

# Rearing and Production Performance of Freshwater Mud Eel, *Monopterus Cuchia* in Different Culture Regimes

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**Abstract** This experiment was conducted to study the effect of different environments on rearing and production performance of freshwater mud eel, *Monopterus cuchia*. The study was conducted over a period of six months from June to November 2013. Different environments such as House tanks, Earthen ditches, Plastic tank and Back yard tanks were used. Except the earthen ditch-2 (control), all environments were fed by different biological food such as small live fish (Tilapia fry), earth worms, small dead fish, snails, small frogs and chicken viscera in different amounts. 40 fishes (approximately 1kg in weight) were stocked into each of the environment. At the end of the experiment, the highest mean of final length ( $32.89 \pm 2.65423$ ) and final weight ( $109.69 \pm 2.92777$ ) were obtained in earthen ditch-1. The weight gain in length  $17.78 \pm 0.24$  and in weight  $85.07 \pm 0.15$  with 92.5% survival and production (4.07kg) were also highest in earthen ditch-1. However, earthen ditch-2 which was used as control has also shown satisfactory results in terms of weight gain in length and weight  $14.1 \pm 0.48$  and  $66.66 \pm 0.82$  respectively with 87.5% survival. On the other hand, the lowest mean growth considering final length ( $28.45 \pm 2.80092$ ) and weight ( $67.24 \pm 3.79328$ ) were recorded in house tank-2 while the weight gain in length ( $11.86 \pm 0.26$ ) and in weight ( $41.84 \pm 0.59$ ) were also observed in house tank-2 with the production of 2.02kg by 75% survival. Based on Pearson Correlation coefficient there were no significant correlations between lengths and weights of fish in different culture regimes. Significant value ( $P=0.000$ ) of each of the environments implies that *M. cuchia* can be reared significantly except back yard tank-1 ( $P=0.009$ ). But, in case of earthen ditch-1 the highest value was found in both length and weight with 5% significance level due to supplied live feeds. On the basis of the better growth, survival and production, it is suggested that the earthen ditch is one of the suitable culture environments of *M. cuchia*. From this study, it was also found that the live feed are suitable for obtaining highest growth performance based on the findings of plastic tank, house tanks 1 and house tank 3.

**Keywords** *Monopterus cuchia*, Rearing, Culture Environments, Production

## 1. Introduction

The freshwater mud eel, *Monopterus cuchia* is a popular delicious fish with high market price as well as contain nutritional elements [1]. This is found widely in open water resources of Bangladesh with natural care, particularly in mud holes, shallow beels (kind of water body) and paddy fields etc. However, due to its dual systems of respiration by the gills and the skin [3] this fish can thrive in various adverse conditions such as low oxygen levels, high temperature, shallow water and polluted water [2]. Like other eels, this freshwater mud eel provide different ecosystem functioning which is ecologically important in food chains, acting as predators of harmful animals and different invertebrates and being consumed in its various stages by mammals, birds and small vertebrates. The unique adaptation that allows mud eel to be successful in their environments, primarily for wedging through small openings, while some are adapted to burrowing into soft substrates or living a pelagic existence [4].

The meat of freshwater mud eel has a great demand in the world market, such as China, Indonesia, Thailand, Japan, Phillipines, Korea etc. In Bangladesh, this freshwater mud eel is now considered as an export fishery item which is playing an important role to collect huge foreign currencies as well as contribute to meet the animal protein demand [5,6]. However, their demand in Bangladesh is very low, comprise only 1.5% of the total fish landing center at different parts of the country [5]. In comparison with other fish or fishery products, the demand for freshwater eel in Bangladesh for domestic consumption is less. Generally, rejected underweight freshwater eel for export and damaged eel come to the local and urban markets for domestic consumption. Tribal people buy dead eel for their consumption due to low price can be ranged 4-5 USD per kg [6], however, it is commercially important due to its high demand for export and the value of earnings has been steadily increasing [7]. Maximum freshwater eel is being exported from Sylhet district of Bangladesh (120 tons per month) [6]. It can

generate employment directly and indirectly in terms of people employed in the marketing and other associated business while more than 8,000 fishers, traders, transporters and exporters are found to be involved in this sector [6]. *M. cuchia* is presumed a low-cost enterprise to the farmers [7] and raising this species is easy to do and achieves a more profit than other small size fish culture activities [8,9]. Though, this fish is rich in nature of Bangladesh, however, reducing this fish due to overfishing while marketing of this fish is completely depends on capture. Though, different capture techniques are established to collect this fish [10], however, no culture practice of this fish is established whereas few works have so far been done on this fish, either taxonomic, biodiversity, genetics, or in different aspects of its biology [1, 2, 6,7,11-15]. Since there is no culture system for this freshwater eel in Bangladesh, however, the preliminary observation in cemented cistern on growth, survival and diet condition of this mud eel has been done [7, 15]. In addition, this fish has also been identified for polyculture in seasonal and perennial ponds as well as in paddy fields, but it was not developed [16]. It is suggested that this fish can easily be cultured in a small tank, aquarium and other vessels. Most species adjust well to life in captive conditions and are very hardy inhabitants. A large aquarium with adequate hiding places and well-sealed lid is essential for maintaining this fish. Freshwater eel culture does not necessarily require large water bodies and expensive formulated feed [7]. Though the mud eel is quite hardy and pollution resistant, it can be profitably raised with aquatic crops like swamp cabbage [1]. But, this fish is now a vulnerable species in Bangladesh [17] because of commercial fishing, excessive use of pesticides, disease and destroying their natural habitat by different environmental stresses [11] while commercial fishing is available only. As no technology for commercial culture and production of this fish is developed in Bangladesh while supply demand is increasing day by day, therefore, it is necessary to develop a scientific eel culture system.

It is time to think about expanding freshwater eel fisheries and develop new technologies to increase its production for capture the world market. By improving cultural techniques we can earn lot of foreign currency and this will help to develop national economy of the country. Therefore, the freshwater mud eel, *M. cuchia* was observed considering suitable environments for rearing with live and dead feeds for survival and growth as well as compare the production of this fish in Bangladesh in different culture regimes. Considering high export demand and high nutritional elements of *M. cuchia*, this research work may be an alternative livelihood for people involved in fisheries sector.

## 2. Materials and Methods

### 2.1. Experimental Set up and Sample Collection

Like some previous works [7,15] the experiment was conducted in three tanks in the Fish Breeding House under the Department of Genetic Engineering and Biotechnology (GEB), Shahjalal University of Science and Technology (SUST), Sylhet. In addition, two earthen ditches and two backyard tanks were selected in a rural house, Chatak, Sunamgonj. Experiment with a plastic tank was designed in a pond of tilapia hatchery at Kamal Bazar, Sylhet. The fingerlings of this freshwater mud eel were collected from the “Seven Star Motso Arot”, Rashidpur Bazar, about 15 kilometers away from Sylhet. Fish were identified as mud eel by external morphology [18] and also by the help of local fisherman. The fish were put into a plastic cage with some water and brought to the fish breeding house of the Department of GEB, SUST carefully. Collected fish fries were divided into six categories and placed in different places such as house tanks, earthen ditches, backyard tanks and plastic tank. In each place approximately 1kg fish equal 40 individuals in number was released.

### 2.2. Shelter Management and Stocking Density

Three cemented tanks in breeding house were selected for part of this experiment. The length, width and height of each tank were 1 x 1.5 x 1 meter. Tanks were connected with regular water supply and maintained water depth in each tank with 13-15 inch. First of all, three tanks were filled with water and kept as it is for two days without fish. Then, after two days fish were placed in each tank. Two earthen ditches were selected near of a rural house, Chatak, Sunamgonj which was already made. The length, width and depth were around 4<sup>2</sup> meter with 18-24 inches depth. The earthen ditches were filled with water and maintained with 24 inch for two days without fish. One tank was constructed with bamboo and lined with plastic and measure with 1 x 1.5 x 1.5 meter which was settled down in experimental pond of tilapia hatchery at Kamal Bazar, Sylhet. In this case pond water was used for rearing fish considering 15 inch of water depth. There were water-hyacinth placed to cover the fish. Two backyard tanks were selected in the back place of a house and the length, width and height of each tank was 1 x 1.5 x 0.5 meter respectively filled with 10-12 inch of water. An amount of 1kg (40 in number) of fish was placed in each shelter. But before releasing the fingerlings, initially fishes were measured for all environments considering length and weight of fish (Table 1).

**Table 1.** Stocking rates in different environments

Culture environments	Fingerlings size (Average in cm)	Fingerlings weight (Average in g)	Number of fish	Av. weight of fish (kg)	Rearing period (month)
House tank 1	15	24.6	40	1	6
House tank 2	15.5	25.4	40	1	6
House tank 3	14	23.5	40	1	6
Backyard tank 1	14.5	23.8	40	1	6
Backyard tank 2	15.7	25.4	40	1	6
Plastic tank	13.9	23.8	40	1	6
Earthen ditch 1	14.5	25	40	1	6
Earthen ditch 2	15.7	25.5	40	1	6

**Table 2.** Given different types of feed in different environments

Name of supplied feed	Amount of different feed (g)							
	HT 1	HT 2	HT 3	BT 1	BT 2	PT	ED1	ED2
Small live fish (Tilapia fry)	100	-	50	-	-	50	-	-
Earth worms	100	-	100	150	150	50	150	-
Small dead fish	100	100	-	-	-	-	100	-
Snails	50	50	-	50	50	-	50	-
Small frog	100	100	-	100	100	100	100	-
Chicken viscera	-	-	-	50	50	-	-	-

\*HT= House Tank, BT=Backyard Tank, PT=Plastic Tank, ED = Earthen Ditch

### 2.3. Water Management for all the Culture Systems

Before construction of any culture environment, it is wiser to think about water management system including source, discharge and quality of water [16, 18, 19]. For culturing fish it is necessary to supply water regularly and without water it is quite difficult to maintain fish in alive. In this experiment different captive environments were used. Different sources of water were used for the different culture systems. Water temperature, pH and dissolved oxygen level were recorded through the experiment. For breeding house tanks, water was supplied through pipes from the submerge system. Each tank was well designed and water level was maintained about 13-15 inches. Water was exchanged within three days interval. Natural water was used for earthen ditches considering 18-24 inches deep, however, when needed water was supplied from outside. In Plastic tank, water was maintained around 15 inches and water was changed weekly by bucket from pond. In case of backyard tanks, water was supplied from the pond by plastic bucket considering 10-12 inches of deep and water was exchanged biweekly. Sometimes algae and tiny moss were used in backyard tanks and plastic tank.

### 2.4. Supplied Feed

In this experiment different types of feeds were given to the different environments for rearing and production of *M. cuchia*. Different types of feed such as small dead fish, earth worms, small live fish (Tilapia fry), snails, small frog and chicken viscera were given where few are related to the two

previous works [7,15]. Feed were supplied to each of the different environment in different amounts (Table 2). Two people were appointed for looking after fishes that were placed outside the SUST campus. Some instructions were given them to supply food in different amounts. Every time feed were given at the morning at 9 am and alternate food was supplied. Tilapia fry was used as feed and given weekly at the morning.

### 2.5. Statistical Analysis

To compare the significance of the findings, paired sample statistics for mean and standard deviation, paired sample correlations and paired sample significance test were calculated for the growth of experimental fish considering length and weight data from different environments. The statistical data was analyzed with Duncan's Multiple Range Test at 5% significance level by using Microsoft Excel Software.

## 3. Results

### 3.1. Maintained Physico-chemical Parameters of the Water

During the experiment, physico-chemical parameters such as pH, dissolved oxygen and temperature for different rearing conditions were maintained and recorded monthly. The recorded pH from 7.33 to 7.45, temperature from 23-30°C and dissolved oxygen from 4.4-5.5 were observed in

house tanks. The pH of earthen ditches were ranged from 7.30-7.45 and temperature range was from 22.3°C-30.5°C as well as dissolved oxygen was recorded from 4.5-5.5. The pH, temperature and dissolved oxygen of back yard tanks were recorded from 7.30-7.60, from 22.2°C-29.1°C and from 4.4-5.2 respectively. Finally, the pH, temperature and dissolved oxygen were recorded 7.20-7.55, 23.2°C-30.3°C and 4.5-5.5 respectively for plastic tank.

### 3.2. Observed Growth Performance of Fishes in Different Culture Conditions

Growth performance of this experiment was measured considering the length and weight parameters. After six months of experiment all fishes from different culture conditions were collected separately, and length and weight was measured (Table 3) while in house tank-1 the initial average weight and length of fish were 24.4g and 15cm respectively with 87.5% survival rate and in that case final average weight and length were found 95.15g and 30.6cm respectively. On the other hand, initial average length and weight of the 40 fishes were 15.5 cm and 25.4g respectively while survival rate was recorded 77.5% and final weight and length 67.55g and 25.05cm was recorded in the second house tank. Furthermore, in case of house tank-3, initial length and weight were 14cm and 23.3g respectively with 82.5% of survival rate and final growth was recorded with average weight and length 87.75g and 29.1 cm respectively. The average growth of the three house tanks were observed 70.75g, 42.15g and 64.45g respectively.

The initial average length and weight of the fishes were 14.5cm and 25g in earthen ditch 1 and 25.5g and 15.7 cm in earthen ditch 2 respectively. After six months of experiment the average final weight and length of the fishes were recorded 110.15g and 32.75cm respectively in earthen ditch 1 with 92.5% of survival rate whereas with 87.5% survival the final length and weight was recorded 30.2cm and 91.65g respectively in earthen ditch 2. Finally the average growth of

each of the ditch was found 85.15g and 66.15 g respectively (Table 3). Again, the average final length and weight were found 29.1 cm and 87.15g respectively in the plastic tank whereas the initial average length and weight of fishes were 13.9cm and 23.8g respectively (Table 3). The average growth of plastic tank was recorded 63.35 g with 82.5% survival of fish. Growth performance of collected fish from backyard tanks has been studied where the average initial length and weight were found 14.5cm and 23.8g respectively and the final length and weight in average were recorded 25.1cm and 67.65g respectively for the backyard tank 1. Survival rate was found 75% in backyard tank 1 where 77.5% was observed in back yard tank-2. Another observation was seen in backyard tank 2 where the average initial length and weight were observed 15.7cm and 25.4g and the average final length and weight were recorded 25.4cm and 68.55g respectively. The average growth in back yard tank-1 and 2 were found 43.85g and 43.15g respectively.

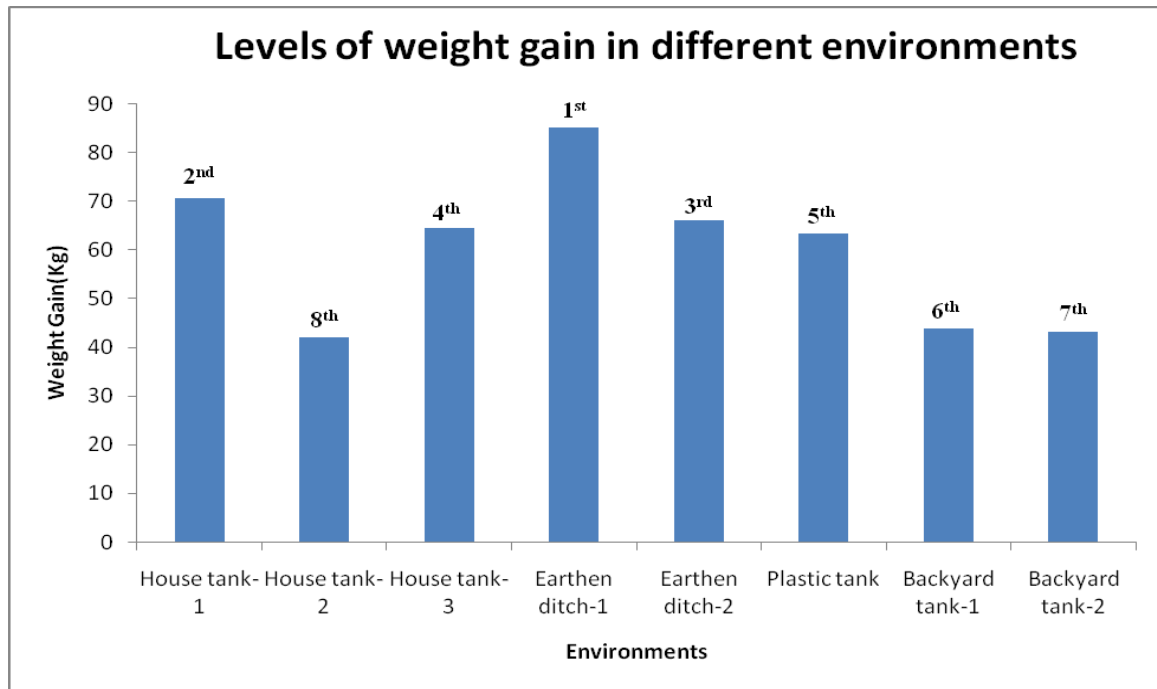
### 3.3. Distinguish Growth from Different Culture Regime

At the end of the experiment, average growth performance of *M. cuchia* in different environments was situated in figure 1. The highest average growth (85.15g) was found in earthen ditch-1 where the different external feed was supplied with natural food and the lowest growth (42.15g) was recorded in house tank-2 where small dead fish was given. Second highest growth was found in house tank-1 (70.75g) where live feed was given. Despite of maintaining as a control, it was found that the average growth was recorded 66.15 g in earthen ditch-2 which was third position in case of growth of experimental fish with only natural food. The fourth highest growth was found from house tank-3 (64.45 g) where only live feed was given, followed by plastic tank (63.35 g), back yard tank-1 (43.85 g) and back yard tank-2 (43.15 g) respectively.

**Table 3.** Observed growth performance of *M. cuchia* in different environments

Environments	IL (Av. in cm)	FL (Av. in cm)	IW (Av. in g)	FW (Av. in g)	Survival (%)	Growth (g)
House tank-1	15	30.6	24.4	95.15	87.5	70.75
House tank-2	15.5	25.05	25.4	67.55	75	42.15
House tank-3	14	29.1	23.3	87.75	82.5	64.45
Earthen ditch-1	14.5	32.75	25	110.15	92.5	85.15
Earthen ditch-2	15.7	30.2	25.5	91.65	87.5	66.15
Plastic tank	13.9	29.1	23.8	87.15	82.5	63.35
Backyard tank-1	14.5	25.1	23.8	67.65	80	43.85
Backyard tank-2	15.7	25.4	25.4	68.55	77.5	43.15

\*IL = Initial Length, FL = Final Length, IW = Initial weight, FW = Final weight, WG = Weight gain



**Figure 1.** Growth performance of *M. cuchia* in different environments

**Table 4.** Production performance of fish in different environments

Environments	Final harvest (No.)	Weight gain (g)		Production (kg)
House tank-1	35	70.75	L= 15.38 ± 0.13 W= 71.15 ± 1.86	3.3
House tank-2	30	42.15	L= 11.86 ± 0.26 W= 41.84 ± 0.59	2.02
House tank-3	33	64.45	L= 15.07 ± 0.39 W= 65.01 ± 0.38	2.89
Earthen ditch-1	37	85.15	L= 17.78 ± 0.24 W= 85.07 ± 0.15	4.07
Earthen ditch-2 (Control)	35	66.15	L= 14.1 ± 0.48 W= 66.66 ± 0.82	3.2
Plastic tank	33	63.35	L= 16.45 ± 0.61 W= 62.74 ± 0.65	2.87
Backyard tank-1	31	43.85	L= 5.1 ± 1.04 W= 44.05 ± 1.45	2.09
Backyard tank-2	31	43.15	L= 10.46 ± 1.02 W= 42.7 ± 0.82	2.12
Total	265	479.00	-	22.56

### 3.4. Production Performance of Experimental Fish in Different Environments

Based on Paired Sample Statistics, it has been shown that the highest mean final length ( $32.89 \pm 2.65423$ ) with weight gain in length  $17.78 \pm 0.24$  and final weight ( $109.69 \pm 2.92777$ ) with weight gain in weight  $85.07 \pm 0.15$  both was recorded in earthen ditch-1 whereas lowest mean of final length ( $28.45 \pm 2.80092$ ) with weight gain in length

$11.86 \pm 0.26$  and final weight ( $67.24 \pm 3.79328$ ) with weight gain in weight  $41.84 \pm 0.59$  was in house tank-2. Pearson Correlation coefficient has been calculated for each environment for both length and weight of *M. cuchia*. Here, correlation coefficient was calculated as a pair such as initial length, final length and initial weight, final weight and it was clearly indicating that there were no significant correlations ( $<0.00$ ) between these pairs. Descriptive statistics gives an indication that earthen ditch-1 gives more mean value in both

length and weight. Paired sample t test was done since we have the same object for measure before and after intervention. For each of the environments ( $P=0.000$ ) implies that *M. cuchia* can be reared significantly except back yard tank-1 ( $P=0.009$ ). But, in earthen ditch-1 it was up to 95% confidence level due to supplied live foods. In case of earthen ditch-1 mean values were highest so it may be suggested to implement with earthen ditch-1 for getting better production.

Growth performance of experimental fishes collected from all different environments showed satisfactory results. The highest production was found in earthen ditch-1, where 37 fishes were found representing an amount of 4.07kg of fish (Table 4). Conversely, the lowest growth performance was found in house tank-2 showed the opposite of this study having the least figure (2.02kg) out of the eight categories (Table 4). Another significant production was found 3.3kg of fish in house tank-1. The growth performance of rest of the environments such as back yard tank-1 and 2, plastic tank, house tank-3 and earthen ditch-2 were recorded 2.09kg, 2.12kg, 2.87kg, 2.89kg and 3.2 kg of fish respectively. After six months, total amount of 22.56kg fish was found from 265 harvested individuals (Table 4).

#### 4. Discussion

The present study was conducted to determine the suitable environment for the best rearing and production performance of freshwater mud eel, *M. cuchia*. Considering different environments such as house tanks, earthen ditches, plastic tank and back yard tanks growth performance was recorded highest in earthen ditch-1 in terms of weight gain (in length  $17.78 \pm 0.24$  and in weight  $85.07 \pm 0.15$ ) and survival (92.5%). Conversely, growth performance in terms of weight gain (in length  $11.86 \pm 0.26$  and in weight  $41.84 \pm 0.59$ ) and survival (75%) was lowest in house tank-2. The supplied feed in earthen ditch-1, were earth worms, snails, small dead fish and small frogs. Besides, in house tank-2, chicken viscera, small frogs, snails and small dead fish were supplied. The production performance in the present study was quite satisfactory after six months observation. The second highest growth performance in terms of weight gain was in house tank-1 (in length  $15.38 \pm 0.13$  and in weight  $71.15 \pm 1.86$ ) whereas supplied feed were given earth worms, small dead fish, small frogs, small live fish (Tilapia fry) and snails. The highest growth  $310.63 \pm 17.59$ g was found as weight individually in rice field culture in five month of experiment [16] which is differ from the present findings. Although, the environmental conditions were same but different amount of supplied feed has different impacts on growth performance of fishes from tank-1, 2 and 3. In the present study, it was observed that the earthworms and small live fish (tilapia) were the best among all other supplied foods for better growth performance of freshwater mud eel, *M. cuchia*. As soon as the feed were supplied they engulfed it quickly. Narejo *et al.*, [7] reported that this fish which were cultured

in cemented cisterns with dead fish and found well growth, however, this study completely disagrees with some previous findings in freshwater mud eel as well as other eel fish [1,7,20,21] while this study found that earth worms and small live fish (Tilapia fry) were effective for better growth performance of *M. cuchia*. On the other hand, this findings with mostly related with findings of Chakraborty *et. al.* considering the same types of foods use [16].

For better growth and development optimum temperature is a key factor. In this study, increasing weight gain was found during June to November, 2013 with optimum water temperature was 19-31°C, suitable for freshwater eel, *M. cuchia* and similar result was found by Narejo *et.al.* [7]. Nasar [1] reported an ideal temperature of 20-35°C for proper feeding and growth of *M. cuchia*. Usui [21] reported that below a temperature of 12°C *A. japonica*, *A. anguilla* and *A. rostrata* do not feed and thus do not grow at all. In the present study, the increasing trend of mean growth (final length and weight) was found in earthen ditch-1. Insignificant correlations were observed between the growth parameter in all environments. In this study, paired t-test gives significant values at 95% significant level ( $P=0.000$ ) in almost all the environments and highly significant result was found in backyard tank-1 ( $P=0.009$ ). It may be due to the effect of surroundings. The survival rate of fish fed with small live fish (Tilapia fry), earthworms, frogs, chicken viscera, snails and small dead fish ranged from 75% to 92.5% while highest survival rate was in earthen ditch-1 and lowest in house tank-2. Nahar *et al.* [22] and Narejo *et al.* [14] reported quite different survival rate (83%) in *C. gariepinus* and (70%) in snake eel, *P. boro* respectively when fed with dead small fish.

The total production of fish ranged from 2.1 kg to 4.07kg by 6 months of this experiment where Narejo *et al.* [7] found the total production of fish ranged from 0.241 to 0.624 kg/m<sup>2</sup>/year. Besides, highest production of fish was in earthen ditch-1 (4.07 kg) might be due to greater survival rate and lowest production was in house tank-2 (2.1 kg). The second highest production was in house tank-1 (3.3 kg) followed by earthen ditch 2 (3.2 kg). In case of earthen ditch-1, survival rate, growth performance and production were higher than the other environments. In earthen ditches there was enough space for mud eel to move around and hide. This natural environment allows mud eel to mature better than the others. In breeding house, three tanks were in same environmental conditions, but, different foods in different amounts cause variation in growth performance and production of the three tanks. The production from plastic tank is quite well (2.87 kg) while the food such as live small fish (Tilapia fry), earth worms and small frog were given in plastic tank. In backyard tank 1 and 2 the amount of given food were same. So, growth performance was nearly 2.16 kg and 2.12 kg respectively. It was clear from the present study that mud eel shows its best growth performance and production in natural environment.

## 5. Conclusions

The freshwater mud eel is a well established export product that will be made a great contribution in national economy of Bangladesh and its culture could be considered as an alternative option for poor people and immersing trade for fishery products traders while eel aquaculture industry is completely absent only capture based fishery practice are performed [23]. Comparing different culture regimes earthen ditches is the best one for proper maintaining and rearing of *M. cuchia* in terms of yield and profits. Though, tank systems were found more productive with live feed than others, however, to build up tanks and to buy live feed may cost effective for rural people which may not be economically feasible to them, rather earthen ditch will be prepared surrounding the house and maintain of culture will be very easier. Promoting social awareness about the nutritive value and export demand of this fish among the rural people can be encouraged to involve in culturing mud eel as an alternative livelihood. This can be a profitable sector for those involved in fisheries as it requires less capital.

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