benefits three to four million "mostly poor" Bangladeshis while providing livelihood directly numbering some 11, 50,000 people. In 2007-2008, a total of 2, 23,095 Metric ton shrimp produced in Bangladesh that contributes 19,567.90 core taka in the GNP. There is ample demand in the international markets for shrimp and Bangladesh is blessed with an environment friendly for shrimp production. Technological innovation has been creating a greater impact on domestic economy. A primary study was undertaken to detect the problems plaguing the different levels of the value chain of shrimp in the country. The increasing demand and steadily rising prices of shrimp encouraged its cultivation in the coastal belt of the country (DoF, 2010).

Bangladesh has placed a high priority on coastal aquaculture. Coastal aquaculture, particularly in shrimp aquaculture is presently an important coastal industry in Bangladesh (Thia-Eng *et al.*, 1989). However, this industry has come at a huge environmental cost to coastal communities and ecosystems (Yeh, 2002) because it is accompanied by mangrove destruction, loss of fishery communities and biodiversity, pollution of land and water, loss of employment activity, and even violation of human rights (Salequzzaman, 2001).

In Bangladesh shrimp farming is generally practiced improved traditional way and for this reason considerable amount of nutrients (nitrogen and phosphorus) entered into the shrimp ponds or ghers through inlet water is entrapped into the ghers (Islam *et al.*, 2006). Most shrimp and fish production is conducted in ponds, and ponds have effluents after heavy rains and when they are drained (Boyd and Gautier, 2001).

Water also is discharged from some ponds in response to water exchange. Although there is considerable interest in water reuse, or closed cycle production systems, it currently is not technically or economically feasible to conduct most types of aquaculture without discharge. Fertilizer and feeds are applied to ponds to promote shrimp and fish production and normally, no more than 25 % to 30 % of the nitrogen and phosphorus applied to ponds in fertilizers and feeds is recovered in fish or shrimp at harvest (Boyd and Tucker, 1992). Ponds have a remarkable ability to assimilate nitrogen and phosphorus through physical, chemical and biological process (Schwartz and Boyd, 1994). Nevertheless, ponds often have higher concentrations of nutrients; plankton, suspended solids and oxygen demand than the water bodies into which they discharge (Schwartz and Boyd, 1994). The present study was attempted to find out all the input and output materials into the shrimp ponds, to assess the available fish, shrimp and crabs into the 3 ponds and also to estimate the nutrient mass balance for coastal shrimp ponds.

Materials and Methods

Site selection:

Chakaria Upazila which geographical coordinates are 21° 45' 0" North, 92° 5' 0" the highest shrimp culture and production area for Cox’s Bazar, situated in the south-eastern coast of Bangladesh was selected for the research work. The geographical coordinates of Chakaria is 21° 45' 0" North, 92° 5' 0" East. The selected experimental culture ponds are located in the south side of the Matamuhuri river estuary under the West Barabheola union in Ilishia. Tidal water was let into the pond by opening sluice gate for 3-5 days during each spring tide through a creek that originates near the mouth of Matamuhuri estuary (Fig. 1).

Selection of experimental ponds:

3 types of coastal shrimp ponds selected for the research work on the basis of water exchanged system. First category of pond was river connected pond (RCP) where water was exchanged of this pond occurred directly from the river. Second category of pond was canal connected pond (CCP) where water was exchanged occurred from canal through river and third category of pond was pond connected pond (PCP) where water was exchange or water source depends on another culture pond. All the experimental ponds have been selected for the experiments were broodstock ponds.

Sampling Design:

The entire network of the present programme comprised of the one year sampling and twice of the month, full moon and new moon. Time to sampling collection from the selected ponds selected by using tide table referenced by BIWTA (Bangladesh Inland Water Transport Authority) to know the starting and ending time of ebb and flood and adjusting for the station to be sampled.

Sampling System:

Water and soil samples were collected from selected ponds throughout the year to observed water and soil quality dynamics. At first intake water was collected from the ponds. Then the inflow water samples were collected during spring tide, just at the time of entering river or canal or pond water into the culture ponds through the inlet and outflow samples were collected during neap tide, from outlet at discharging period.

Firstly, individual budget (ha^{-1} cycle^{-1}) of each type of ponds were made. Then identified all input and output materials into the selected ponds estimating the rough nutrient budget of the shrimp farms total amount of nutrient (N and P) from input (feed, fertilizer, rainfall, and post larvae), output (harvest), and inflow and discharged water and sediment was estimated.

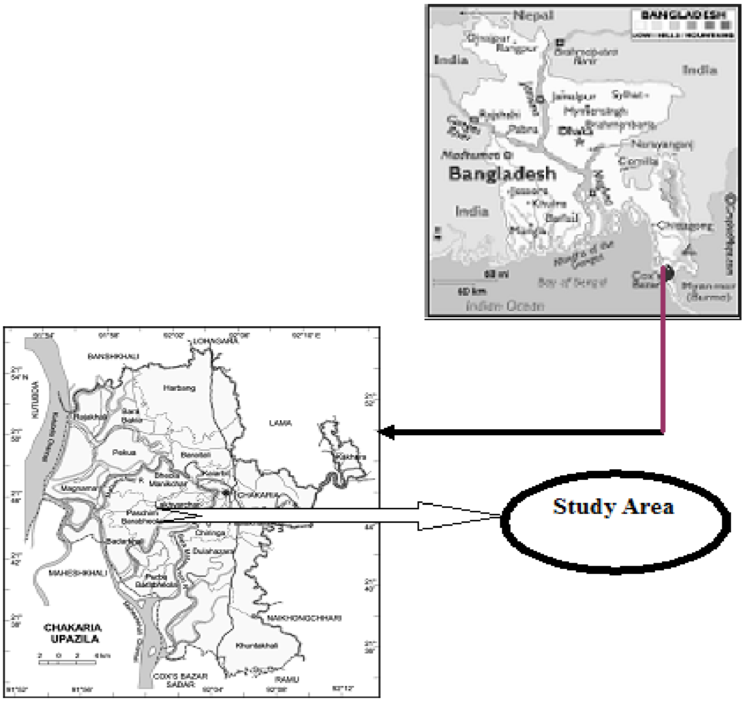

Figure 1. Geographical location of Ilishia, Chakaria, Cox's Bazar, Bangladeesh.

Identification of fin, shell fish and crabs and their Nutrient analysis:

For the analysis of mass balance, abundance of fish, shrimp and crabs were identified because these are the important sources of nutrients (N and P) into the ponds. To find out the nutrient composition (N and P) collected samples were preserved in 10 % formalin and then transferred to 5 % formalin in plastic pots and brought back to the Institute of Marine sciences and fisheries lab, cu Identification of fish, shrimp and crab were made through the wide use Shafi and Quddus (1983). Nitrogen and Phosphorus value of identified samples were determined by kjeldhal method (West *et al.*, 1966) and Lovell (1989).

Results and Discussion

Coastal shrimp aquaculture in Bangladesh is still traditional to improve traditional. Farmers use low amount of lime and fertilizer and the application of feed were rare to absent (Barua and Sarker, 2011 ; Barua and Zamal, 2010 ; Barua and Zamal, 2011). Present study indicated that improve traditional system of shrimp culture not provides any significant loading of nutrients to the surrounding coastal environment. In the present study, shrimp farmers of the experimental ponds used mineral fertilizer like triple super phosphate (TSP) and Urea; organic fertilizers like cow dung. Some locally available ingredients are supplied to the shrimp ponds as home made feed which are rice bran, wheat bran, mustard oil cake and rice starch (Table 1). Organic fertilizers (cow dung) and mineral or inorganic fertilizers (urea, T.S.P) were used into the experimental ponds for increasing natural productivity (Table 2). Feed in the form of rice bran, mustard oil cake, wheat bran, rice starch were applied at the beginning. After (30-45) days lose feed was applied 1 time a day in this entire farm still harvesting (Table 3).

In the present study, all the shrimp ponds are improved traditional ponds and asa a results polyculture has been practiced in these ponds or fish, shrimp fries and also crabs enter into the ponds by tidal water inletting periods. Shrimp (*Penaeus monodon*), prawn (*Macrobrachium rosenbergii*), tilapia (*Oreochormis niloticus*) fries are supplied into the ponds. Fish, shrimp and crabs are important source of nutrients in shrimp ponds. During the investigation, 20 species of fish, 8 species of shrimp and prawn, and 2 species of crab were identified from the experimental ponds (Table 4).

In the present study, it was found that fertilizer was the highest contributor of Total nitrogen (TN) and Total Phosphorus (TP) of canal connected pond estimated N 66.27 % and P 93.3 %. Water supply was the second contributor of nutrient supply estimated 20.53 % N and 1.59 % P. feed contributed 12.87 % N and 5 % P. The total inputs of nitrogen and phosphorus were 78.471 kg $ha^{-1}cycle^{-1}$ and 50.94 kg $ha^{-1}cycle^{-1}$. Only 32.015 % of nitrogen and 6.75 % of phosphorus were removed as harvested form. A large portion, 39.02 % N and 90.8% P which accounts for 30.438 kg N and 45.36 kg P $ha^{-1}cycle^{-1}$ were remained in the sediments. Mass balance showed that nutrient input through supply water and disposal through discharged were approximately same. The input and output value for TN was 20.53 % (16.11kg $cycle^{-1}$) and 20.65 % (16.11 kg $cycle^{-1}$) also TP was 1.59 % (0.805 kg $cycle^{-1}$) and 1.61 % (0.805 kg $cycle^{-1}$) (Table 5).

During the investigation in river connected pond it was estimated that fertilizer was the highest contributor of Total nitrogen (TN) and Total phosphorus (TP) as N 62.9 % and P 89.7 %. Feed was the second contributor, estimated 19.09 % N and 8.26% P. Total inputs of nitrogen and phosphorus were 92.214 kg $ha^{-1}cycle^{-1}$ and 43.457 kg $ha^{-1}cycle^{-1}$. Only 38.98 % of nitrogen and 11 % of phosphorus were removed as harvested form. A large portion, 35.17 % N and 87 % P which accounts for 32.42 kg N and 37.43 kg P $ha^{-1}cycle^{-1}$ were remained in the sediments. Mass balance showed that nutrient input through supply water and disposal through discharged were approximately same. The input and output value for TN was 17.74 % (16.35 kg $cycle^{-1}$) and 17.73 % (16.35 kg $cycle^{-1}$) also TP was 1.88 % (0.817 kg $cycle^{-1}$) and 1.90 % (0.817 kg $cycle^{-1}$) (Table 6).

Table 1. List of identified input and output materials into the shrimp ponds.

Nutrient input	**Nutrient Output**
Mineral fertilizer	Crop product (fish, shrimp, crab)
Organic fertilizer	Crop residues
Feed	Denitrification
Fish and shrimp fry	Water discharge
Water supply	Sedimentation
Rainfall	

Table 2. Fertilizer Application into the experimental ponds.

Types of pond	**Area of pond**	**Mineral Fertilizer**		**Organic Fertilizer**	
		Type	**Amount (kg)**	**Types**	**Amount (kg)**
Canal connected pond	200	T.S.P	1200	Cow dung	30000
		Urea	800		
River connected pond	265	T.S.P	1325	Cow dung	50000
		Urea	1000		
Pond connected pond	70	T.S.P	280	Cow dung	5000
		Urea	200		

Table 3. Application of feed (ingredients) into the experimental ponds.

Types of Pond	Feed type	ingredients	Amount of feed (kg)	Rate of application (kg/acre)	Feeding method	Feeding frequency
Canal connected Pond	loose	Rice bran, wheat bran	2450	12.25	Broad casting	1
River connected Pond	loose	Rice bran, wheat bran, mustard oil cake, rice starch	3772	14.23	Broad casting	1
Canal connected Pond	loose	Rice bran, Mustard oilcake, wheat bran	735.42	10.50	Broad casting	1

Table 4. Checklist of fish and nutrient availability.

Sceintific name	**Bengali name**	**English name**	**% of N**	**% of P**
Fish				
Lates Calcarifer	Vetki/Koral Machh	Giant Seaperch	3.04	0.590
Mystus gulio	Nuna Tengra /Guilla	Bagrid Cat fish	2.64	0.500
Liza tada	Gool Bata	Tade Grey Mullet	3.50	0.490
Mugil cephalus	Khorul Bata	Flathead Gray Mullet	3.36	0.375
Pomadasys hasta	Sadha Datina	Lined Silver Grunter	3.30	0.500
Eleutheronema tetradactylum	Thailla	Fourfinger Threadfin	3.00	0.400
Anguilla bengalensis	Kuicha	Eel	3.30	0.390
Saurida tumbil	Achila/Tiktiki Machh	Greater Lizard Fish	2.88	0.370
Sillago domina	Tolar Dandi	Lady Fish	2.90	0.480
Johnius argentatus	Lalpoa	Silver Pennah Croacker	3.20	0.390
Scatophagus argus	Bishtara	Spotted scat	3.50	0.420
Setipinna taty	Tailla Phasa	Scaly hairfin Anchovy	2.98	0.350
Escualosa thoracata	Hichiri	White sardine	3.00	0.320
Hyporhamphus limbatus	Ek-Thuitta	Congaturi halfbeak	3.20	0.540
Apocryptes sp	Chiring	Goby	3.10	0.410
Oreochormis niloticia	Tilapia	Nile tilapia	3.13	0.540
Muraenesox bagio	Kamila	Eel	3.52	0.400
Terapon jarbua	Borguni	Crescent perch	3.50	0.320
Acentrogobius caninus	Nunna baila	Dog-toothed goby	3.12	0.290
Cynoglossus cynoglossus	Kukur-jib	Bengal tongue sole	3.40	0.300
Mean Nutrient			**3.17**	**0.430**
Shrimp				
Penaeus semisulcatus	Bagatara Chingri	Green Tiger Shrimp	3.30	0.480
Penaeus indicus	Chaka Chingri	Indian White Shrimp	3.40	0.540
Penaeus merguiensis	Baga Chama Chingri	Banana Shrimp	3.10	0.620
Metapenaeus monoceros	Horina/Loilla Chingri	Brown/Speckled Shrimp	3.10	0.726
Metapenaeus brevicornis	Loilla Chingri	Brown/Yellow Shrimp	3.20	0.745
M. spinulatus	Chama Chingri	Spotted Brown Shrimp	3.40	0.623
Acetes sp.	Gura icha	Rice Shrimp	3.40	0.740
Macrobrachium rosenbergii	Galda Chingri	Freshwater Prawn	3.20	0.820
Mean Nutrient			**3.26**	**0.661**
Crab				
Scylla Serrata	Sila kakra	Mud Crab	3.20	0.530
Portunus pelagicus	Samudra kakra	Swimming Crab	3.12	0.520
Portunus sanguniolentus	Kakra	Swimming Crab	3.00	0.500
Mean nutrient			**3.10**	**0.520**

Table 5. Mass balance of canal connected pond (per hector basis).

Inputs	**Type**	**Volume used (kg)**	**Nitrogen**			**Phosphorus**		
			N% per kg	**Kg N/cycle**	**% of total**	**P % per kg**	**Kg P/cycle**	**% of total**
Feed	Rice bran	450	1.7	7.65	9.74	0.5	2.25	4.41
	Wheat bran	100	2.46	2.46	3.13	0.3	0.3	0.58
Fertilizer	Urea	100	44	44	56.08	0	0	0
	T.S.P	150	0	0	0.00	30	45	88.3
	Cow dung	500	1.6	8.00	10.19	0.5	2.5	5.0
Fry		0.3	8.1	0.024	0.03	2	0.0006	0.00
Water supply		8056739	0.0002	16.11	20.53	0.00001	0.805	1.59
Rainfall		454000	0.00005	0.227	0.29	0.00002	0.09	0.17
Total inputs per cycle		8512039	57.860	78.471	100%	30.30	50.945	100
Outputs								
Shrimps	Harvested	300	3.26	9.78	12.53	0.3	0.9	1.8
	Mortality	70	3.26	2.28	2.92	0.3	0.21	1.20
Fish	Harvested	280	3.17	8.876	11.38	0.430	1.204	2.40
	Mortality	30	3.17	0.951	1.21	0.430	0.129	0.25
Crab	Harvested	100	3.10	3.1	3.97	0.52	0.52	1.04
Denitrification		0	0.000	6.450	8.26	0.000	0.000	0.00
Total nutrients removed				31.437	40.30	2.58	3.83	7.67
Water	Waste water	8056739	0.0002	16.11	20.65	0.00001	0.805	1.61
	Harvest drainage	2500	0.0006	0.015	0.01	0.00001	0.0002	0.00
Total outputs in water				16.125	20.67		0.8052	1.61
Stays in sediment				30.438	39.02		45.36	90.8
Total Output				78.00	100%		50.00	100

Table 6. Mass balance of River connected pond.

Inputs	Type	Volume used (kg)	Nitrogen			Phosphorus		
			N% per kg	Kg N/cycle	% of total	P % per kg	Kg P/cycle	% of total
Feed	Rice bran	500	1.7	8.5	9.21	0.5	2.5	5.75
	Wheat bran	150	2.46	3.69	4.00	0.3	0.45	1.03
	Mustard oil cake	100	5.13	5.13	5.56	0.6	0.6	1.38
	Rice starch	50	0.6	0.3	0.325	0.09	0.045	0.10
Fertilizer	Urea	110	44	48.4	52.49	0	0	0
	T.S.P	120	0	0	0	30	36	82.84
	Cow dung	600	1.6	9.6	10.41	0.5	3	6.90
Fry		0.2	8.5	0.017	0.018	2	0.0004	0.00
Water supply		8175069	0.0002	16.35	17.74	0.00001	0.817	1.88
Rainfall		454000	0.00005	0.227	0.25	0.00002	0.0454	0.17
Total inputs per cycle		8630699.2	63.99	92.214	100%	33.99	43.457	100
Outputs								
Shrimps	Harvested	500	3.26	16.3	17.68	0.3	1.5	3.48
	Mortality	100	3.26	3.26	3.53	0.9	0.9	2.09
Fish	Harvested	300	3.17	9.51	10.31	0.430	1.29	3
	Mortality	100	3.17	3.17	3.43	0.430	0.43	1
Crab	Harvested	120	3.10	3.72	4.03	0.52	0.624	1.45
Denitrification		0	0.000	7.450	8.02	0.000	0.000	0.00
Total nutrients removed		1120	15.96	43.41	47.08	2.58	4.744	11.0
Water	Waste water	8175069	0.0002	16.35	17.73	0.00001	0.817	1.9
	Harvest drainage	2000	0.0006	0.012		0.00001	0.0002	0.00
Total outputs in water				16.362	17.75		0.8172	1.90
Stays in sediment				32.42	35.17		37.43	87.0
Total Output		8178189	15.96	92.192	100%		43.00	100

Nutrient mass balance of pond connected pond indicated that fertilizer also the highest contributor of Total nitrogen (TN) and Total Phosphorus (TP) estimated N 72.86 % and P 93.56 %. Feed was the second contributor, estimated 17.53 % N and 4.71 % P. The total inputs of nitrogen and phosphorus were 54.896 kg $ha^{-1}cycle^{-1}$ and 33.685 kg $ha^{-1}cycle^{-1}$. Only 32.01 % of nitrogen and 7.02 % of phosphorus were removed as harvested form. A large portion, 39.02 % N and 90.6 % P which accounts for 23.34 kg N and 30.47 kg P $ha^{-1}cycle^{-1}$ were remained in the sediments. Mass balance showed that nutrient input through supply water and disposal through discharged were approximately same. The input and output value for TN was 9.17 % (5.034 kg $cycle^{-1}$) and 9.23 % (5.034 kg $cycle^{-1}$) also TP was 1.49 % (0.503 kg $cycle^{-1}$) and 1.50 % (0.503 kg $cycle^{-1}$) (Table 7).

So, the overall nutrient mass balance of the present study indicates that fertilizer was the highest nutrient contributor (65.58 % TN and 91.57 % TP) of all three shrimp ponds followed by supplementary feed produced second highest nutrient contributor for experimental ponds (18.11 % N and 6.56 % P) (Table 8). From the analysis it was found that Nutrient recycling (%) into the shrimp ponds also varied in the three types of ponds. In PCP, 1.68 % TN and in RCP 1.60 % TP, 2.30 % N and 4.67 % TP and 5 % TN and 5.08 % TP in PCP recycled into the ponds per water let in during the day by the comparison of nutrients in intake, outlet and inlet water when tidal water exchange has been done (Table 9).

Excessive use of fertilizer and feeds in semi-intensive and in intensive (Briggs and Funge-Smith, 1994) culture system causes considerable amount of nutrient discharge in the natural water through the discharge canal. Undoubtedly, The effluent loading is strongly affected by the water exchange rate throughout the growth cycle which indicates that small amount of nutrients enrichment within the farms was occurred rather load to he river. Generally, farmers of the extensive shrimp culture ponds supplied with small amount of nutrients by the feed and fertilizers. The average input of nitrogen and phosphorus to intensive shrimp culture in Thailand was 858 kg TN $ha^{-1}cycle^{-1}$ and 291 kg $ha^{-1}cycle^{-1}$ (Briggs and Funge-Smith, 1994), which is 11 time for TN and 7 times for the estimated average input of he present study. Rouf *et al.* (2005) reported that average input of nitrogen and phosphorus to improved traditional shrimp culture in south west region of Bangladesh was 48.706 kg TN ha^{-1} $cycle^{-1}$ and 28.954 kg $ha^{-1}cycle^{-1}$. In the present study pond are supplied very low amount of feeds (rice bran, mustered oil cake, wheat bran, rice starch) with more reliance on fertilization.

Schindler *et al.* (1996) reported that fishes are important pools of nitrogen (N) and phosphorus (P), and they have important direct and indirect effects on cycling of these potentially limiting nutrients in lakes. N:P ratios in fish excretion (supply ratios) are high but potentially variable because of fishes' high P requirement and the likelihood of P limitation of fish growth, limitation of fish growth due to availability of P in food was exceedingly rare in natural ecosystems. As a result, the predicted N:P supply ratio from fish excretion was low and relatively constant. In the present study area, shrimps, prawns, crabs and fin fish fries are recruited by the tidal influence and grown in ponds, canals and salt pens of coastal area.

Table 7. Nutrient mass balance of Pond connected pond.

Inputs	Type	Volume used (kg)	Nitrogen			Phosphorus		
			N% Per kg	**Kg N/cycle**	**% of total**	**P % per kg**	**Kg P/cycle**	**% of total**
Feed	Rice bran	150	1.7	2.55	4.64	0.5	0.75	2.22
	Wheat bran	100	2.46	2.46	4.48	0.3	0.3	0.89
	Mustard oil cake	90	5.13	4.617	8.410	0.6	0.54	1.60
Fertilizer	Urea	80	44	35.2	64.12	0	0	0
	T.S.P	100	0	0	0.00	30	30	89.1
	Cow dung	300	1.6	4.8	8.74	0.5	1.5	4.46
Fry		0.1	8.1	0.008	0.014	2	0.002	0.00
Water supply		5034367	0.0001	5.034	9.17	0.00001	0.503	1.49
Rainfall		454000	0.00005	0.227	0.413	0.00002	0.09	0.27
Total inputs per cycle		5489187.1	62.99	54.89	100%	33.90	33.685	100%
Outputs								
Shrimps	Harvested	250	3.26	8.15	12.53	0.3	0.75	2.23
	Mortality	50	3.26	1.63	2.92	0.9	0.45	1.34
Fish	Harvested	240	3.17	7.608	11.38	0.430	1.032	3.07
	Mortality	30	3.17	0.951	1.21	0.430	0.129	0.38
Crab	Harvested	50	3.10	1.585	3.97	0.52	0.26	0.78
Denitrification		0	0.000	6.190	8.26	0.000	0.000	0.00
Total nutrients removed		620	15.96	26.114	40.30	2.58	2.621	7.81
Water	Waste water	5034367	0.0001	5.034	9.23	0.00001	0.503	1.50
	Harvest drainage	1800	0.0004	0.007	0.01	0.00001	0.0001	0.00
Total outputs in water				5.041	20.67		0.503	1.50
Stays in sediment				23.34	39.02		30.47	90.7
Total Output		5036787	15.96	54.49	100%		33.59	100

Table 8. Over all Mass balance of experimental ponds.

Inputs	**Type**	**Volume used (kg)**	**Nitrogen**			**Phosphorus**		
			N% Per kg	**Kg N/cycle**	**% of total**	**P % per kg**	**Kg P/cycle**	**% of total**
Feed	Rice bran	367	1.7	6.24	7.91	0.5	1.84	4.29
	Wheat bran	117	2.46	2.88	3.65	0.3	0.35	0.82
	Mustered oil cake	95	5.13	4.87	6.17	0.6	0.57	1.33
	Rice Starch	50	0.6	0.30	0.38	0.09	0.05	0.12
Fertilizer	Urea	97	44	42.68	54.11	0	0	0
	T.S.P	123	0	0	0.00	30	36.90	86.11
	Cow dung	467	1.6	7.47	9.47	0.5	2.34	5.46
Fry		0.2	8.1	0.02	0.03	2	0.00	0.00
Water supply		7088725	0.0002	14.18	17.98	0.00001	0.71	1.66
Rainfall		454000	0.00005	0.23	0.30	0.00002	0.09	0.21
Total inputs per cycle		7544041	63.5902	78.87	100%	34.00	42.85	100%
Outputs								
Shrimps	Harvested	350	3.26	11.41	14.63	0.3	1.05	2.10
	Mortality	74	3.26	2.41	3.09	0.9	0.67	1.34
Fish	Harvested	274	3.17	8.69	11.14	0.430	1.18	2.36
	Mortality	54	3.17	1.71	2.19	0.430	0.23	0.46
Crab	Harvested	90	3.10	2.80	3.60	0.52	0.47	0.94
Denitrification		0	0.000	6.70	8.60	0.000	0.000	0.00
Total nutrients removed		842	15.96	33.72	43.25	2.58	3.6	7.2
Water	Waste water	7088725	0.0002	14.18	18.18	0.00001	0.71	1.42
	Harvest drainage	2100	0.0006	0.01	0.01	0.00001	0.000	0.00
Total outputs in water				14.19	18.19		0.71	1.42
Stays in sediment				30.09	38.58		45.69	91.38
Total Output				78.00	100%		50.00	100

Table 9. Category wise Nutrient recycling (%) in the experimental ponds.

Pond types	**Total Nitrogen (mg/l) (Mean)**				**Total Phosphorus (mg/l) (Mean)**			
	Intake	**Outlet**	**Inlet**	**% of TN recycling**	**Intake**	**Outlet**	**Inlet**	**% of TP recycling**
Canal connected	2.98	2.67	2.62	1.68 %	0.623	0.60	0.59	1.60%
River connected	3.264	2.80	2.725	2.30%	0.643	0.56	0.59	4.67%
Pond connected	2.803	2.43	2.29	5.00%	0.59	0.51	0.54	5.08%

Among them *Lates calcarifer, Eleutheronema etradactylum and Oreochromis mossambicus* are the serious shrimp predator in the shrimp culture pond. So, the availability of fish, shrimp and crabs into the experimental ponds of present study indicated the contributor for good result of nutrient into the shrimp ponds. An average yield of 52 % of the total weight came from only Penaeus monodon, 19 % came from other same species (*P. inidcus*, *Metapenaeus monocerous* and *Metapenaeus brevicornis)* and the rest 29% came from brackish water fin fish (*Mugil Persia, M. corsula, Lates calcarifer, Mystus gulio, Oreochormis nilotica*, etc.) grown in conjunction with cultured shrimp. But by value, these fin fish contributed only 6 % of the total amount. Although not targeted for culture, but these fin fish provide a good contribution in terms of increasing yield and value to the farmers and specially when the farmers experienced was mortality of the cultured *P monodon* species due to disease (Alam, 2004).

In the present study, it was found that average intake of nutrients (TN 14.18 $kgcl^{-1}$ and TP 0.71 $kgcl^{-1}$) through supply water and discharged water (TN 14.19 $kgcl^{-1}$ and TP 0.71 $kgcl^{-1}$). So, it is clear that improved traditional shrimp culture not released higher amount of nutrients to the wider aquatic environment, rather acting as a nutrient removal from that system.

According to Edwards (1993), in extensive and semi-intensive systems, typically a major part of nitrogen and phosphorus is accumulated in the sediments. This also strongly supports the findings of the present study. 30.09 kg N and 45.69 kg P ha $cycle^{-1}$ accounts for 38.58 % of TN and 91.38 % of TP output ended up in sediments and unaccounted for. According to Islam *et al.* (2006) 10 % of nitrogen was estimated as unaccounted. Unaccounted nitrogen may have been trapped in the systems or lost through denitrification, ammonia volatilization and diffusion at high pH (Briggs and Funge-Smith, 1994) and seepage (Boyd, 1989). When calculating nitrogen budget for shrimp farms, denitrification and ammonia volatilization are two potential loses of nitrogen that are often not measured directly (Jackson *et al.*, 2003).

Conclusion and Recommendation

Nutrient enrichment, growth performance, water and soil quality and production of shrimp found very poor concentration in pond connected pond which practiced reused water from another shrimp pond. So, farmers must need to stop use reused water as a water sources for shrimp culture. Effective strategies to control the occurrence and spread of disease are primarily related to proper management of the production system. For the sustainable aquaculture use fertilizers only as needed to maintain phytoplankton blooms, Select stocking and feeding rates that do not exceed the assimilative capacity of pond, feeds should be of high quality, water stable, and contain no more nitrogen and phosphorus than necessary, do not use water exchange or reduce water exchange rates as much as possible, reuse water should be stopped for the water sources of shrimp culture, shrimp pond waste should be recycled to use in pond where possible.

Research finding of the present study suggest that the present level of coastal shrimp culture practice no longer risk of exceeding environmental capacity. The water quality in shrimp ponds and aquatic system during culture cycle in this experiment was also in acceptable range. Generally very few amount of feed (some ingredients) applied into the pond which provides nutrient is significantly lower, that results in the low aquaculture production. Because of less production and having less to no chance of environmental capacity degradation shrimp farms should be provided with adequate fertilizer and feed to increase shrimp production.

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