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Research Article

Evaluating the Economic Viability of Floating Duck House and Growth Performance of Jinding Ducks under Semi-Intensive Rearing

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Abstract

The study was aimed to observe the feasibility and economic viability of the floating duck house (FDH) and evaluate the growth of Jinding ducks reared on the floating duck house. The FDH house was constructed with locally available materials. The length and width of the FDH were 18 feet and 14 feet respectively. A total of 150-day-old ducklings were collected and reared up to 12 weeks of age to observe the growth performance of Jinding ducks. After completion of brooding of ducklings in a brooder house, the ducks were then transferred and reared on the FDH. The ducklings were fed a starter diet up to 4 weeks of age and self-formulated feed up to 12 weeks of age. During the experimental period, feed intake, live body weight, body weight gain, feed conversion ratio (FCR), survivability and benefit-cost ratio were recorded and calculated. The result showed that the Factor of Safety (Fs) of the FDH was 4.04 that is higher than recommended minimum suggested value (2.5), asserting the ability of the FDH to float with this existing load. The average final body weight, body weight gain, feed intake, and FCR were determined to be 1647.25 g/bird, 1605.35 g/bird, 5099.42 g/bird, and 3.18 respectively after calculating all growth data. About 96.67% of ducks were survived during this experimental period, and the net profit was Tk. 42.51/-.per kg live birds. Thus, it can be inferred that raising ducks in floating duck houses specially designed for low-lying areas such as *haor* would be a suitable option to ensure the profitability and economic viability of the duck farming enterprise.

Introduction

Since the beginning of the twenty-first century, Bangladesh's poultry sector has grown into an unrivaled means of rapid profit, local job creation, and low-cost animal protein production. The poultry sector of the country mostly produces chicken, but duck, pigeon, quail, goose, turkey, and guinea fowl are available year-round (Das et al., 2018). Duck is a promising species of poultry in Bangladesh (Jha and Chakrabarti, 2017). The climate and environment of Bangladesh are suitable for duck habitation and the country's numerous bodies of water make duck production possible. Asia considerably contributes to the global duck population, with China, Vietnam, Indonesia, Malaysia, and Bangladesh being the primary countries with higher duck numbers. Moreover, Bangladesh is the most densely populated country with ducks in the world having a total of 64.75 million of ducks with an average of 438.8 ducks per square kilometer (Jalaludeen and Churchill, 2022), which are typically raised by small and medium sized farmers (DLS, 2022). According to Islam et al. (2003), duck meat and eggs account for 30% of overall poultry meat and egg consumption. Because of the problem with antibiotic resistance, people prefer duck meat to chicken, and making the species a good and stable source of protein in our society. In addition, duck production has a lot of benefits. The birds are simple to rear, since they do not require much room for rearing and the input in terms of feed, housing facilities and management requirement are manageable under the traditional manner of raising. Furthermore, unlike chickens, ducks are resilient reasonably immune to common diseases, and exhibit no cannibalism or agnostic behavior (Batty, 1985; Ahmed and Islam, 1986;

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Banerjee, 1992). They are also effective exterminators of potato beetles, grasshoppers, snails and slugs as well as reduce weeds and pests of rice fields which ultimately help the farmers in crop management and production (Manda et al., 1993; Edar et al., 1996). Although, ducks are raised throughout the country, they are particularly popular along the coast and in low-lying areas such as the north-east and south. Because the regions are blessed with an abundance of surface water, the agricultural lands in these regions become submerged for over 8 months of the year, making them ideal for duck production. Ducks plays an important role in poultry production in *haor* basin, the costal belt and the low-lying areas of Bangladesh, producing meat and eggs, while also generating cash for the needy people. Duck rearing has had a stronger socioeconomic and economic empowerment of *haor* women (Khanum and Mahadi, 2015). Khaki Campbell, Jinding, Indian Runner, Nageswari, *Deshi* White and *Deshi* Black are the egg type duck breeds available in Bangladesh with the first three being exotic and most popular, commonly preferred by our farmers. Islam et al. (2012) noted that practically every family in the *haor* region owns a few ducks (5 to 100 birds/family), especially during the rainy and autumn season, when the natural feed resources such as snails, fish, pests, various aquatic weeds etc. become available and abundant in water bodies surrounds the localities.

Adult ducks are reared in the *haor* region using intensive and/or semi-intensive rearing system, where the birds are housed in various '*baors*'. '*Baor*', is local term referring to a temporary small duck shelter composed of bamboo, *tin* and wire net. Parent breeder ducks are kept in *'baors'* for a specific period, typically a few days to obtain natural feeds from those specific areas. Once the feeds are finished, the duck flock along with the shelter (*tin*, wire net, bamboo and other belongings) relocate to a new place. It's a continual method of raising ducks in *haor* and low-lying water dwelling areas of the country. So, the duck farmers confront significant challenges are not only moving of ducks and ducks from one location to another but also predators 'attacks, rain, heat stress, natural calamities, disease contaminations that affects bird's performance and thereby farm profitability. Keeping all aforementioned issues in mind, a novel duck rearing technique on a FDH was tested in Bangladesh Agricultural University (BAU) Poultry Farm to determine the growing performance of meat-type ducks, feasibility and economic sustainability of the system in small-scale duck rearing.

Materials and Methods

The whole experimental works were divided into two distinct phases. The first phase involved the construction of a floating duck house at BAU Poultry Farm, whereas the second phase focused on observing the growth performance of layer type ducks that were raised in the constructed floating duck house. The duck house was suspended on the pond at BAU Poultry Farm.

Phase-I: Construction of the (FDH)

Development of Basic Concept, Collection of Raw Materials and Construction of the (FDH)

Due to the novelty of this project in Bangladesh, there was a lack of knowledge on the construction of the proposed FDH. Nevertheless, a comprehensive dialogue was conducted with several relevant specialists to elicit essential details regarding the FDH. Discussions were held with the Professors of the Department of Farm Structure and Environmental Engineering at Bangladesh Agricultural University, as well as stakeholders from *haor* and low-lying areas, duck keepers from various regions, and livestock experts in the relevant field. An initial concept was thereby developed on the construction, durability, feasibility, and overall cost of the potential construction project. The creation of the floating duck house involved the utilization of many raw materials, with plastic barrels being the primary material. A total of 20 plastic drums, weighing approximately 10 kg each, were obtained from the local market in Mymensingh town. Prior to selecting plastic drums as the floating material, significant consideration was given to their durability, strength, thickness in relation to weight, and water absorbency factor. The primary frame of the house was built using 30 pieces of 1.5-inch angle, weighing a total of 291 kg. Additionally, 21 pieces of 1-inch angle, weighing 159.4 kg were also obtained. The selection of materials was done with great attention to quality. Bamboo was utilized as slat materials for constructing a floating duck house. The roof was constructed using a ¾ inch plain sheet, weighing 53 kg, which was obtained from the local market. Additionally, several other raw materials, including farrow sheet, cutting paper, *tarkata*, GI *tar*, wire net, and paint, were procured. The frame design of the house was devised by an agricultural engineer and it was a gable type open-sided structure. The slat and roof were created by a carpenter, while the house's fencing was provided by wire net. The roof was constructed using a flat sheet, with an additional one-foot extension on each side of the house to provide a comfortable resting place for ducks while they scavenge. After the construction was finished, the duck house was subsequently placed on the surface of the pond water at BAU Poultry Farm. The house was effectively floated in the pond water, indicating that the design and construction of the trial house were flawless.

Phase-II: Observation of the Growth Performance of Layer-Type Ducks Reared on the FDH at BAU Poultry Farm

House preparation, collection of birds, brooding and other managements:

An open-sided shed type house was considered for brooding of experimental ducklings. Prior to placing the ducklings, the house underwent thorough cleaning, disinfection, and a resting period of at least 7 days. The essential equipment, including as feeders, drinkers, brooders, etc., were appropriately cleaned and disinfected. The ceiling, walls, and floor were meticulously cleaned using detergent and bleaching powder. The entire room was disinfected with potassium permanganate. The brooder and brooder guard, as well as the drinkers and feeders, were properly placed and checked before the ducklings arrived. The brooding was performed at the brooder house for initial four weeks during the winter season. Throughout the brooding phase, the ducklings got the same level of care and management. Brooding was carried out in two electric brooders furnished with 200-watt electric lamps suspended as the heat source. The temperature was then gradually reduced by lifting the bulbs as needed, taking into account the comfort of the ducklings. To maximize the brooding temperature, changes were made to the number and type of bulbs utilized, such as switching from 100-watt and 200-watt lighting. A thermo-hygrometer was suspended at the same height as the birds in the brooder to measure and monitor the temperature and relative humidity throughout the brooding period.

Feeding, Watering, Light Management and Vaccination of the Ducklings

Appropriate feeders and drinkers were provided based on the number and age of the experimental ducklings and mature ducks. During the brooding period, 6 round type drinkers and 3 plate type feeders were provided for 150 ducklings. However, as the bird became matured the number of both feeders and drinkers were increased individually to 10, where each feeder and drinker was accessible to 15 ducks. The feeders and drinkers underwent a thorough washing and cleaning twice daily. As commercial duck feed was not readily available, thus the ducklings were given broiler starter feed from day-old to 4 weeks of age. From 5 to 12 weeks, they were then provided with a hand-mixed feed. Feeds were provided thrice daily, while fresh water was accessible continuously. Table 1 shows the specific nutritional composition of commercial broiler starter feed and hand-mixed grower feed.

Table 1. Feed ingredients and chemical composition of the commercial starter feed and self-formulated grower diet fed to the experimental ducklings

Starter feed (1-4 week)		Grower feed (5-12 weeks)			
		Composition of ingredients		Chemical composition	
Nutrients	Amount	Name of the ingredients	Amount (kg) in 100 kg mixed feed	Nutrients	Amount
ME (Kcal/kg)	3000	Maize	45.6	ME(Kcal/kg)	2900
CP (%)	23	Rice polish	19.18	CP (%)	22
Calcium (%)	0.95	Soybean meal	22.5	Calcium (%)	0.65
Av. Phosphorous (%)	0.45	Protein concentrate	8.3	Av. phosphorus (%)	0.40
Lysine (%)	1.05	Wheat bran	2.4	Lysine (%)	0.90
Methionine (%)	0.45	Methionine	0.15		
Moisture (%)	12	Lysine	0.05		
Fiber (%)	5	Oil	0.1		
		Di-calcium hosphate	0.75		
		Limestone	0.35		
		Grower premix	0.25		
		Common salt	0.37		
		Total =	100 kg		

ME = Metabolizable energy, Kcal = kilo calorie, kg = kilogram; Av.=Available

The initial three days were characterized by a continuous 24-hour period of lighting, which was then reduced in duration over time. Following their period of brooding, the birds were consistently exposed to natural daylight throughout the day, while electric lamps were utilized at night to ensure sufficient illumination. The temperature (◦C) and relative humidity (%) were recorded three times a day using thermo-hygrometer. After completion of the brooding period, the ducklings were transferred to a floating duck house with a floor area of 1.68 square feet per bird. The birds had the identical care and management during the entire growing period. During day time, the ducks were left to scavenge on the pond where they freely moved on the water and also had access to duckweeds, azolla, snails, small fishes, insects, phytoplankton and other natural sources of feeds. They were also allowed to spend their time in pond for scavenging, swimming, preening and cleaning their body and also allowed to express other natural behaviors that they usually preserve. The ducks were vaccinated against duck plague vaccination on Day 28, with a booster dose on Day 35. Duck cholera vaccine was also administered on Day 56, with a boosteer dose administered on Day 65.

Records keeping and benefit-cost analysis

Recordings were made of all essential parameters related to growth performance such as body weight, body weight gain, feed intake, FCR and mortality up to 12 weeks of age. Weekly records of feed consumption were maintained until the final week, and the feed conversion ratio was then computed. The ducklings were weighed on a weekly basis in the early morning before to being fed. A digital weighing scale was used to measure the birds' weight, and the weekly increase in weight was subsequently determined based on the recorded weights each week. Records of dead birds were diligently maintained, and the rate of survival was determined by considering the initial population size of birds at the start of the experiment. For the purpose of conducting a benefit-cost analysis, detailed records were kept for each individual cost item associated with the experiment. These included expenses such as the purchase of ducklings, feed, depreciation of housing and equipment, vaccines, medicine, litter materials, electricity, labor, and any other relevant expenditures incurred over the entire experimental period. Finally, the cost benefits were calculated in terms of per bird and per kg of body weight.

Results and Discussion

Floating Capacity Calculation

Floating capacity refers to material's intrinsic ability of a material to support a load while in a floating state. It is depended on the volume of specific material. The volume of an item must be calculated by taking into account both its diameter and height. The buoyant material used in the investigation was plastic drum with a diameter of 2 feet and a height of 3 feet. The load capacity of a single drum = (Volume of a drum × Water in a cubic foot space), = $(\frac{\pi d^2 h}{4} \times 28.31)$, = $(\frac{3.1416 \times 2^2 \times 3}{4} \times 28.31)$, = 266.79 Kg. So, total capacity of 20 drum/s = (266.79 ×20), = 5335.8 kg.

Total Load Calculation

There was a total of 20 plastic barrels used as the primary floating material for the FDH. Each of them has a weight of around 10 kg, resulting in a total weight of 200 kg. The structure of the floating house was constructed utilizing 1-inch and 1.5-inch angle iron with *pati*. A combined quantity of 30 units of 1.5-inch angle (equivalent to 291 kg), a total of 21 units of 1-inch angle (equivalent to 159 kg), and 0.75 inches of *pati* (weighing 50 kg) were utilized. A total of 16 plain sheets, each measuring 8 ft × 2.5 ft and weighing 56 kg in total (3.5 kg per sheet), were utilized for the ceiling. The floating house's slat was constructed using a 20 kg bamboo material. A total of 17 plastic round feeders and 17 round plastic drinkers, weighing a combined 5 kg, were utilized for the purpose of feeding and drinking. A total of 200 kg of grain was stored for the birds on the floating house. The floating house had a maximum capacity of 166 ducks, with each duck weighing an average of 1.65 kg. The cumulative weight of the birds amounted to 274 kg. A labor was employed to raise these birds, who had an approximate body weight of 65 kg.

Calculation of total load of floating duck house is given below:

Name of the materials used	Weight of each material
Drum	=200 kg
Angle and *pati*	=500 kg
Plain sheet	=56 kg
Slat	=20 kg
Duck weight	=274 kg
Feed weight	=200 kg
Equipment	=5 kg
Labor weight (1)	=65 kg
Total	**=1320 kg**

Factor of safety (Fs) = $\frac{5335.8}{1320}$ =4.04

The Fs quantifies the degree to which a system surpasses the necessary strength for a given load, or the structural capability of a system beyond the anticipated or real loads (Muvunzi et al., 2022). The minimum suggested value for the Factor of Safety (Fs) is 2.5, considering both ends bearing and shaft resistance. Based on current research, the overall weight is 1320 kg, while the load capacity of the floating house is 5335.8 kg. The determined factor of safety is 4.04, indicating that the structure is capable of securely sustaining weights of up to 404 tons, surpassing the acceptable threshold. The total weight of our floating duck house is only 1320 kg. The floating duck house is designed to support the weight of labor, feed, and ducks while remaining buoyant.

Overall growth performance of the experimental ducks reared on the constructed FDH

Table 3 shows the overall growth performance of Jinding ducks of various ages reared on the FDH, including live body weight, body weight gain and feed intake. The ducks attained final body weight of 1647.25

g/bird at 12 weeks of age. The body weight gain of ducks noticeably increased from 110.5 g/bird in the first week to 153.11 g/bird by the third week. Interestingly, the trend of body weight gains gradually reduced thereafter with the advancement of age. The average weight of ducks reared on floating houses (1647.25 g/bird) exceeded the average weight of Jinding ducks (1428.25 g/bird) reared using traditional village husbandry methods as reported by Islam et al. (2012). In addition, Zhang et al. (1988) demonstrated that the body weight of Jinding ducks at 150 days old was 1500g, which was somewhat less than the body weight seen in our study, where Jinding ducks were raised for 84 days. The ability of ducks to scavenge and engage in natural behaviors such as paddling and preening etc. freely during daytime might have contributed to the increased body weight observed in ducks reared on floating duck houses.

Table 3. Weekly average body weight, body weight gain and feed intake of the experimental ducks reared on floating duck house

Age (Weeks)	Initial body weight (g/bird)	Final body weight (g/bird)	Body weight gain (g/bird)	Feed intake (g/bird)
1	41.90	152.40	110.50	179.00
2	152.40	295.73	143.33	248.32
3	295.73	448.84	153.11	315.47
4	448.84	597.25	148.41	402.66
5	597.25	739.33	142.08	434.98
6	739.33	869.16	129.83	445.48
7	869.16	1002.23	133.07	483.76
8	1002.23	1137.08	134.85	515.22
9	1137.08	1270.66	133.58	520.18
10	1270.66	1399.92	129.26	513.56
11	1399.92	1527.02	127.10	522.49
12	1527.02	1647.25	120.23	518.32
Total			**1605.35**	**5099.42**

Furthermore, Kabir et al. (2007) found final weight of 1.60 kg, 1.63 kg and 1.42 kg, respectively in both supplemented and control group of ducks reared under semi-scavenging system but in present study, we observed a similar body weight of ducks reared on floating duck house without any supplemental diet. The weekly average body weight gain of experimental ducks (120.23 g) in present study was higher than that of the findings of Islam et al. (2012) who reported a body weight gain of 97.62 g at 12 weeks of age. Another study by Parvez et al. (2020) reported a lower body weight and body weight gain of 1100 g/bird and 12.69 g/bird/day; 1256.66 g/bird and 14.55 g/bird/day at 12 weeks of age in treatment groups, where 25 g and 50 g feed were supplemented along with scavenging at *haor* area.

The weekly FCR of Jinding ducks reared on floating duck house represented in Figure 1.

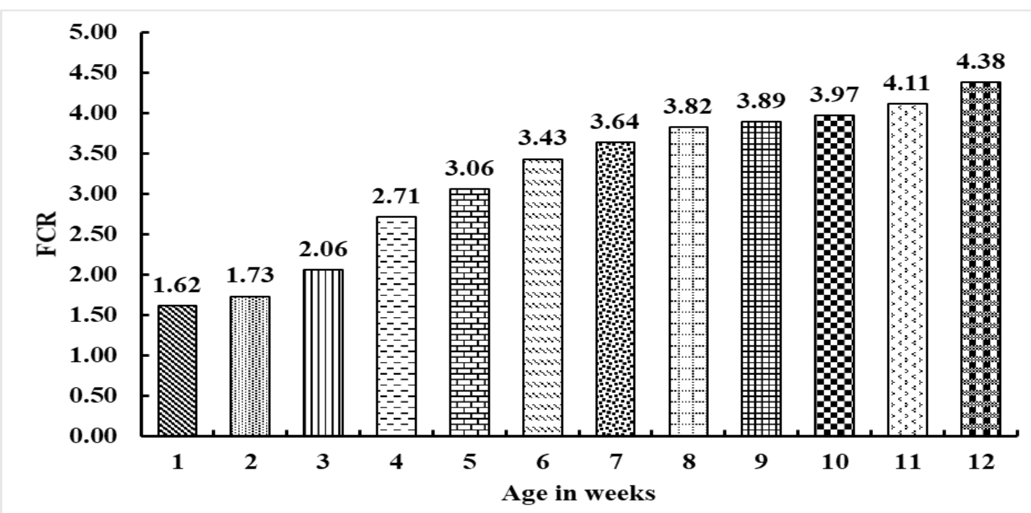

Figure 1. Weekly FCR of Jinding ducks reared on FDH (Floating Duck House)

In this study, feed intake and FCR followed the upward trends with the advancement of rearing period. Whereas the average feed intake and FCR was 179 g/bird and 1.62 in the first week of age, it gradually increased as the birds aged. The average and cumulative feed intake of Jinding ducks at 12 weeks of age were 518.32 and 5099.42 g/bird, respectively. The final FCR at 12 weeks of age was 4.3 with an average of 3.18. Moreover, Parvez et al. (2020) also claimed that the highest and cumulative feed intake of Jinding ducks at 12 week of age rearing under fully scavenging system in *haor* areas of Bangladesh were 3667.48 g/bird and 2266.64 g/bird with FCR of 2.06 and 2.91, respectively in 50 g and 25 g dietary feed supplemented groups.

Figure 2 shows the Survival rate (%) of Jinding ducks raised on FDH. Death was observed only at an early age up to 4 weeks and thereafter no mortality was found up to this rearing period.

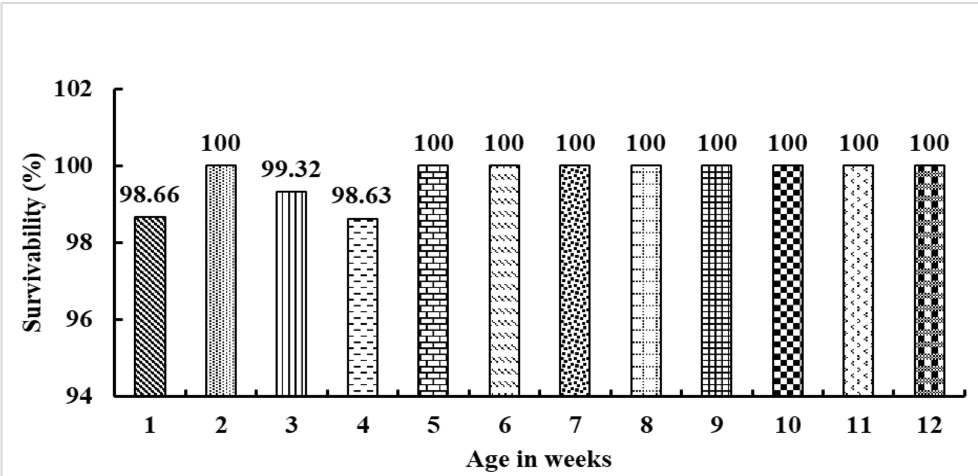

Figure 2. Survivability (%) of Jinding ducks reared on floating duck house

The current study represented about 98.66%, 99.32% and 98.63% survivability at 1, 3 and 4 weeks of age, respectively. During the experimental period, a total of 5 birds were died. Result showed 96.67% survivability of Jinding ducks during this experimental period. However, Parvez et al. (2020) observed 88-89% mortality in Jinding ducks up to 12 weeks of age rearing under fully scavenging condition in *Haor* areas of Bangladesh. Islam et al. (2012) also claimed 82.23% survivability of Jinding ducks in his study at Barishal and Bhola regions. These referred data showed relatively lower survivability than our present study.

Benefit-cost analysis of FDH

The costs and profit margin of raising Jinding ducks using a semi-scavenging system in a FDH are displayed in Table 4 and 5. The construction of the floating duck house incurred a total expenditure of tk. 94,964.

Table 4. Total expenditure for the construction of floating duck house

Materials used	Amount	Unit price (Tk.)	Total (Tk.)
Plastic drum	20 Piece	1350.00	27000.00
Angle (1.5 inch)	30 Piece	68.50	19935.00
Angle (1 inch)	21 Piece	63.00	10050.00
Angle *pati* (3/4 inch)	50 kg	58.00	3074.00
Ferro sheet and cutting paper	-	-	940.00
Lock	1 piece	95.00	95.00
Color	1 pot	1400.00	1400.00
Plane sheet	-	-	15870.00
Carpenter cost	-	-	20600.00
		Total =	**98,964.00**

Considering the depreciation cost, the total cost per duck for housing is tk. 16.5. This calculation assumes that the floating duck house has a durability of approximately 12 years and can accommodate 166 birds per batch, with a total of 3 batches reared per year. The market price of the mature ducks was Tk. 200.00 per kg bird, resulting an average income is 321.00 tk. per duck. Result showed tk.68/duck profit margin from 12 weeks Jinding ducks which representing 43.94% with a benefit cost ratio of 1.268.

Table 5. Benefit-cost analyses of the experimental ducks reared on the floating duck house

Parameters	Amount
Expenditure	
Cost of duckling (Tk./duckling)	20.00
Feed cost (BDT. @ 41 Tk./kg) (Tk./duck)	205.00
Medicine and vaccination cost (Tk./duck)	1.50
Miscellaneous (Labor, electricity, transport, litter etc.) (Tk./duck)	10.00
Total housing cost (Tk./duck) (considering durability 12 year, 3 batch per year, shed area 252 sq. ft., capacity 166 ducks)	16.50
Total cost (Tk./duck)	**253.00**
Income	
Duck sale (Tk./duck) (BDT. @ 200 Tk./kg)	321.00
Profit margin (Tk./duck)	68.00
Profit margin (Tk./kg duck)	42.51
Profit margin (%)	26.88
Benefit-cost ratio (BCR)	**1.268**

According to Islam et al. (2012), the profit margin for growing Jinding ducks for a period of 3 months was tk. 89.10 per duck, with a percentage profit margin and benefit cost ratio of 55.38% and 1.55, respectively. In a different study, Parvez et al. (2020) also claimed 38 tk. & 26 tk. net returns per bird with a benefit cost ratio of 1.30 and 1.10 of Jinding ducks reared in *haor* area supplemented with 25 g and 50 g feeds/bird, respectively. Hence, based on the aforementioned facts, it is evident that raising ducks in a floating shed using a semi-scavenging system is a more profitable and may be a lucrative option for the farmers who opt to raise small numbers of ducks at *haor* area.

Summary and Conclusion

An affordable low-cost 'floating duck house' can be constructed with readily available local resources. By raising ducks on a floating duck house, farmers have the flexibility to move the house wherever and whenever necessary, allowing for convenient access to natural feed resources. This approach greatly lower production costs while increases the profitability of duck farming. As a result, adopting the practice of raising ducks in FDH might be considered as better alternative to the conventional *'baor'* systems in *haor* and other low-lying areas, to ease the rearing process and enhancing the overall performance of the ducks.

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