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Improved Extensive Shrimp Farming Uplifted Yield of Coastal Ghers in Southwest Bangladesh

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Abstract

Shrimp is known as the white gold of Bangladesh because it is the second highest foreign currency earning source and 97% of the produced shrimp being exported. The present study is the report on the assessment of culture status of extensive shrimp ghers and intervention for increasing production of black tiger shrimp (*Penaeus monodon*) in traditional gher system. The study was conducted at three different ghers in the south-west coastal region of Khulna district where multiple stocking (six successive stocking) and multiple harvesting was practiced during new-moon and full-moon period. Very lower production were recorded in extensive ghers 364.61 kg/ha, 380.31 kg/ha and 278.4 kg/ha in gher-1, gher-2 and gher-3 respectively in 2014. Hence, some little interventions like increasing gher depth, liming and use of PCR tested post larvae (PL) were taken to uplift the production. Interestingly, after 180 days of rearing, the average weight of shrimp was increased and the recorded production was 497.52 kg/ha, 435.44 kg/ha and 480.99 kg/ha in gher-1, gher-2 and gher-3 respectively in 2015 which increased alike in 2016 (680 kg/ha, 512 kg/ha and 466 kg/ha respectively). A strong correlation were found between temperature and production (R^2 = 0.7055) and moderate correlation were found between production and depth (R^2 = 0.456) that ultimately plays significant role on average production of shrimp. So, our research findings suggests that, the production of shrimp (*P. monodon*) can be increased significantly by improving the management practices in extensive shrimp ghers.

Keywords: Bangladesh; Depth; Dolomite; Extensive; Intervention; Shrimp.

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1. Introduction

Shrimp (*Penaeus monodon*) culture is an important economic activity in Bangladesh. About 275583 ha lands are used for shrimp culture in the coastal areas of the country [1]. Shrimp aquaculture contributes 5% of national GDP in Bangladesh and nearly 8.5 million people of coastal areas depend tirelessly on this sector for their livelihood [2]. Farmers in Bangladesh are mainly practiced two types of shrimp culture systems, extensive traditional and improved traditional with various stocking densities and different degrees of management [3]. Above 90% of the overall farms still practice extensive or traditional system. This culture practice is characterized by a larger sized gher with extreme lower depth, low stocking density, no feeding and fertilization and poor management of water quality. Though Bangladesh earns significant amount of foreign currency by exporting shrimp and lion share of this earning comes from culture sector but shrimp production per unit area in Bangladesh is still one of the lowest in compared to other shrimp growing countries in the world [4]. The present rate of overall shrimp production in Bangladesh is around 811.0 kg/ha [5] but in traditional gher culture system it is still lower 300.0 kg/ha [6]. This low production is due to the invasion of bacterial and viral diseases, improper management and low primary productivity of the ghers. Throughout the south-west coastal area, bacterial and viral disease spread is in epidemic form which causes massive production losses in shrimp of Bangladesh [7]. The causative agent of the diseases are *Vibrio parahaemolyticus*, white spot syndrome virus, white spot baculovirus etc [7-8]. It is suspected that any type of disease is generally caused due to degradation of environmental factors i.e., poor management causing low primary productivity of the gher ecosystem. The depth of shrimp ghers is very low (av. 30 cm) with very poor productivity in the southwest Bangladesh. As a result, different filamentous algae and aquatic weeds densely grow in ghers which decreases the overall production. Most of the shrimp farmers in this country are poor and illiterate. The marginal poor farmers of the coastal areas are not capable of producing shrimp using high tech shrimp culture, which involves high investment and skilled technicians for intensive management. Besides, most of the ghers are dependent on other ghers for water inlet. These ghers are not suitable for production of shrimp using high tech production system. Good management practices have a great influence on production of shrimp in different culture system of Paikgacha Upazila [9]. Individual shrimp ghers with small culture units incorporating better management practices can improve production of shrimp (*P. monodon*) [10]. In this context, the present experiment had been conducted with the aim of improving productivity of shrimp ghers through little cultural interventions (increase of pond depth, soil and water liming, stocking of PCR tested seed etc) within their capabilities.

2. Materials and Methods

2.1 Study Location and Duration

Three traditional farmers' ghers from three different locations of Paikgacha upazila, Khulna were selected for this study. The locations of gher-1, gher-2 and gher-3 were Bandikathi, Sorole and Betbunia respectively. Total area of the study ghers were (5000, 3960 and 6050) m^2 respectively. For water supply all three ghers depends on the surrounding canal connected with river. The study was conducted for three successive years of 2014, 2015 and 2016 with a rearing period of 180 days each.

2.2 Culture status of shrimp ghers before intervention

During the first year survey period (2013-14) the production and culture practices including ghers preparation and application of different inputs by the farmers were being observed closely and recorded. The collected information is presented in Table 1.

Table 1: Preparation of traditional extensive ghers and stocking of shrimp before interventions of improved management practices by the farmers in 2013-14.

Particulars	*Gher* -1	*Gher*- 2	*Gher*- 3
Pond drying	Dried	Dried	Dried
Water depth (cm)	45-58	48-55	45-55
Soil liming	60 kg/ha CaO	75 kg/ha CaO	120 kg/ha CaO
	Cowdung: 300kg/ha		TSP: 25 kg/ha
Soil fertilization (During *gher* preparation)	TSP: 18 kg/ha	No	Urea: 25 kg/ha
	Urea:18 kg/ha		MOC: 20 kg/ha
Killing of predatory fish	No	No	No
Water liming	No	No	No
Water fertilization	No	No	No
PCR tested PL	No	No	No
	1st : 2/m^2	1st : 2/m^2	1st : 2 /m^2
	2nd : 1/m^2	2nd : 2/m^2	2nd : 2/ m^2
Stocking density (No/m^2)	3rd : 2/m^2	3rd : 2/m^2	3rd : 2/ m^2
(Multiple stocking)	4th : 1/m^2	4th : 2/m^2	4th : 2/ m^2
	5th : 2/m^2	5th : 2/m^2	5th : 2/m^2
	6th : 2/m^2	6th : 2/m^2	6th : 2/m^2

2.3 Intervention for increasing production of shrimp in extensive system

During 2014-15 and 2015-16, the culture practices were improved with the following interventions in the traditional culture system (a) Increasing pond depth: Pond was re-excavated for increasing depth to observe the impact on production. (b) Soil and water liming: Soil of the ghers was treated with CaO @ 250 kg/ha and water was limed with $CaMg(CO_3)_2$ (dolomite) @ 15 ppm. (c) Killing of predatory fishes: After water intake, rotenone was applied @ 2 ppm to kill predatory and weed fishes. (d) Stocking of PCR tested PL: PCR tested PL was purchased from WorldFish Center and supplied to the farmers to stock in the gher. (e) In-pond nursing of PL: A nursery was constructed at one corner of each gher encircling 50-60 m^2 areas by nylon net fastened in bamboo frame. During each stocking, shrimp PL was stocked in the nursery and reared for 15 days before releasing into the ghers. In the nursery, PL was fed with CP nursery feed (Code-2001) two times daily. (f) Pond management: Growth of aquatic weeds was controlled by manual eradication. Water of the ghers was exchanged between low-tide and high-tide period wherever necessary. No feed is used for rearing of shrimp.

2.4 Hydrographical parameters

The water quality parameters were analyzed as pH by digital pH meter, turbidity/transparency by Secchi disc [11], temperature recorded by using mercury thermometer and salinity by using refractometer [12] and dissolved oxygen (DO meter, model DO 175, Hach) were measured fortnightly. The alkalinity and inorganic nutrients (ammonia, nitrate and phosphate) of three selected ghers were determined using water quality parameters analyzing kit according to the manufacturer's protocol.

2.5 Biological characteristics of water

Qualitative and quantitative analysis of both phytoplankton and zooplankton were done following drop count method [13]. Identification of plankton was made following [14-15].

2.6 Harvesting of shrimp

After 70 days of 1st stocking, selected/multiple harvesting of shrimps was done in every new and full moon period by trapping method. Data of each catch was recorded and total production was calculated through summation of each catch.

2.7 Data analysis

The collected data and information has been statistically analyzed with MS Excel and presented as figures and tables to express the research findings in a meaningful way.

3. Results

3.1 Hydrographical parameters

The hydrographical parameters of the selected ghers are furnished in Table 2 and Table 3. There were found a slight variation in fluctuation of temperature among the ghers and was slightly higher than the suitable range for growth of shrimp [16-18]. Interestingly, water temperature was slightly higher in first year surveyed ghers (29-34)℃ having low depth in contrast to following two years (26-30)℃. The salinity level in different ghers varied from (9-22) ppt which were favorable for the growth of shrimp as mentioned by [19] that the optimum range of salinity for *P. monodon* farming would be 10 ppt to 25 ppt.

Table 2: Hydrographical parameters of selected ghers before interventions

Year	**2013-14**		
Parameters	***Gher*- 1**	***Gher*- 2**	***Gher*- 3**
Depth (cm)	46-58	48-55	52-58
Temperature (℃)	31-33	29-34	30-33
Salinity (ppt)	10-17	14-18	09-17
Transparency (cm)	30-35	36-40	32-43
pH	8.5-9.2	7.5-8.1	8.4-8.9
Alkalinity (mg/l)	140-160	152-160	180-220
Dissolved oxygen (mg/l)	4.3-5.0	4.4-4.53	4.0-5.90

Table 3: Hydrographical parameters of selected ghers after interventions

Years	**2014-15**	**2015-16**	**2014-15**	**2015-16**	**2014-15**	**2015-16**
Parameters	***Gher*- 1**	***Gher*- 1**	***Gher*- 2**	***Gher*- 2**	***Gher*- 3**	***Gher*- 3**
Depth (cm)	68-75	85-90	70-75	82-90	70-75	78-90
Temperature (℃)	26-30	26-28	27-29	26-29	26-30	27-30
Salinity (ppt)	10-17	12-19	09-18	13-20	09-18	14-22
Transparency (cm)	30-35	27-41	35-42	36-40	32-43	33-45
pH	8.5-9.2	7.4-8.4	8.2-9.0	7.5-8.1	8.4-8.9	7.7-8.5
Alkalinity (mg/l)	140-160	146-154	180-240	152-160	180-220	174-238
Dissolved oxygen (mg/l)	4.9-5.88	4.70-5.91	4.76-6.12	5.44-6.53	4.4-5.87	4.16- 6.34

3.2 Biological characteristics of water

Most common phytoplanktons were observed like *Scenedesmus*, *Cyclotella*, *Coscinodiscus*, *Spirulina* and *Synedra* spp. Among the zooplanktons there were rotifers, nauplius larvae, cladocerans and copepods etc. The quantity of phytoplankton and zooplankton of the selected ghers are presented in Table 4.

Table 4: Biological characteristics of the selected ghers during the culture period

Year	**2014-15**		
Plankton	***Gher* 1**	***Gher* 2**	***Gher* 3**
Phytoplankton (No./L)	2.4×10^3-3.5×10^3	2.2×10^3-2.5×10^3	2.5×10^3-3.3×10^3
Zooplankton (No./L)	0.5×10^2-1.2×10^3	0.4×10^3-1.1×10^3	0.42×10^3-0.90×10^3
	2015-16		
Phytoplankton (No./L)	2.7×10^3-3.9×10^3	2.2×10^3-2.7×10^3	3.2×10^3-7.1×10^3
Zooplankton (No./L)	0.3×10^3-1.1×10^3	0.4×10^3-0.9×10^3	0.5×10^3-1.2×10^3

3.3 Production scenario of shrimp

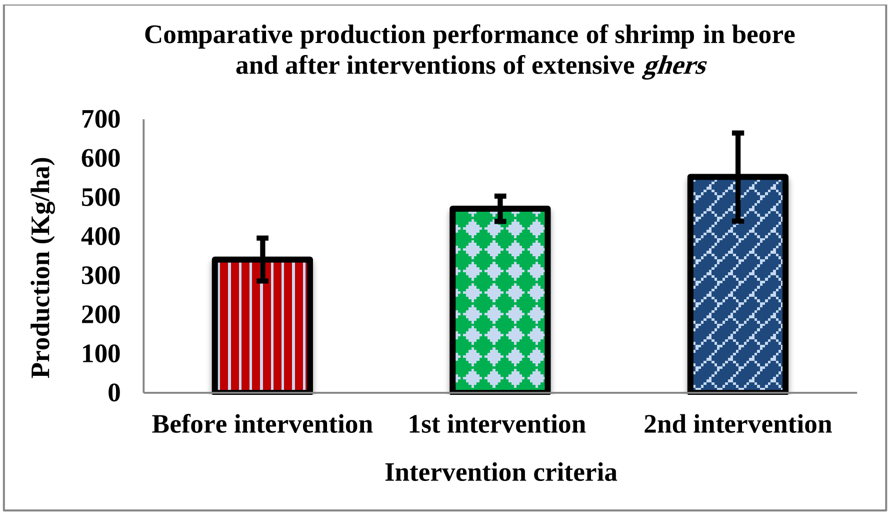

Figure 1: Production (Kg/ha) of shrimp from three ghers of three successive years

Production performance of shrimp in three experimental ghers has been depicted in Figure 1. After 70 days of 1st stocking, selected (multiple) harvesting of shrimps was done in every new and full moon period by trapping method up to 180 days of rearing. Total harvest was higher than the traditional extensive culture practices.

3.4 Relationship of production with depth, temperature

From our practical experience in field we have seen that temperature was relatively lower in gher having higher water depth than the lower water depth. Our statistical data represent that, although there is no strong correlation between production and depth (R^2 = 0.456) but a moderate correlation was found. Thus water depth has some positive effect on production level that was marked (figure 2) optimum at 82 cm depth which ultimately influence on water temperature.

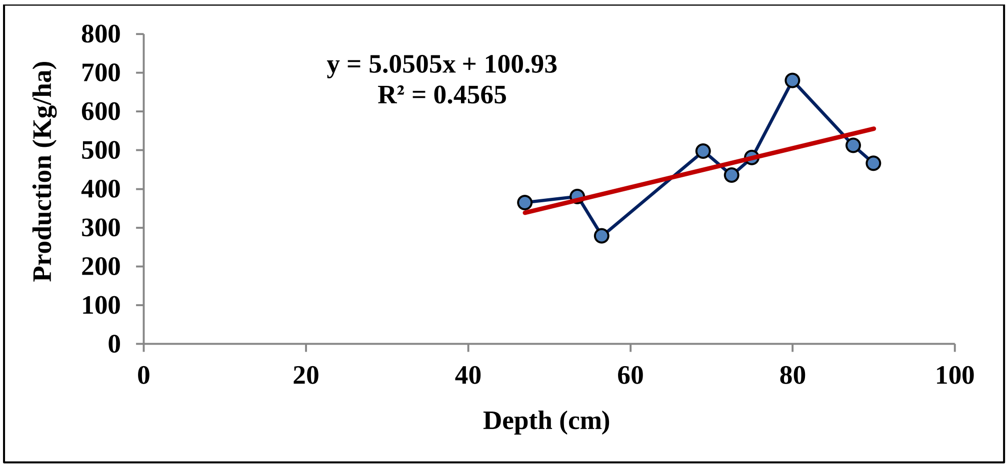

Figure 2: Relationship of production and depth

Higher production was obtained at 27 ℃ (Figure 3) reflecting a strong correlation between production and temperature with a R^2 value of 0.7055 which implies that temperature might have significant effect on average production.

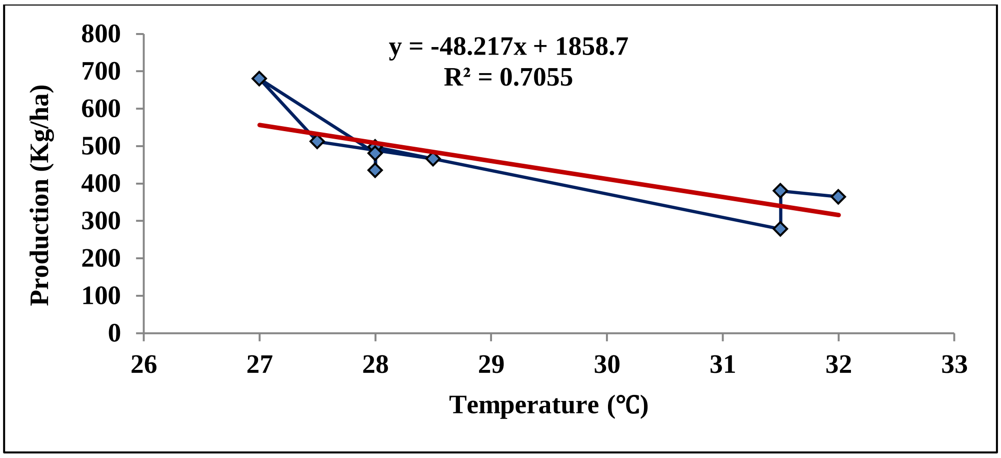

Figure 3: Relationship of production and temperature

4. Discussion

The optimum range of water pH for shrimp culture is 7-9 [20]. Besides several authors have reported a wide variation in pH 7.5-9.2 [21] and 7.68-8.35 [22] in shrimp farms and found the ranges favorable for shrimp culture. Hence, pH values in all the shrimp ghers were observed within these ranges. The transparency is mainly depends on the presence of phytoplankton population. The secchi disc reading should be 30-40 cm [23] observed 30-50 cm for his study whereas the transparency of present study was between the ranges of 27-45 cm. The recorded alkalinity of the selected ghers was between the ranges of 140-240 mg/l which is closely similar as [24]. DO is considered as one of the crucial factor for shrimp culture [25-26]. The DO level of the experimental ghers varied between 4.0-5.90 mg/l before interventions and 4.4-6.53 mg/l whereas [27-28] considered 4-8 ppm of DO as favorable range for shrimp culture and [29] reported that dissolved oxygen content of a shrimp farm should be >4.0 mg/I. We observed that, DO level was little bit higher in ghers with lower water temperature after increasing depth. These results are closely consistent with the report of [30] where he mentioned water with higher temperature holds less oxygen than cooler water. During 1st interventions the production was (497.52 kg/ha) in gher-1, (435.44 kg/ha) in gher-2 and (480.99 kg/ha) in gher-3. Meanwhile production of shrimp in gher-1 (680 kg/ha) was highest than those of gher-2 (512 kg/ha) and gher-3 (466 kg/ha) in 2014-15. These findings are closely consistent with the findings of [9, 24, 31]. So, our findings implied that after interventions in the extensive ghers the total production of shrimp can be increased in a significant rate than the traditional culture practice. Temperature is one of the critical physical modifiers that influence on energy flow, growth and biological effects in marine organisms [32]. Defective production will be occurred when the water temperature falls out of optimum temperature range for significant epoch [33]. Reference [34] suggested that temperature optima is >30℃ for small shrimp (<5 g) while for large shrimp; the optimum temperature is about 27℃, similarly shrimp yield was found increased in pond between 26 and 28℃ temperature and yield was impaired when temperature was above 33℃ [35]. The optimum temperature range of both shrimp and prawn found at 28-30℃ [36-37]. In the present study, water temperature was remaining under optimum ranged. A significantly best survival and growth of *Penaeus vannamei* between 28-30℃ temperatures was observed by [38] which is interestingly coincide with our results. Similarly, higher production was obtained at 27℃ (Figure 3) reflecting a strong correlation between temperature and production with a R^2 value of 0.7055 which implies that temperature may have significant effect on average production. The collected data from DO level, temperature and depth reflecting that, they are firmly co-related each other.

5. Limitations of the study

The number of experimental ghers were only three (03). Therefore, it is difficult to draw a robust conclusion based on this limited number of ghers. Thus more ghers need to be covered to make a concreate conclusion about production of extensive and improved extensive shrimp ghers in coastal regions of Bangladesh. PCR tested PL were insufficient to stock in the experimental ghers. If sufficient PCR tested PL were found then it might be possible to overcome the production losses due to disease outbreak like WSSV and AHPND thus the overall shrimp production could be increased. In this study physicochemical characteristics of sediment sample were not assessed due to lack of facilities.

6. Conclusion

Before intervention, the average gher depth were very low and farm owner's faces excessive water crisis and rapid fluctuations of water quality parameters occurred during heavy rain leading shrimp death. After intervention, the production of shrimp was higher than the previous year because of increasing gher depth, use of PCR tested PL and also for the improvement of other management practices. The present work suggests that the production of shrimp (*P. monodon*) can be increased significantly by improving the management practices in extensive traditional shrimp ghers.

7. Recommendations

It is vividly clear that, a little improvement of management practices in extensive shrimp ghers can increase the production at a great scale. As the farmers are habituated in traditional extensive farming so they need to be trained up to improve the old extensive farming practices.

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References

[1]. Department of Fisheries (2015) National Fish Week 2015 Compendium. Department of Fisheries, Ministry of Fisheries and Livestock, People's Republic of Bangladesh.

[2]. Department of Fisheries (2013) National Fish Week 2013 Compendium. Department of Fisheries, Ministry of Fisheries and Livestock, People's Republic of Bangladesh.

[3]. Karim MR. "Present status and strategies for future development of shrimp farming in Bangladesh," in Proc. BAU- NORAD, 2003, pp. 1-8.

[4]. Braten B. "Environmental impacts and socio-economic problems of shrimp farming in various countries," presented at the workshop on environmental and socioeconomic impacts of shrimp farming

in Bangladesh held at BAU, Mymensingh 2001.

[5]. Department of Fisheries (2016) National Fish Week 2016 Compendium. Department of Fisheries, Ministry of Fisheries and Livestock, People's Republic of Bangladesh.

[6]. Parvez S. "New shrimp farming system to boost yields" The Daily Star (Apr. 20, 2015), sec. A p.1.

[7]. Ahmmed S, Khan MAAK, Eshik MME, et al. (2019) "Genomic and evolutionary features of two AHPND positive Vibrio parahaemolyticus strains isolated from shrimp (Penaeus monodon) of south-west Bangladesh." BMC Microbiology, vol. 19, 270.

[8]. Flegel TW (2006) "Detection of major penaeid shrimp viruses in Asia, a historical perspective with emphasis on Thailand." Aquaculture 258: 1–33.

[9]. Washim MMR (2014) "Studies on the production, disease management and marketing of shrimp (Penaeus monodon) in some shrimp cluster areas of Paikgachha sub-districts (upazila) in Khulna," a thesis submitted to department of Fisheries Technology, BAU.

[10]. Wahab MA, Bergheim A and Braaten B (2003) "Water quality and partial mass budget in extensive shrimp ponds in Bangladesh." Aquaculture 218: 413–423.

[11]. Coche AG and Muir JF (1996) "Management for freshwater fish culture." Simple methods for aquaculture 21, FAO, Training Series.p233.

[12]. Zafar MA, Haque MM, Aziz MSB and Alam MM (2015) "Study on water and soil quality parameters of shrimp and prawn farming in the Central west region of Bangladesh." J. Bangladesh Agril. Univ. 13(1), 153–160

[13]. APHA (American Public Health Association) (1998) "American Water Works Association, Water Pollution Control Federation". Standard Methods for the Examination of Water and Wastewater. 20th ed., Washington, DC, USA.

[14]. Ward HB and Whipple GC (1959) "Freshwater Biology" 2nd edition, John Wiley and Sons, Incorporated, New York, 1248p.

[15]. Presecot, G.W. 1962. "Algae of the Western Great Lakes Area". Revised. Ed W. M. C. Brown Company, 135 South locust street, Dubuque, Iowa, 977pp.

[16]. Fast AW, Carpenter KE, Estilo VJ, Gonzales HJ. (1988) "Effects of water depth and artificial mixing on dynamics of Philippines brackishwater shrimp ponds". Aquacultural engineering. 1;7(5):349-61.

[17]. Apud FD, 1989. "Recent development in prawn culture." Aquaculture extension Pamphlet No.1, Aquaculture Department, SEAFDEC, Tibauan, Iloilo, Philippines, 24 pp.

[18]. Latif MA and MM Islam, 1995. "Improved polyculture of shrimp and mullet. In: Fisheries Development Technology." A fish fortnight compendium. Fisheries Research Institute, Mymensingh. 15-22 pp.

[19]. Chiu YN, 1988. "Site selection for intensive prawn farms. In: Technical Consideration for the Management and Operation of Intensive Prawn Farms." edited by Y.N. Chiu, L.M. Santos and R.O. Juliano, U.P. Aquaculture Society, Iioilo city, the Philippines, PP. 25-28.

[20]. Boyd CE and AW Fast, 1992. Pond monitoring and management. In: Marine Shrimp Culture: Principles and Practices, edited by A. W. Fast and L. J. Lester Elsevier, Amsterdam, PP. 497-508.

[21]. Hoq ME, 2002. Studies on mangrove fisheries resources of Sundarbans, its exploitation and utilization. Ph. D. Dissertation, Dept. of Fisheries Technology, Faculty of Fisheries, Bangladesh Agricultural

University, Mymensingh, 95-124 pp.

[22]. Shofiquzzoha AFM, ML Islam and SU Ahmed, 2001. “Optimization of stocking rates of shrimp (Penaeus monodon) with brackishwater finfish in a polyculture system.” J. Bio. Sci., 1 (8): 694-697.

[23]. Ramakrishnareddy, 2000. “Culture of the tiger shrimp Penaeus monodon (Fabricus) in low saline waters.” M.Sc., dissertation, Annamalai 2 University, pp: 31.

[24]. Debnath PP, M Karim and QAZ M Kudrat-E-Kabir. 2013. “Comparative Study on Growth Performance of Bagda (P. monodon, Fabricius, 1798) in Traditional and Semi-intensive Culture Systems.” Science and Technology 3(1): 1-16

[25]. Lin YC and Chen JC, 2003. “Acute toxicity of nitrite on Litopenaeus vannamei (Boone) juveniles at different salinity levels.” Aquaculture 224:193-201.

[26]. Cobo ML, Sonnenholzner S, Wille M, Sorgeloos P. 2014. “Ammonia tolerance of Litopenaeus vannamei (Boone) larvae.” Aquaculture Research 45:470-475.

[27]. Banerjea SM 1967. “Water quality and soil condition of fish ponds in some state of India in relation to fish production.” Ind. J. Fish., 14: 114-144.

[28]. Pakrasi BB 1978. “Ecology of brackishwater ponds.” In: Training in Brackishwater prawn and fish farming, held at Kakdwip Res. Cen. 30: 13-16.

[29]. Zhang P, X Zang and G Huang, 2006. “The effects of body weight, temperature, salinity, pH, light intensity and feeding condition on lethal DO levels of white leg shrimp, Litpenaeus vannamei (Boone, 1931).” Aquaculture, 256: 579-587.

[30]. Higgins P 2013. “Dissolved Oxygen Management and Related Costs in Pond Aquaculture.” https://www.ysi.com/ysi-blog/water. (Accessed on 29/11/2017)

[31]. Chandra KJ, Chowdhury and DR Das, 2010. “Shrimp Culture Practices at Farmers’ Level in Bagerhat District.” Journal of Progressive Agriculture 21(1 & 2) 177-182.

[32]. Brett J. 1979. “Environmental factors and growth.” Fish Physiology, 8, 599-675.

[33]. Wickins JF, Lee DOC 2008. Crustacean farming: Ranching and culture (2nd ed.). Ames, Iowa, USA: Blackwell Science.

[34]. Wyban, J., Walsh, W.A., Godin, D.M., 1995. “Temperature effects on growth, feeding rate and feed conversion of the Pacific white shrimp.” Aquaculture 138, 267-279.

[35]. Abdelrahman, HA, Abebe, A and Boyd, CE, 2018. “Influence of variation in water temperature on survival, growth and yield of Pacific white shrimp Litopenaeus vannamei in inland ponds for low- salinity culture.” Aquaculture Research 1-15.

[36]. New MB. “Commercial freshwater prawn farming around the world.” In: New MB, Valenti WC. (eds), freshwater prawn culture: The farming of Macrobrachium rosenbergii, Blackewll Science, UK. 2000;290-325.

[37]. Mazid MA. “Training manual on water quality management in shrimp farm Bangladesh quality support program fisheries.” UNIDO, DHAKA, Bangladesh. 2009;108.

[38]. Ponce-Palafox J, Martinez-Palacios CA, Ross LG, 1997. “The effects of salinity and temperature on the growth and survival rates of juvenile white shrimp, Penaeus vannamei, Boone, 1931.” Aquaculture, 157:107-115.