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An Overview on Sustainable Aqua-Farming Integration in the Mid Coastal Region of Bangladesh

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ABSTRACT

Present study was carried from during January 2013 to September 2013 to find out the aqua farming integration at farm in mid coastal region through assessing the level of integration, ecological context on sustainability, physico-chemical parameters of water and soil and socio-economic status of coastal people. Six integrated aqua farm has been selected for study. Data collection occurred through personal interview, semi-structured questionnaire and cross-check interview. Dominant farming systems and level of integration was identified and financial profitability of farming systems figured out for sustainable production. The main profit comes from fish production. Moreover, livestock, vegetables birds, poultry rising also contribute to the farm income. In the integrated system, many interrelationships were discovered such as crop byproducts were fed to animals, while fish and animal manures were returned to the crops and fish in the ponds. During the study period water quality parameters found in suitable ratios for aqua-farming and meteorological condition found in favor. Also, the salinity of the bottom soil ranged between 0.1-0.3 (ECe) (dS m^{-1}) and phosphorus value was between 1.0-4.0 (μg g^{-1} soil). A large number of middlemen are engaged in the production and marketing of farm products. More over these farms created opportunity of employment and economic growth for coastal people. The current study revealed that, the sustainable aqua farming integration should play a significant role in the people of mid coastal area if local people involve themselves with this integrating system by the help of government and non-government organizations.

Key words: Aqua-farming, level of integration, physico-chemical parameters, coastal area

INTRODUCTION

Hunger and malnutrition remain amongst the most devastating problems facing the world poor and needy (FAO., 2002). About 80-90 million people have to be fed yearly and most of them are in the developing countries. The most reliable source of protein for people who depend on fish is faced daily with the fear of food shortage (World Fish Centre, 2003). In view of this, integrated fish farming is a diversified and coordinated way of farming with fish as the main target along with other farm products (Ayinla, 2004). The items produced are to be used either as a source of feed, fertilizer or source of additional income (Chen, 1989). One of the appealing features of integrated farming is that it leads us to view farms in terms of interdependent components (Dalsgaard *et al*., 1995). Considering the integrated fish farming in the livelihood of every segment of the poor

population make provision of food, employment opportunities and recirculation of by-products for maximum utilization. Sustainable agriculture depends upon eco-friendly culture system for its survival (Dhawan and Karu, 2002). Currently, the farmers mainly practice mono farming or seasonal farming. Farming integration is needed where crop/fishery/livestock integration are inter dependent of each other. Fish-livestock production in combination with planted crops on pond dykes could be a workable pattern of an integrated system. Based on geo-morphological condition and hydrological features, Noakhali, Laxmipur and Chandpur district cover the mid coastal region of Bangladesh. These coastal communities face multiple vulnerabilities more varied and more intensive than other communities of the other parts. The local people are very prone to climate change, so it is essential for them to adapt themselves with such situation. Thus, there is the need for a suitable aquaculture system to meet this increasing demand and also maximize the utilization of the available limited resources without much wastage integrated fish farming offers hope in this direction. This research critically reviews the economic and ecological benefit of integrated fish farming. The main objectives of this research are:

- To find out the level of integration at farm
- Ecological context on sustainability at the farm site
- To examine the physico-chemical parameters of water and soil in the selected area
- Socio-economic status of that people who are related to sustainable aqua-farming integration

MATERIALS AND METHODS

Site selection: The present study was conducted in the mid-coastal region of Bangladesh where six selected integrated aqua farm at namely, Suborno Agro Based Initiative (SABI), Bismillah Agro Production (BAP), Jolpuri Agro Fisheries (JAF), Kaderia Agro (KA), Southern Agro (SA) and Bangla Bazar Agro Fisheries (BAF). The work was carried out during January 2013 to September 2013.

Data collection: The current study was done through personal interview and integrated aqua farm survey by semi structured questionnaire where, Mahmud and Mamun (2012) used the same materials and methods. Meteorological data were collected through cross-check interviews. The surface water sample was collected directly from the undisturbed surface of each farm's pond. The sample was usually collected 6 inches below the water surface. The sampling pot was dipped into water for filling and immediately sealed under water. Water temperature was taken monthly by the digital thermometer. Dissolved oxygen was estimated by HANNA Instruments HI 9146 Portable Water proof Microprocessor Dissolve Oxygen Meter with the range 0.00 to 45 mg L^{-1} O_2. The pH ware measure by HANNNA Instruments pHep HI 96107 Pocket sized pH meter. Hardness was measured by HANNA Instrument HI 3812 Portable Hardness Test Kit with the range of 0.0-30.0 mg L^{-1} (ppm) $CaCO_3$ and 0.0-300 mg L^{-1} (ppm) $CaCO_3$. Alkalinity was measured by HANNA Instrument HI 3811 Portable Alkalinity Test Kit with the range of 0.0-100.0 mg L^{-1} (ppm) $CaCO_3$ and 0.0-300 mg L^{-1} (ppm) $CaCO_3$. TDS was taken by the Portable digital TDS meter (HANNA-DiST 1; H108301). Water salinity was taken by the portable Refractometer. The pH of the soil measured with HANNA HI 9210N ATC pH Meter and the contents of K of the soil extract were measured by using a flame photometer. The contents of P and S in the soil were measured by using a Spectrophotometer.

Data processing and analysis: The collected data were summarized and scrutinized carefully and recorded. Finally relevant tables were prepared in accordance with the objectives of the study. Data presented mostly in the tabular form because it is simple in calculation, widely used and easy to understand. Microsoft word and Microsoft excel were used for data analysis and for chart, graph and diagram preparation.

RESULT

Cultured fish in integrated farm: During the investigation, 20 species were found in culture in the six farm's pond. The most common cultured species are *Catla catla* (Catla), *Labeo rohita* (Rui), *Labeo calbasu* (Kalibaus) and *Cirrhinus mrigala* (Mrigal), whereas 7 exotic fishes were found (Table 1). Only in Banglabazar Agro cultures cat fishes and fish production in the year 2012-13 (Table 2).

Livestock: Among the six investigated farms SABI, Bismilla, Southern, Banglabazar and Jolpuri Agro rearing livestock e.g., cows with the combination of fish production (Table 3). Number of the

Table 1: Fish species found in six integrated farm's pond

Species (scientific name)	English name	Local name
Channa striatas	Stripped snakehead murrel	Shol
Channa punctatus	Spotted snakehead	Taki
Amblypharyngodon mola	Mola carplet	Mola
Aristichthys nobilis	Bighead carp	Bighead carp
Barbonemus gonionotus	Silver barb	Thai sarputi
Catla catla	Catla	Catla
Cirrhinus mrigala	Mrigal	Mrigal
Ctenopharyngodon idella	Grass carp	Grass carp
Cyprinus carpio	Common carp	Common carp
Hypopthalmichthys molitrix	Silver carp	Silver carp
Labeo rohita	Rohu	Rui
Labeo calbasu	Orangefin labeo	Kalibaus
Puntius ticto	Ticto barb	Tit punti
Puntius sophore	Spotfin swamp barb	Jat punti
Clarias batrachus	Walking catfish	Magur
Heteropneustes fossilis	Stinging catfish	Shing
Pangasius pangasius	Thai pangus	Thai pangus
Oreochromis mossambicus	Mozambique tilapia	Tilapia
Anabus testudinus	Climbing perch	Koi
Colisa fasciatus	Giant gourami	Khailsha

Table 2: Fish production in integrated farm in the year of 2012-2013

	Monoculture-monosex tilapia	Poly culture-carps	Other cat fish
Farm name	(tons/season)		
SABI	8	12	
BAP	15	10	
SA	11	10	
JAF	3	5	
KA	12	8	
BAF			6-7

Table 3: Number of livestock in six different farms and their daily production

Farm name	Number of cows	Daily milk production (L)	Price in BDT (kg L^{-1})
SABI	60	200	50.0
BAP	36	80	50.0
BAF	15	25	50.0
SA	12	10	50.0
JAF	06	6-7	50.0

Table 4: Vegetables production found in six

Vegetables name	Local name
Cucumber	Sosa
Yard long bean	Borboti
Okra	Dheros
Bitter gourd	Tita korola
Sweet gourd	Misti kumra
Indian spinach	Puisakh
Maize	Vutta
Kangkong	kolmisakh
Red amaranth	Lal sakh
Country bean	Seim
Bottle gourd	Lau
Snake gourd	Chichiga
Ginger	Ada
Taro	Olkochu

livestock in the farms varies from each other. Livestock was the capital investment in SABI and Bismillah. They give birth of offspring and added benefit to the farm capital. Besides selling of milk daily farm generates extra profit.

Poultry: Among the six investigated farms Bismilla, Southern and Kaderia Agro Fisheries rearing poultry e.g., broiler, layer and duck with the combination of fish production. These three practiced poultry rising because of considering consumer's preference and local price structure, only three types of poultry farming is economically viable:

- Chicken egg production
- Duck egg production
- Chicken meat (broiler) production in selected places

Bismilla and Southern Agro raising only broiler chicken while Kaderia Agro raising duck. These farms run poultry as a cycle. Thirty days is count as a cycle. After 30 days raising poultry are sold.

Vegetables and birds: Vegetables were a major component of the integrated farm. The investigated six farms provide an essential and extra care to the vegetables production. The farm generates profit by producing seasonal and all year round vegetables (Table 4).

Among these investigated farms, Bismilla and Kaderia Agro reared birds specially pigeon with the combination of fish production. These two farms firstly higher species of pigeon offspring and raising them and sold them at high price.

Table 5: Level of integration at selected farm

Name of the farm and cost-benefit	Fish	Livestock	Poultry	Birds (pigeon)	Vegetables
Bismilla agro production					
Investment (BDT)	796400	1400000	950520	34000	150000
Return (BDT)	1320000	1875000	1400000	270000	350000
Total benefit (BDT)	523000	475000	449480	236000	200000
Level of integration (%)	28	25	24	12	11
Southern agro					
Investment (BDT)	1204300	700000	550210	0	200000
Return (BDT)	1820000	975000	950210	0	375000
Total benefit (BDT)	615700	275000	400000	0	175000
Level of integration (%)	44	24	23	0	9
Jolpuri agro fisheries					
Investment (BDT)	900000	300000	0	0	200000
Return (BDT)	1450000	395000	0	0	350000
Total benefit (BDT)	550000	95000	0	0	150000
Level of integration (%)	69	12	0	0	19
Suborno agro based					
Investment (BDT)	1500000	3000000	0	0	50000
Return (BDT)	2300000	3750000	0	0	105000
Initiative (SABI)					
Total benefit (BDT)	800000	750000	0	0	55000
Level of integration (%)	50	47	0	0	3
Bangla bazar agro fisheries					
Investment (BDT)	195000	550000	0	0	150000
Return (BDT)	500500	715000	0	0	350000
Total benefit (BDT)	305500	165000	0	0	200000
Level of integration (%)	69	12	0	0	19
Kaderia agro					
Investment (BDT)	550725	0	400000	150000	100000
Return (BDT)	950865	0	650000	370000	220000
Total benefit (BDT)	400000	0	250000	220000	120000
Level of integration (%)	41	0	25	22	12

Level of integration: SABI is an integrated farm in where level of integration largely depends on fish and livestock. About 50% of its return on investment comes from fish, 47% comes from livestock and 3% comes from vegetables production (Table 5).

Ecological context of sustainability: Sustainable agriculture depends upon eco-friendly culture system for its survival. One of the appealing features of the investigated integrated farm is that it leads us to view farms in terms of interdependent components. In the integrated system, the interrelationships are many; crop byproducts are fed to animals, while fish and animal manures are returned to the crops and fish in the ponds. The fish fed on insects and weed in the rice field planted inside the pond and this in turn can increase the available nutrients to the crop. The ecological efficiency of an integrated fish farm is very paramount to the success of the entire farming enterprise, this is discussed below.

Water quality parameters in integrated farms: During the study period the water quality of the six farms pond was examined (Table 6). The water depths of the six integrated fish farm pond were different slightly. The depth of nursery pond found 2-3 feet and the grow-out pond depth found 3-8 feet.

Table 6: Average water quality parameters in integrated farms

Parameters	SABI	BAP	SA	JAF	KA	BAF
DO (ppm)	4.55	4.25	4.10	3.57	3.95	4.30
pH	6.70	7.20	8.83	6.50	6.80	7.50
Hardness (ppm)	26.12	26.50	25.25	24.85	26.97	24.08
Temperature (°C)	33.11	32.82	32.95	33.25	34.47	34.12
Salinity (ppt)	0.00	0.00	0.00	0.00	0.00	0.00

Table 7: Nutritional properties of the bottom mud of fish soil during dry seasons (October to December 13)

Name of the farm	pH	Salinity (Ece) (dS m^{-1})	Phosphorus (µg g^{-1} soil)	Sulphar (µg g^{-1} soil)	Potassium (mL/100 g)
SABI	6.9	0.1	1.0	135	0.24
BAP	7.5	0.1	2.0	70	0.21
JAF	5.8	0.2	2.0	77	0.22
SA	8.1	0.3	4.0	63	0.33
KA	6.8	0.1	1.0	45	0.22
BAF	7.3	0.1	2.0	59	0.27

Table 8: Monthly average meteorological record of mid coastal region has been collected from Bangladesh Meteorology Department (BMD) (2013, up to September)

Month (2013)	Temperature (°C)	Rainfall (mm)	Humidity (average)	Sunshine (h)
January	19.02	0.00	82.25	5.96
February	23.25	0.40	77.16	6.64
March	27.14	4.25	75.57	7.23
April	30.78	8.36	81.17	8.12
May	30.53	32.24	82.25	6.25
June	30.57	205.16	83.13	4.56
July	29.60	180.65	84.52	5.37
August	29.36	137.85	87.56	3.12
September	28.23	50.67	86.76	6.40

Nutritional properties of soil: Soil salinity is one of the major factors determining land use and land productivity in the fish culture pond. Soil salinity and its annual cycle, annual cycle spatial variation and long term trend determine the agriculture product. Accordingly to my observation the salinity of the bottom soil ranged between 0.1-0.3 (Ec) (dS m^{-1}) (Table 7). Which relatively low and has no adverse effects on the soil and water productivity. The ideal pH range for soils is 6-8 (BAFRU, 1990).

Meteorological status in mid coastal region of Bangladesh: Rainfall varies from place to place, year to year and season to season. Rainfall influences the amount of water in fish pond. Also precipitation falling on the land may become runoff. As runoff it dissolves various substances that may affect the water used for aquaculture. Rainfall affects runoff pollution from land, the temperature, pH and the total dissolved solids of surface water. Higher average rainfall was found in July and dry season was indicated with no rain fall, the January, 2013 (Table 8).

Socio-economical contribution of the integrated farm: People in the study area are mainly poor. Their main occupation is agriculture, fishing and business. As the investigated integrated farm create opportunities for the local people to engage in the farm production and mitigates their nutritional demands. A large number of middlemen, farmers approximately two thousands are engaged in the production and marketing of farm products.

DISCUSSION

A number of studies were conducted in the 1989s to test the technical and environmental feasibility of integrated fish farming in Nigeria to investigate economic and ecological efficiency (Huazhu and Baotony, 1989). Study revealed that the production of fishes in six different farms has got no variation. Although the management practice and surrounding environment were more or less similar for all farm. Excessive aquatic vegetation might also cause of low fish production. Apart from that these presence of aquatic weed might be food supply for the herbivorous species.

CONCLUSION

Climate change stresses will have complex pressure on fisheries and aquaculture and threatened the fish production and livelihood of the communities. Noakhali, Lakshmipur and Chandpur as mid-coastal region, coastal habitats and resources are likely to be impacted through natural calamities, where extremes of nutrient enrichment and invasive species. Coastal fishing communities face a double exposure of reduced fisheries resources and increased risks of coastal flooding and storm surges. It is clear from present investigation and field experiences that the socio-ecological context of integrated fish farming plays a major role not only for food security but also for ecological context.

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